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Ageing and the Balance of Care

An Investigation into the Relationship between and Determinants of Acute Hospital Bed and Long-Term Care Utilisation

A dissertation submitted to the University of Dublin
for the Degree of Doctor of Philosophy

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June 2011

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Summary

The central theme of this thesis is the effect of ageing on the balance between acute and long-term care (LTC). The thesis comprises two separate but related enquiries. The first enquiry is an econometric analysis of the drivers of acute bed and long-term care utilisation across member countries of the Organisation for Economic Co-operation and Development (OECD). The second enquiry is an examination of long-term care supply and demand in Ireland which includes: analysis of the first comprehensive, longitudinal Irish data on disability prevalence; and the development of a statistical model predicting demand for residential long-term care, based on projected demographic change, trends in disability rates in older age and a policy of reconfiguring care from the acute to the community and long-term care sectors.

The central findings in the model of acute bed utilisation for a panel of 17 OECD countries over the years 1985-2006 are:

- Deaths are a significant upward driver of acute bed utilisation;
- Deaths of people aged 35-74 are significant upward drivers of acute bed utilisation while deaths of people aged 75-84 are insignificant when the panel is restricted to countries where most deaths at older ages occur outside hospitals;
- Conversely, deaths of people aged 75-84 are significant upward drivers of acute bed utilisation while deaths of people aged 35-74 are insignificant when the panel is restricted to countries where most deaths at older ages occur within hospitals;
- Convergence between male and female life expectancies has reduced acute bed utilisation at most values for population age, and may reflect the availability of older partners to care for one another and better health among older people;
- Female labour force participation (FLFP) is insignificant in its effect on acute bed utilisation across the full panel but, when the panel excludes Southern European countries where low acute bed utilisation rates have been accompanied by high rates of informal caring, FLFP is found to be a significant downward driver of acute bed utilisation.
- Age, represented by the population share aged 65 and over, was an upward driver of utilisation in the 1980s but, as the age share of population has increased and life expectancies have converged across these OECD countries, age has become

insignificant to or a downward driver of acute bed utilisation. The effect of age varies with the degree of convergence between male and female life expectancies.

The central findings in the model of LTC utilisation for a panel of 7 OECD countries over the years 1997-2006 are:

- Age represented by share of population aged 65 and over is a significant upward driver of LTC utilisation. This effect is reduced by converging life expectancies;
- Female labour force participation is a significant upward driver of LTC utilisation;
- Convergence between female and male life expectancies has a significant reducing effect on LTC utilisation. This effect is moderated by population age and is only significant when the percentage of population aged 65 and over exceeds 17%.

Although data inadequacy prevents an analysis of acute bed and LTC utilisation in the same model, this thesis postulates from these findings that in many OECD countries, increased population age and FLFP have driven increased LTC utilisation, which in turn has facilitated reduced acute bed utilisation. Examination of the role of female labour force participation as a driver of acute and long-term care utilisation and of GDP supports a conclusion that:

- GDP is an over-stated measure of national welfare because it does not take into account the welfare loss when informal care supply diminishes as FLFP rises. This re-assessment of the measurement of national welfare has implications for the analysis of the effect of national income on health spending; and for international comparisons of health spending and GDP.

The central findings in this analysis of LTC supply and demand in Ireland are:

- Longitudinal data on Irish disability rates show clear evidence of declining disability prevalence among older people in Ireland over the period 2002-2006;
- Despite converging life expectancies between men and women and reduced disability prevalence, there was a greater proportionate increase in residents of LTC institutions than in the population aged 80 and over from 2003-2006;
- An explanation for increased demand for residential long-term care is supplied by rapid increases in FLFP, which reduced the supply of informal carers;
- Increasing FLFP combined with forecast rapid growth in the older population and reductions in acute care capacity will require increased formal LTC supply.

Acknowledgements

I wish to thank my supervisor, Professor Charles Normand, for his academic guidance and encouragement and for the privilege of learning from his deep knowledge of health policy and economics. I also wish to thank some of the many others who have assisted me on my path to completing this dissertation: Professor Frances Ruane for her encouragement to undertake the endeavour and her sound advice on how to approach it; Dr John Frain for his generosity in sharing his expertise; Dr Samantha Smith, Dr Grace Lordan and Dr Marta Zieba for their collegial support; Professor Richard Layte and my co-researchers on the ESRI/TCD study on the impact of demographic change on Irish health care for a truly thought-provoking co-operation; and my sister, Dr Anne Wren, for some enjoyable discussions of new concepts and challenging issues.

As ever, I am sincerely grateful to my husband, Cormac O'Rourke, and my daughters, Claire and Sorcha, for their good-humoured support, interest and understanding, without which I could never have attempted this undertaking.

Ageing and the Balance of Care

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SECTION ONE: INTRODUCTION

Chapter 1 Introduction

In developed countries as national income grows and population ages, use of acute hospital beds diminishes. Yet it is popularly believed that national income and ageing are upward drivers of health care utilisation.

This thesis finds that death rather than age drives acute bed utilisation in developed countries; that since the 1990s as the share of population aged 65 and over has increased, age has become either insignificant to or a downward driver of acute bed utilisation; that convergence between the life expectancies of men and women has reduced acute bed utilisation; and that the role of national income as an upward driver of health spending or utilisation is over-stated because national income is in turn driven by female labour force participation. In analysis of drivers of long-term care utilisation, this thesis finds that rising female labour force participation and ageing of population have been upward drivers of utilisation while convergence in male and female life expectancies has been a downward driver.

This thesis started from an interest in how health care spending is compared internationally (Wren 2004; Tussing and Wren 2006) from which came a realisation that if health and long-term care spending are separated, then how countries apportion care between these sectors may critically undermine comparison of the proportion of national income devoted to healthcare. Understanding the relationship between acute and long-term care - the balance of care - emerges as a central requirement for interpreting differences between countries in health care spending.

The central theme of this thesis is the effect of ageing on that balance of care. The thesis comprises two separate but related enquiries. The first enquiry is an examination of the drivers of acute and long-term care utilisation across member countries of the Organisation for Economic Co-operation and Development (OECD). This is an econometric analysis employing data from international databases which began with the objective of

determining whether a formula could be discerned across countries relating acute care utilisation to long-term care utilisation as population ages; and, when the data would not support that objective, developed into an analysis of separate models of the cross-country determinants of acute bed and long-term care utilisation. The second enquiry is an examination of long-term care supply and demand in one country - Ireland - which includes: analysis of the first comprehensive, longitudinal Irish data on disability prevalence; and the development of a statistical model predicting demand for residential long-term care, based on projected demographic change, evolving trends in disability rates in older age and a policy of reconfiguring care from the acute to the community and long-term care sectors.

It is a central hypothesis of this thesis that the balance of care is a simultaneous relationship in which acute and long-term care utilisation and spending are inverse drivers of one another. Long-term care can be delivered either formally in residential or community settings or informally by family members or other unpaid carers. Within country studies support an understanding of the balance of care as a simultaneous relationship and have found evidence that acute and long-term care provision substitute for one another; and that the alternative forms of long-term care substitute for one another. In general, the increased utilisation or supply of care in one setting reduces the utilisation of care in another (Carr-Hill et al. 1994; Martin and Smith 1996; Portrait et al. 2000; European Commission 2001; Bolin et al. 2008; Werblow et al. 2007; Bonsang 2009; Forder 2009).

Although inadequate long-term care data have prevented achievement of the original objective of this research of modelling this balance between acute and long-term care across countries, using cross-country data this thesis tests subsidiary hypotheses about the drivers of acute and long-term care utilisation, which offer insights into the inter-relationship of care in alternative settings. The cross-country analysis models drivers of acute bed utilisation, measured by acute bed days per capita; and of long-term care utilisation, measured by numbers of recipients of formal long-term care in institutions and at home as a percentage of population.

The hypotheses that this thesis tests in the cross-country analysis of drivers of acute bed utilisation for 17 OECD countries over the 22 years from 1985 to 2006 are:

1) Whether population ageing is an upward driver of acute bed utilisation;
2) Whether national income (GDP per capita) is an upward driver of acute bed utilisation;
3) Whether the finding in within-country studies that proximity to death is a more important upward driver of health spending and utilisation than calendar age holds for acute bed utilisation across countries;
4) Whether cross-country variation in acute bed utilisation reflects the within-country evidence on alternative locations of death - the balance of care at the end of life;
5) Whether increased female labour force participation which proxies for reduced supply of informal carers has the effect of increasing acute bed utilisation;
6) Whether convergence in male and female life expectancy which could be expected to reduce numbers of older people living alone and increase care of older people for one another reduces acute bed utilisation;
7) Whether convergence in life expectancies moderates the effect of population ageing on acute bed utilisation.

The research and analysis in this thesis has been undertaken from a desire to add to understanding of the impact of ageing on health and social care and of how countries with differing levels of resourcing and forms of organisation of health and social care might experience the effect of ageing differently. The role played by population ageing in determining health spending or utilisation remains a topic of debate. Despite consensus based on national studies that proximity to death is a more important determinant of health spending and utilisation than calendar age, heretofore there has been no cross-country macro study of this proposition. In the acute utilisation model, the testing of hypotheses 1 and 3 is designed to examine this proposition. Whereas previous studies of ageing and health spending employing cross-country macro data did not separate the effect of proximity to death (the decedent effect) from the effect of age, and previous studies of decedent effects employed micro-data for individual countries or across countries, this thesis extends the analysis by developing a cross-country macro model of acute bed utilisation incorporating decedent effects, age, national income, female labour force participation and converging life expectancies between men and women.

The testing of hypotheses 4 to 7 is designed to provide insights into the balance of care. In testing hypotheses 5 to 7 female labour force participation and converging life

expectancies are proxy measures of the supply of informal care: female labour force participation is inversely related to the supply of informal care by adult children of their parents and other older relatives; convergence in life expectancies is a measure of the availability of older spouses to care for one another. Neither can be an exact measure of the availability of care from these sources and this thesis acknowledges and discusses their limitations. Their inclusion in this analysis is designed to examine the effect of informal care supply on acute bed utilisation. In testing hypothesis 4 evidence from within countries on the location of all deaths and of deaths at varying ages is employed to examine whether acute utilisation varies across countries in accordance with the location of the most intensive care at the end of life - a particularly important aspect of the balance of care, since proximity to death is confirmed as a central driver of acute bed utilisation.

The central findings in the analysis of drivers of acute bed utilisation for a panel of 17 OECD countries over the years 1985-2006 are:

- Deaths are a significant upward driver of acute bed utilisation;
- Deaths of people aged 35 to 74 are significant upward drivers of acute bed utilisation while deaths of people aged 75 to 84 are insignificant when the panel is restricted to countries where there is evidence that most deaths at older ages occur outside hospitals;
- In contrast, deaths of people aged 75 to 84 are significant upward drivers of acute bed utilisation while deaths of people aged 35 to 74 are insignificant when the panel is restricted to countries where there is evidence that most deaths at older ages occur within hospitals;
- Convergence between male and female life expectancies has a significant reducing effect on acute bed utilisation at most values for population age, and may reflect both the availability of older partners to care for one another and improved health status among older people;
- Female labour force participation (FLFP) is insignificant in its effect on acute bed utilisation across the full panel but, when the panel excludes the Southern European countries where low acute bed utilisation rates have traditionally been accompanied by high rates of informal caring, FLFP is found to be a significant downward driver of acute bed utilisation.

- Age, represented by the population share aged 65 and over, was an upward driver of utilisation in the 1980s but, as the age share of population has increased and life expectancies have converged across these OECD countries, age has become insignificant to or a downward driver of acute bed utilisation. The effect of age varies with the degree of convergence between male and female life expectancies.

The cross-country analysis of long-term care utilisation in this thesis cannot test so broad a range of hypotheses because of data limitations. Designed to examine the effects on long-term care utilisation of population age and the supply of informal care, the hypotheses that this thesis tests in this cross-country analysis of drivers of long-term care utilisation for 7 OECD countries over the 10 years 1997-2006, are:

8) Whether population ageing is an upward driver of long-term care utilisation;
9) Whether increased female labour force participation which proxies for reduced supply of informal carers has the effect of increasing long-term care utilisation;
10) Whether convergence in male and female life expectancy which could be expected to reduce numbers of older people living alone and increase care of older people for one another reduces long-term care utilisation;
11) Whether convergence in life expectancies moderates the effect of population ageing on long-term care utilisation.

The central findings in this analysis of drivers of long-term care (LTC) utilisation for the panel of 7 OECD countries over the years 1997-2006 are:

- Age represented by share of population aged 65 and over is a significant upward driver of LTC utilisation. This effect is moderated and reduced by converging life expectancies; and is insignificant when the difference between male and female life expectancy is below 5 years;
- Female labour force participation is a significant upward driver of LTC utilisation;
- Convergence between female and male life expectancies has a significant reducing effect on LTC utilisation. This effect is moderated by population age and is only significant when the percentage of population aged 65 and over exceeds 17%.

The findings for both of these separate models of utilisation are qualified by the potential bias which may arise due to the omission in each model of a variable representing the alternative form of utilisation or supply of care. The findings for LTC utilisation are further qualified because the panel on which they are based is very small due to data inadequacies, which has the effect of limiting the determinants that can be examined. Data limitations prevent the analysis of the effects of acute and long-term care utilisation on one another by estimation of a system of simultaneous equations in which each form of utilisation appears as a driver of the other, using methodologies to address the reverse causation or endogeneity of the two forms of utilisation. Such an approach has been applied successfully in examining the balance of care in within-country analysis (Forder 2009). Although this thesis advances a hypothesis about a balance of care mechanism suggested by the findings for the separate models for acute and long-term care utilisation, because of such data limitations this hypothesis cannot be tested definitively in a composite model. The role of age and female labour force participation as upward drivers of LTC utilisation, across a panel of 7 OECD countries; and as downward drivers of acute bed utilisation across a panel that excludes the Southern European countries in the latter years of this analysis suggests the hypothesis that: as population age has increased and female labour force participation has risen, these combined factors have driven increased LTC utilisation, which in turn has facilitated reduced acute bed utilisation in 14 OECD countries outside Southern Europe. This remains an untested hypothesis because of data constraints.

This examination of the balance of care is primarily empirical - it is an examination of the degree to which there are common factors which drive acute and long-term care utilisation across countries; and the degree to which unobserved factors that influence utilisation patterns but are not captured in the cross-country data can be understood from within-country studies and other evidence. The re-configuration within countries of the balance of care is informed by differing welfare perspectives: national health policies motivated by fiscal concerns support the movement of care from the acute hospital sector to less costly settings, with varied consequences for health outcomes (McKee 2004; PA Consulting Group 2007a); a rights-based approach to care for people with disabilities including older people, promotes provision of care outside institutions as a rights issue (Mansell et al. 2007a); and a normative approach to the provision of long-term care, informed by research on quantitative, preference-based outcome measurement values social outcomes found to

be important to older people (Netten et al. 2002; 2005; 2006; Wanless 2006). Whereas such explicit national policies and norms may unambiguously support a preference for care in one setting over another in a particular country, across countries there are greatly differing approaches to the provision of informal care reflecting the nature of family ties, co-residence patterns and the view or tradition of female labour force participation (Reher 1998; Mortensen et al. 2004; Huber et al. 2009). A North-South gradient is evident within Europe with relatively greater emphasis on formal care in Northern Europe and a relatively greater propensity to care for relatives in Southern Europe (Crespo and Mira 2008). Where more care is delivered informally, intense care needs particularly at the end of life may require acute hospital admission; whereas where there is a greater tradition of formal care in residential long-term care settings, such acute admission is less likely to be required (European Commission 2001; Jakobsson et al. 2006).

A welfare perspective that regards increased GDP per capita as an appropriate measure of national welfare would favour the Northern paradigm to the Southern, formal care in residences or at home over informal care, greater female labour force participation over more co-resident home caring. The new home economics that analyses the household as a unit of production as well as consumption and the theory of the social production of welfare offer an alternative framework to assess welfare. By including non-monetized transactions, the social production of welfare theory allows the formulation of a general model for the consumption of social care in which the motivation for production is to achieve one's one and others' welfare or utility, including the welfare of other individuals in the informal care network (Netten and Davies 1990). Application of the new home economics to the measurement of GNP has not been successful in developing an internationally comparable measure of national welfare that includes household production (Quah 1989; Deaton 1995). Nonetheless, individual and household choices about the provision of informal care affect the balance of care within countries and, since such choices result in greater or lesser amounts of care entering the national accounts as monetized transactions, affect the relationship of health and long-term care spending to GDP.

Consequently, this thesis examines whether GDP is an appropriate measure of national welfare in analyses of the determinants of health and long-term care utilisation and

expenditure. Analysis of the role of female labour force participation as a driver of acute and long-term care utilisation and of GDP suggests that:

- GDP is an over-stated measure of national welfare because it does not take into account the welfare loss when informal care supply diminishes as female labour force participation rises.

This conclusion has implications for the analysis of the effect of national income on health spending; and for international comparisons of health spending and GDP, both of which measures may be understated by exclusion of the value of informally delivered care. In general, the analysis in this thesis supports approaching international comparisons of health spending with caution since spending on health in a country with under-developed formal LTC will appear excessive compared to spending or utilisation in a country with more developed LTC.

This thesis separately analyses supply and demand for long-term care in Ireland. This analysis includes an examination of Irish data to assess the feasibility of developing a model of long-term care demand. The statistical model developed in this thesis forecasts demand for residential long-term care based on detailed analysis and projection of disability rates, projected demographic change and centrally assuming constant utilisation rates of residential care by older people with disabilities. The data requirements and emerging potential to develop a more complex model employing multi-variate econometric analysis of determinants of utilisation of alternative forms of long-term care are discussed in Appendix B.

The central findings in this analysis of long-term care supply and demand in Ireland are:

- Longitudinal data on Irish disability rates show clear evidence of declining disability prevalence among older people in Ireland over the period 2002-2006;
- Despite evidence of converging life expectancies between men and women and reduced disability prevalence, there was a greater proportionate increase in the population residing in long-term care institutions than in the population aged 80 and over in the period 2003-2006, which suggests reduced supply of care in other settings;

- An explanation for this increase in demand for residential long-term care is supplied by rapid increases in female labour force participation rates, which have reduced the potential supply of informal carers in Ireland;
- Such sharply increasing female labour force participation combined with forecast rapid growth in the population at older ages and planned reductions in acute care capacity will require considerably increased formal LTC supply in all settings.

This thesis is divided into six sections. The remainder of the first section comprises three overview chapters: Chapter 2 reviews the literature on ageing and health and long-term care; Chapter 3 describes and discusses the cross-country data sources employed in this thesis; Chapter 4 reviews the econometric methodologies adopted to analyse these data.
The second section of this thesis comprises related chapters that develop econometric models of utilisation of acute hospital beds and formal long-term care in residences and the community. In a model of the determinants of acute bed utilisation, Chapter 5 analyses the effects on utilisation of age, death, age at death, converging male and female life expectancies, female labour force participation and national income. Chapter 6 develops a model of the determinants of long-term care utilisation; re-examines the determinants of acute bed utilisation in a panel excluding Southern European countries; and, to the degree that the data supports, analyses the relationship between female labour force participation, converging life expectancies and both acute and long-term care. Chapter 7 examines the implications of the relationship of national income to female labour force participation in analysis of health care utilisation.

The third section of this thesis comprises an analysis of long-term care in Ireland: Chapter 8 introduces and describes the context for this analysis; Chapter 9 analyses the supply of and demand for LTC in Ireland; Chapter 10 analyses Irish evidence on the evolution of disability and, employing this evidence, projects future disability trends and LTC demand in Ireland. Earlier versions of much of the content of Chapters 9 and 10 and of some of the more general theoretical discussion in Section 1 have been published in a series of reports on the effect of demographic change in health care in Ireland (Layte et al. 2009a; Layte et al. 2009b), to which I was invited to contribute because of the relevance of my thesis research to this study.

The fourth section is Chapter 11 which brings together reflections and conclusions on both the cross-country and Irish analysis. Section 5 comprises appendices with tabular and supplementary information. Section 6 is a bibliography.

Chapter 2 Literature Review

2.1 Introduction

Most developed countries have ageing populations. This is a consequence of the combination of declining birth rates and increasing life expectancy for older people. For any birth rate, the greater average life expectancy, the higher the proportion of the population comprised of people of greater age. Rates of emigration and immigration may change this picture – and have done so in Ireland, for instance – but in general, in developed countries, population ageing has been a consistent trend over recent decades.

An analysis of the impact of ageing on health care and on the balance between health and long-term care requires definition of the concepts of age, health care and the balance of care, none of which is as straightforward as it might appear. There is evidence that, in a given country at a given time, health care costs are higher at greater ages. It is much less evident that over time ageing of population is a significant driver of health care spending or utilisation. Much of the explanation for this apparent paradox lies in the inconstancy of the relationships of disability or sickness (morbidity) to age. If today's 80-year-old in New York is healthier and more able-bodied than yesterday's 60-year-old in New York or today's 80-year-old in Lesotho, then age insofar as it pertains to health is a relative concept.

For this reason in assessment of the impact of population ageing on health spending or utilisation, theoretical debate centres on the issue of whether morbidity and disability rates at specific ages are constant and might be expected to continue unchanged, as life expectancy increases. Underlying popular and political debate about the impact of population ageing on health spending, and, also evident in some analytical work in the area, is an assumption that these rates remain constant over time and across countries and health care systems. The evidence does not support this. A belief in the constancy of age-specific disability and morbidity also underlies the commonly accepted measure of age -

the percentage of population aged 65 and over. The concept of "age" and this measure are virtually synonymous in much of the literature on ageing and health care. Although, for reasons discussed later, this measure also plays a role in my analysis, it is apparent that, if age is a relative measure, such a cut-off is not only arbitrary but may limit understanding. The OECD has described the modelling of future long-term care costs as a "developing art (rather than science)" because experience over the past 20 years has shown "how difficult it can be to project the wider outcomes of demographic ageing with any accuracy" (OECD 2005).

Precision in analysis of the effect of ageing on health care also requires agreement on what constitutes health care. If "health care" is in effect an umbrella term encompassing long-term care (LTC), then analysis of the impact on it of population age will capture quite different effects then if health care is defined more narrowly as medical or curative care, that takes place in hospital or primary care settings, and specifically excludes long-term care. This is not a semantic distinction. The evidence is that ageing has a more pronounced effect on LTC spending/utilisation than on narrowly-defined health spending. Failure to distinguish between the two sectors can limit the usefulness of both data and its analysis.

The need for long-term care is distinct from the need for acute health care. People in need of LTC have impairments which make them dependent on personal help and nursing care in the long-term and possibly until death (Schulz 2004). No general, internationally comparable definition of LTC need exists. A number of the studies discussed in this chapter share with my analysis a reliance on the OECD Health Database, the pre-eminent repository of cross-country data about health care systems. The OECD's system for distinguishing between the health and social components of long-term care spending has been undergoing a process of refinement since the publication of the OECD's System of Health Accounts (SHA) in 2000 (OECD 2000). Analysis employing OECD health expenditure data sourced prior to the implementation of this system unavoidably suffered from the inclusion in the database of national health data, which might or might not aggregate health and social aspects of long-term care spending. Even after the implementation of the SHA, countries' data have had differing degrees of compliance with OECD definitions (OECD 2002, 2005a, 2005b). Studies of the effect of age which are based on an analysis of data that aggregate health and long-term care measures may well reach differing conclusions to studies that analyse health and long-term care separately; or

studies that analyse the effect of age on either care sector without taking the other into consideration. I describe the OECD's system of health accounts and their definitions in greater detail in the next chapter.

In this analysis the "balance of care" refers to the balance between acute and long-term care in all settings. Long-term care can be delivered either formally in residential or community settings or informally by family members or other unpaid carers. The impact of ageing on the balance between acute and long-term care - the particular focus of this thesis - has been explored in within-country studies but to a lesser degree in studies across countries, which may reflect the international data deficiencies which have also limited the scope of the analysis in this thesis. The central hypothesis underlying the analysis in this thesis that the balance of care is a simultaneous relationship in which acute and long-term care utilisation and spending are inverse drivers of one another is supported by within-country studies.

This chapter reviews the literature on ageing and health and long-term care and on the relationship between health and long-term care; and, in addition, reviews a broader theoretical and analytical literature, which informs this analysis. While my research began from an interest in population ageing and health care, it became evident in the subsequent development of my analysis of the drivers of health and long-term care utilisation that this required familiarity with a diverse literature in health policy and economics, stretching from palliative care to feminist and development economics.

In this chapter I review the literature under the following headings: the effect of ageing on health and long-term care spending and/or utilisation and the related theme of the effect of national income on health care spending (Section 2.2); the relationship of morbidity and disability to age (Section 2.3); the distinction between the effects of age and proximity to death (Section 2.4); the relationship between acute and long-tem care utilisation and expenditure, particularly as demonstrated in the literature on location at death (Section 2.5); the relationship between informal care supply, female labour force participation and health and long-term care utilisation (Section 2.6); the alternative welfare perspectives that inform the literature on the balance between alternative forms of care (Section 2.7); and projections of the effect of age on future health and long-term care spending or utilisation (Section 2.8).

I discuss these themes sequentially with some inevitable overlaps. In instances where I discuss the literature further in the chapters where it is of most direct relevance to my analysis, the references here may be relatively brief. More detailed discussion of health and long-term care in specific countries appears in some chapters. Since the effect of ageing on long-term care in Ireland is a major theme of this thesis, I separately review the Irish literature on ageing and health and social care (Section 2.9). In a final section, I summarise the themes in the literature, which are most pertinent to my analysis.

2.2 Ageing and health and long-term care spending and utilisation

What is the evidence about the relationship between age and health and long-term care spending and/or utilisation, about the variation in these relationships across countries and over time, and about the relationship between growing life expectancy and rates of disability or morbidity?

2.2.1 Expenditure and utilisation by age – cross-sectional patterns

Country-specific studies of cross-sectional patterns have examined the distribution of health spending by age. The typical age-cost curve is described as a "J" curve, reflecting higher health spending per capita on the old and the young than on those in the middle age brackets. An increasing age gradient – i.e. higher health spending per capita for older people - has been observed in Canada, the United States and Sweden (Canadian Institute for Health Information 2005; Keehan et al. 2004; Gerdtham 1993).

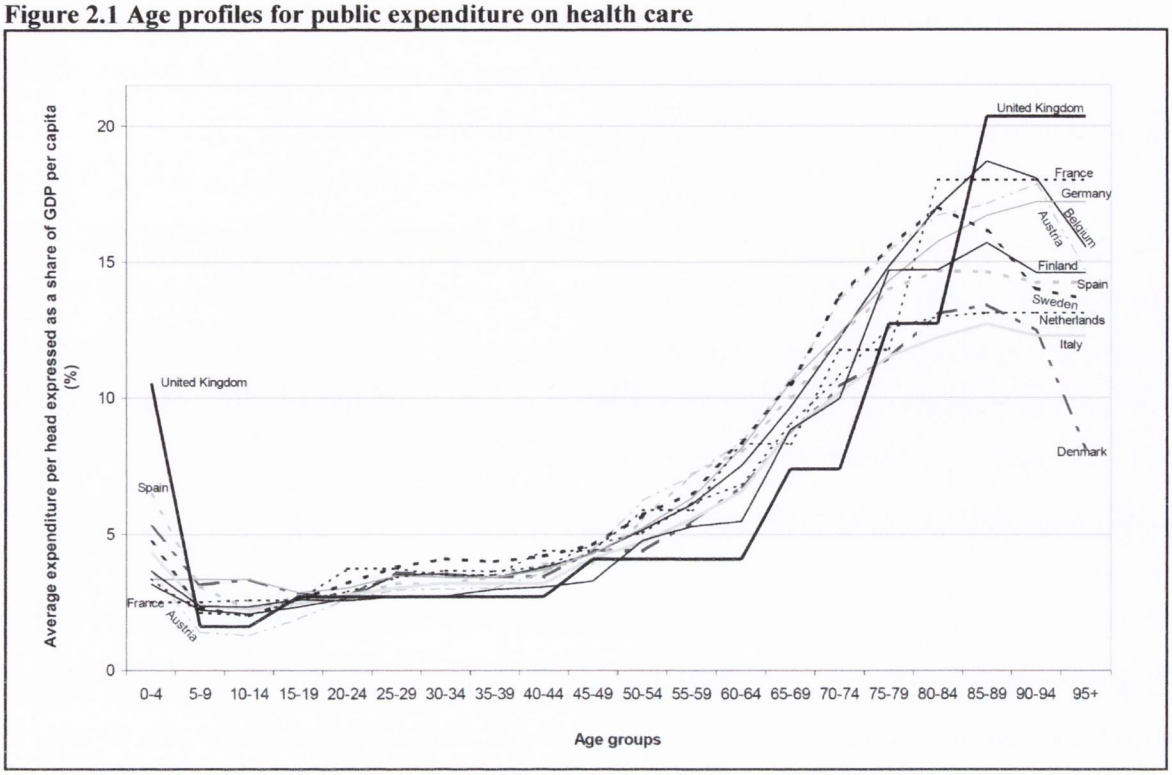
On the other hand, Seshamani and Gray (2002) in a comparison of expenditure by age group in England and Wales in 1985-87 and 1996-99 found that growth in per capita health expenditure among those aged 65 and over was 8% compared to 31% for ages 5-64. The proportion of total expenditure allocated to the population aged 65 and over decreased from 40% to 35%, a trend most noticeable for non-acute hospital costs. This contrasted with findings for Australia, Canada and Japan, where the proportion of national expenditure devoted to the 65 and over age group increased. Seshamani and Gray suggested that their UK findings might be explained by a shift from NHS-provided long-stay care to the independent nursing home sector, which was not captured in their data.

In an assessment of the budgetary challenges posed by ageing, the European Commission (2001) distinguished between health and long-term care spending by asking member states to supply data using the definitions developed by the OECD in its System of Health Accounts. This European Commission Economic Policy Committee report found that while, after childhood, per capita spending increased with age, in those states where expenditure levels for the highest age groups were estimated separately (Belgium, Denmark, Austria and Sweden), expenditure on health care appeared to decline somewhat for the oldest old groups (Figure 2.1). This finding challenges the validity of the "J" curve. In Section 8 of this chapter, I review Irish evidence on age-specific acute hospital discharge rates which shows a similar pattern of decline for the oldest old (Layte et al. 2009a).

When the European Commission (2001) analysed LTC spending separately, there emerged considerable cross-country differences. Whilst average expenditures per head on health care for the most costly age groupings peaked in almost all member states at between 15 to 20 per cent of GDP per capita, the average LTC expenditures per head for the most costly age groupings peaked at much higher levels. The highest peak of LTC average expenditure was for the 95 years and over age-group in Denmark, for whom per capita LTC expenditures were around 90 per cent of GDP per capita (European Commission 2001). Denmark compensated for its lesser health spending on the oldest age groups by its markedly greater LTC spending on these groups (Figure 2.2). This study comments that the considerable differences in long-term care spending levels per head reflect:

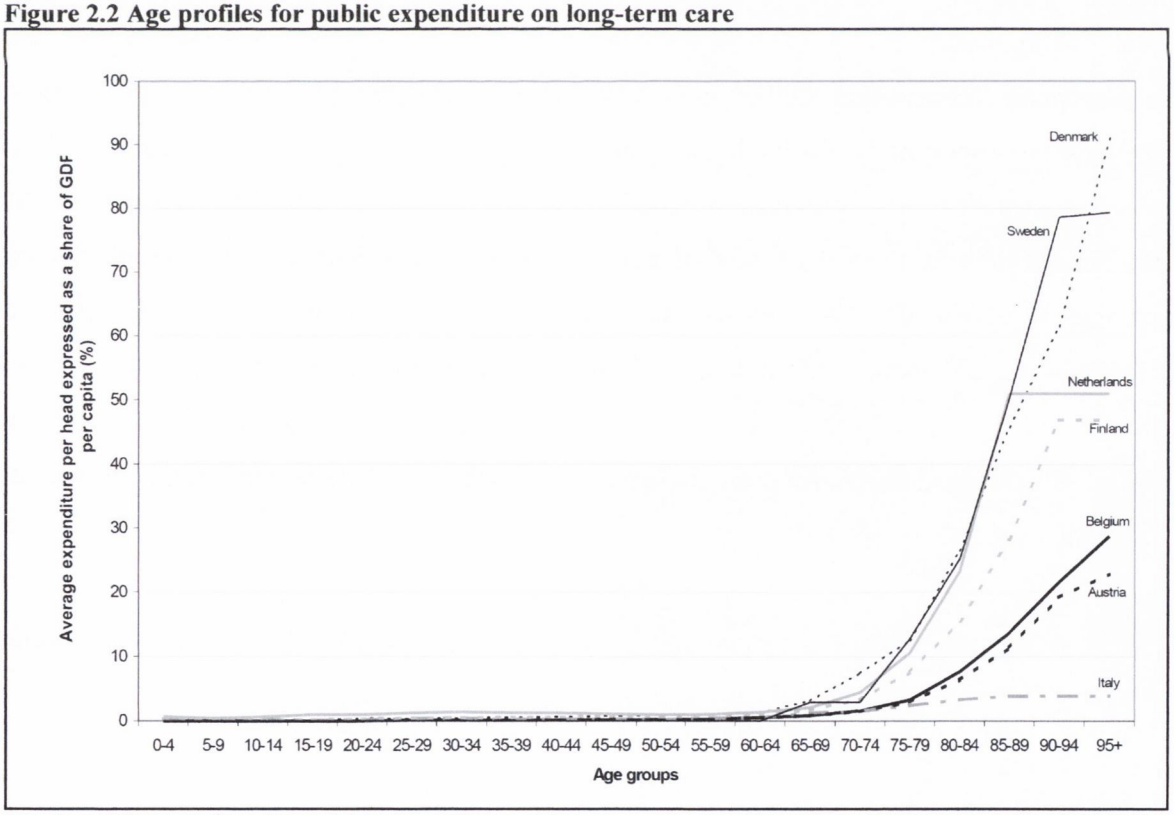
> "...radically different traditions in the provision of care for the elderly. In some Member States, care for the elderly is in large part formal, with a large share of formal care provided in an institutional setting, rather than in the homes of the elderly – thus leading to high levels of public spending on long-term care. In other countries the tradition of care is more for informal provision by family members. However, in those countries where there is limited public provision of formal care, some long-term care is likely to be provided through the health system, and thus is included in data on health care expenditure" (European Commission 2001: 36-37).

Figure 2.1 Age profiles for public expenditure on health care



Graph 4.1 Age profiles for public expenditure on health care, estimated per capita age-related spending for years from 1997 to 2000, depending on member state, reproduced from (European Commission 2001: 34)

Figure 2.2 Age profiles for public expenditure on long-term care



Graph 4.3 Age profiles for public expenditure on long-term care, estimated per capita age-related spending for years from 1998 to 2000, depending on member state, reproduced from (European Commission 2001: 37)

This study, concerned as it was with the budgetary implications of ageing, was examining trends in *public* health and LTC spending. Degrees of state provision or subvention of health and long-term care would affect these observed differences.

Analysis of age-specific health services utilisation (as opposed to expenditure) within the European Union by Layte et al (2005) established that while states have a similar pattern of worsening health status and increasing health services utilisation as age increases, much of this variation is removed by controlling for differences in socio-economic characteristics and health status. This study used longitudinal micro-data for 1995 and 2001 from the European Community Household Panel (ECHP) to estimate multivariate models of health status and health services utilisation for each of the EU-15 member states. Its measures of health service utilisation were GP visits and annual inpatient nights, so it could not ascertain to what degree inpatient night utilisation reflected LTC utilisation. In Sweden increasing age was associated with significantly fewer nights in a hospital. The authors commented that this result seemed to be driven by an outlying observation but it is conceivable that examination of LTC utilisation might have uncovered a link between higher LTC utilisation and lower inpatient night utilisation, comparable to the inverse relationship between LTC and health spending in the oldest age groups found for Denmark in European Commission (2001). Layte et al (2005) found that in Finland in 2001 none of the few observations in the older age ranges (86-90 and 91-95 for men, and 91-95 for women) reported *any* nights in a hospital in the previous year. This finding suggests that the nature of long-term care in Finland may affect demand for acute hospital services among the oldest old. The sample data was restricted because the European Community Household Panel surveys households only and excludes those in institutional care. It might be that the oldest old surveyed in Finland, who were outside institutional care, were by definition the healthiest members of these age brackets and those least likely to require hospital services.

2.2.2 Econometric quantification of effect of age using cross-country macro measures

A sequence of studies has analysed cross-country variations in total health spending, controlling for the influence of other possible drivers of spending by econometric methods. National income has been found to be a more important determinant of health spending than the age structure of the population. Where ageing has been found to be of

significance, there has been great cross-country variability. Such studies have suggested that factors other than income or ageing, such as the system of health finance and delivery or other unobserved country-specific factors, must play an important role. These studies have in general used OECD data, which predated the distinction between the health and social aspects of LTC spending introduced progressively since 2000 with the new OECD System of Health Accounts.

Newhouse (1977) and Parkin et al (1987) regressed per capita health expenditure on per capita GDP and found that 90% and 87% respectively of variations in health spending could be explained by variations in per capita GDP . Gerdtham et al (1992a) found per capita GDP to be the most significant factor explaining cross-country variations in health spending. Using data for 19 OECD countries for 1987 and testing the relationship between per capita health spending and a wide number of variables including health sector characteristics, this study found the proportion of population aged 65 and over to be statistically insignificant in predicting the level of health spending. In contrast, when in a further study Gerdtham et al (1992b) pooled data from three years (1974, 1980 and 1987) for 19 OECD countries to form a panel data set, an increase in the proportion of population aged 64 and over relative to the proportion aged 15 to 64 was predicted to increase health spending.

These early studies all suffered from the limitations of relatively small sample size. Hitiris and Posnett (1992) achieved a sample size of 560 observations covering 20 OECD countries for the 28 years from 1960-1987 and reported a significant relationship between health spending and the proportion of the population aged over 65. They also found GDP to be an important determinant of health spending. They estimated using a fixed effects model with data transformed to correct for heteroscedasticity and autocorrelation, a methodology discussed in Chapter 4.

Employing a similar panel and methodology, O'Connell (1996) found that population ageing affected health spending in some countries but not others in a panel with 336 observations for the years from 1975 to 1990 for 21 OECD countries. O'Connell found the effect of income on health spending to be lower than generally reported. She concluded that unobserved country-specific factors played a major role in determining the amount of resources allocated to health services in a country and also determined if ageing was

associated with increased health spending. Whereas previous studies had analysed ageing effects by employing a single age variable, this study used country-specific age variables to determine the effects of ageing in each country while controlling for changes in income and public sector financing. While a single age variable (for percentage of population aged 65 and over) had a positive and significant effect on per capita health spending for the panel of countries overall, when country-specific age effects were modelled, seven countries had positive and significant coefficients for their country-specific age variables, eight countries had negative and significant coefficients and for six countries the coefficients were not significant.

Barros (1998) found health system characteristics and population ageing to be non-significant in explaining health care expenditure growth, whereas GDP per capita had a significant impact. This study did not compute country-specific effects. Dependent variables were average growth rates in per capita health expenditure over the decades 1960-1990. Barros sourced data for 24 OECD countries from the 1996 version of the OECD database. GDP per capita and the initial level of spending had significant effects. Higher initial spending per capita was related to a lower growth rate in the next decade, implying convergent health spending levels. The study concluded that factors explaining cross-country and over-time differences in levels of health spending need not also be the relevant ones to explain different growth rates.

Christiansen et al (2006) in econometric analysis using country fixed effects found age effects to be insignificant for the original EU15 member countries over the years 1980-2003 when controlling for institutional and technological factors but found that the age group 65-74 was a significant driver of per capita health spending for the EU11 group of new member countries and Turkey over the period 1990-2003.

Other recent studies have sought to address the possibility of spurious regression results due to possible non-stationarity of time series for health expenditure and GDP per capita. A spurious regression arises when an apparently close correlation, such as between health expenditure and GDP, "is the result of common trends rather than evidence of any real economic relationship" (Roberts 2000). These efforts have had mixed results, reviewed by Gerdtham and Jonsson (2000). While Hansen and King (1996) found GDP and health expenditure to be non-stationary in data for 20 OECD countries for the years 1960-1987 so

that panel data estimations of the relationship of GDP to health expenditure might be spurious, McCoskey and Selden (1998) using the same data but a different methodology concluded that non-stationarity was not an issue for these variables in these data. Addressing or testing for non-stationarity in a panel data context is an evolving methodological field and a consensus view has yet to develop on the correct approach (Smith 2000; Baltagi 2008; Greene 2008; Van Elk et al. 2009). Baltagi cites Philips and Moon (1999; 2000) who suggest that independent, cross section data in the panel adds information and this leads to a stronger overall signal than the pure time-series case.

Okunade et al (2004) adopted the approach of analysing annual growth rates in health spending over five-year periods for 17-25 OECD countries over the years 1968-1997. They found the drivers of growth to be economic and institutional, with population aged 65 and over a positive and significant contributor to spending growth over the period 1968-1997.

Van Elk et al (2009) addressed non-stationarity using an error correction model to investigate the short and long-run dynamics of the determinants of health care expenditures across 8 OECD countries over the years 1970-2003. Their model attributed significance to the age shares of population aged 65-74 and 75 and over, although they comment that this "may partly be explained by the high costs of dying which is proxied by the age composition."

The literature on the effect of age on health spending is very largely also a literature on the effect of national income, with both variables frequently appearing in models exploring the effect of a range of potential determinants of health spending. OECD (2006) summarises the empirical evidence on health care income elasticities: while early studies generally found health care to have an income elasticity of greater than one, which makes health care a luxury good, for which consumption increases at a greater rate than income, more recent studies designed to address concerns about non-stationarity and spurious regression estimate income elasticity at less than or close to unity, which suggests a long-run equilibrium between health spending and GDP.

2.3 Ageing and rates of morbidity and disability

The accumulation of this mixed body of evidence which at the very least challenges the intuitively appealing view of ageing as a significant driver of health spending has given added impetus to parallel studies examining evidence about the process of ageing: the evolution of rates of disability and morbidity; and the significance for treatment costs of proximity to death as opposed to ageing *per se*.

Theorists have posited that additional years of life in very old age could have three possible outcomes (OECD 2005):

- Morbidity and disability rates remain the same at specific ages thus extended lifespan is associated with *extended morbidity*. The most pessimistic theories have suggested that increasing longevity might actually be linked to *increasing prevalence of disability*: industrial societies are altering lifestyles in ways that will raise the risk of chronic diseases among older people (Dubos 1965; Omran 1971; Antonovsky 1979); and increased medical expenditure is preserving life in elderly, very ill or disabled persons, who will gain only small amounts of relatively poor quality life. "Our technological successes defy death's claim on the sick and the weak" (Gruenberg 1977: 19).

- Poor health and disability appear at later ages but the extension of lifespan has an upper limit leading to a *compression of morbidity*, first propounded by Fries (1980): "Extension of adult vigor far into a fixed life span compresses the period of senescence near the end of life." Fries suggested the "ideal average life span" was 85 years (Fries 1980: 130).

- Both average lifespan and age of onset of poor health or disability continue to extend, leading to *deferral of disability*. The length of the period of disability depends on the relative rate of extension of lifespan versus ill-health/disability. A refinement of this theory posits the possibility that disability is related to proximity to death not age, and should be viewed as *end-of-life disability*, with its onset deferred at the same rate as the rate of extension of lifespan.

In general, analysis of the international data has tended to support the *deferral of disability* proposition i.e. that both average lifespan and age of onset of poor health or disability have continued to extend. Over long time periods, there is clear evidence of deferred disability accompanying increased life expectancy. Over shorter periods, cross-country comparisons have shown some divergence in trends, which could have a number of causes: differing data collection methods; divergent cultural views of disability leading to differing self-assessments of health status; or concrete circumstances which make physical limitations less disabling in one culture than another (e.g. the availability of public transport, which makes inability to drive less limiting). Alternatively such cross-country differences may reflect real differences in health status deriving from the combined effect of education, income, lifestyle choices and degree of access to quality health care from before birth to old age.

Waidmann and Manton (1998) found a growing body of evidence of declining disability rates among older people in the US. In research employing different surveys and methods, no sustained increase in disability rates was observed. Outside the US, they found that survey data provided evidence of declining disability in France, Belgium, Taiwan, Italy, the Netherlands and Switzerland. In countries where no substantial decline was apparent, such as Australia, Canada, and Britain, there was no consistent evidence that disability rates were rising. How fast disability rates were falling was unclear because disparities in disability measures and sample designs prevented comparability.

Jacobzone et al (1999) examined whether the health of older people was improving fast enough to compensate for population ageing in a study examining the link between disability levels and the need for formal personal care. In countries where cross-sectional evidence was available for at least two points in time five years or more apart (Australia, Canada, France, Germany, Japan, the Netherlands, Sweden, the United Kingdom and the United States), this study found reduced prevalence of disability rates among people aged 65 to 80 years, which was more striking for males than for females. Jacobzone et al concluded that the economic impact of these trends would depend on institutional arrangements for long-term care. Due to different subsidisation levels, public costs of formal home care differed widely between countries, as did the balance between home and institutional care. De-institutionalisation, with recourse to less expensive form of

institutions, appeared to play a larger role than disability trends in determining overall costs.

Manton and Gu (2001) found that the trend towards lower prevalence of disability rates in the United States was not only continuing but growing, with a greater decline in the 1990s than in the 1980s, and cited Fogel and Costa (1997) to argue that this was not just a characteristic of one generation.

Fogel and Costa propounded a theory of "technophysio evolution":

> "We argue that over the past 300 years human physiology has been undergoing profound environmentally induced changes made possible by numerous advances in technology. These changes, which we call *technophysio evolution,* increased body size by over 50%, and greatly improved the robustness and capacity of vital organ systems. Because technophysio evolution is still on going, it is relevant in forecasts of longevity and morbidity and, therefore, to the size of the elderly population and pension and healthcare costs" (Fogel and Costa 1997: 49)

Fogel and Costa used US army veteran records from 1912 to the 1990s to show a long-term trend of similar magnitude to that reported by Manton and Gu. A 0.6% annual rate of decline in chronic morbidity found by Fogel (1994) which persisted over 75 years was later replicated by Costa (2000) for disability.

The Fogel and Costa model argues that improvements in health are too rapid to be caused by evolutionary (genetic) changes. Rather, health changes must be caused by the evolution of the technological environment of the individual—especially in the technologies preserving health. Fogel and Costa's thesis runs counter to the conventional public health view, which accords a relatively minor role to health care in the extension of life expectancy compared to factors such as literacy and diet. In seeking to explain the decline in chronic conditions, they attributed some role to lifestyle changes like reduced smoking, increased exercise and improved nutrition. But they also argued that "another part of the explanation is the increasing effectiveness of medical intervention", instancing the history of hernias. Before World War Two these were generally permanent and often exceedingly

painful conditions. By the 1980s about three-quarters of all veterans who had ever had hernias had been cured.

Fogel and Costa's attribution of significance to medical intervention is supported by the work of Frech and Miller (Frech III and Miller 1999; Miller and Frech III 2004) who found pharmaceutical consumption to have a significant effect on remaining life expectancy in analysis across OECD countries in 1993 and 2000; while Zweifel, Steinmann and Eugster (2005) argue that estimation of a production function for health can be justified from an emerging consensus that at least some components of health care inputs contribute to health with a lag and decreasing marginal effect.

Manton and Gu (2001) found that more educated individuals had a disability rate of only about half as much as less educated people. They argued that an acceleration of the decline in disability would be expected from the projected increase of the level of education among the oldest old in the US. They observed that a number of chronic degenerative diseases such as severe dementia and stroke had a slower rate of progression, or a lower rate of occurrence, over the period 1982 to 1999. Declines in nursing home use also occurred over this period.

Cutler (2001) accepted that "Manton and Gu present clear, overwhelming evidence that the average health of the elderly population is improving" and suggested that the cause of disability decline is multi-factorial. Factors contributing to this decline include: improved medical treatments such as pharmaceutical treatment and joint replacement surgery for arthritis, and cataract surgery which reduces disability associated with visual impairment; behavioural changes such as improved diets and reduced smoking, which lessen the incidence of emphysema, heart disease, and stroke: and the spread of assistive devices such as canes and walkers, walk-in showers, grab bars, microwave ovens, and telephones with larger keypads, which might be particularly important in reduced nursing home utilisation. Previous generations of older people were more exposed as children to infectious diseases and conditions, such as rheumatic fever, typhoid, measles, and malaria which could cause heart disease later in life. Cutler hypothesised that education could influence disability in many ways: by allowing greater access to medical care resources, increasing knowledge about appropriate health behaviors, and by the direct impact of mental stimulation on decline in disability.

Jarvis and Tinker (1999) found evidence from the General Household Survey of 1979 to 1994 that rates of limiting chronic illness and functional disability were also improving in the UK, although lagging behind improvements in the US by several years. Their findings on severe disability were less optimistic, with remarkable stability over time in the proportions of older people with severe disabilities. They cautioned that trends in obesity and smoking among younger people could mean that future generations of older people would not have the good health that "the 'golden' generations now entering old age enjoy".

OECD (2005) found trends in disability free life expectancy (DFLE) differed across countries. Several countries – including Germany, Japan, Netherlands, the UK and the US - showed a trend of a growing number of years of DFLE in the latter decades of the 20th century. In some cases, years of additional life expectancy exceeded years of additional DFLE, implying an increased need for formal or informal care. The OECD also found, however, that the trend was not clear for many countries, which might or might not reflect issues of measurement.

OECD (2007a) assessed the most recent evidence on trends in severe disability among the population aged 65 and over in 12 countries. This study found clear evidence of a decline in disability in five countries (Denmark, Finland, Italy, the Netherlands and the United States). Three countries (Belgium, Japan and Sweden) reported an increasing rate of severe disability among people aged 65 and over during the past five to ten years, and two countries (Australia, Canada) reported a stable rate. In France and the UK, data from different surveys showed different trends in disability rates among older people, making it impossible to reach any definitive conclusion on the direction of the trend.

In 2005, the AGIR (Ageing, Health and Retirement in Europe) research network concluded a project investigating the effect of population ageing on public health and long-term care expenditures, public pensions and government finances in EU countries over the period 2002-50. Schulz (2003) found a positive connection between increasing life expectancy and health status in Germany although Ahn et al (2004) observed no general trend in the relationship between increased life expectancy and health status in 10 EU countries. The project concluded that "health and disability limitations will probably advance less rapidly than age, thus allowing for healthier life, but this is not to be taken for granted as available data still lacks enough conclusiveness" (Mortensen 2005). The

evidence for Ireland in Ahn et al (2004) is discussed in Section 3 of this thesis, in which I analyse the first comprehensive longitudinal data on disability rates in Ireland and find clear evidence of declining disability rates among older Irish people over the years 2002-2006 (published in Layte et al. 2009b).

2.4 Ageing and proximity to death

National studies of the costs of care for people close to the end of life (decedents) and for survivors have illustrated that health care costs are more closely related to proximity to death than calendar age. Evidence of this decedent effect has been demonstrated within: Switzerland (Zweifel et al. 1999; Felder et al. 2000; Zweifel et al. 2004); Canada (McGrail et al. 2000) ; Ireland (Layte 2007) ; the US (Lubitz and Riley 1993; Spillman and Lubitz 2000); and Japan (Sato and Fushimi 2009). A study in Germany demonstrated that acute hospital bed utilisation is also driven by proximity to death not age (Busse et al. 2002).

Lubitz and Riley (1993) analysed US Medicare payment data over the period 1976-1988 for people in their last year of life (decedents) and for survivors to assess the resources devoted to the dying. They found much higher costs for decedents than survivors but with a pattern of lower payments for older as compared to younger decedents, while payments for survivors increased with age up to age 89 after which they decreased.

Zweifel et al (1999) used longitudinal data from two Swiss private health insurance funds covering 14,000 people in the 1980s and 1990s to study the relationship between health care expenditure (HCE) and age. From econometric analysis of HCE in the last eight quarters of life of individuals who died during the period 1983–1992 they found that HCE depended on remaining lifetime but not on calendar age, at least beyond 65˙. They concluded that if one controlled for remaining lifetime, age had no effect on demand and suggested that the positive relationship between age and HCE observed in cross-sectional data might be caused "by the simple fact that at age 80, for example, there are many more individuals living in their last 2 years than at age 65".

Felder et al (2000) sourced data from a Swiss health insurance company for 415 deceased people, the majority of whom were aged 65 or over at the time of death which occurred

over the years 1987-1992. They found that HCE increased with closeness to death; for people aged over 65, there was a significant decrease in cost of dying as age increased; patients with supplementary insurance for hospital treatment incurred higher costs of dying; and low-income households spent less on health care services in the last two years of life than high-income households.

McGrail et al (2000) employed linked data from British Columbia covering health and social care to compare the costs of care for all decedents to the costs for all survivors in chosen age categories for the years 1987-88 and 1994-95. They concluded that the costs of acute care rose with age but proximity to death was more important in determining costs. The additional costs of dying fell with age. Costs of nursing and social care rose with age and additional costs for the dying increased with age. They argued that in planning services it is important to take into account the relatively larger impact of ageing on social and nursing care than on acute care

Busse et al (2002) analysed the number of days spent in hospital by survivors and decedents insured by one German sickness fund from 1989 to 1995. They found that in the last year of life the number of days spent in hospital was lowest for the young (under age 25) and the old (aged 85+) and greatest at ages 55–64. The ratio of days to survivors was highest at age 35–44. Numbers of hospital days per year of life, averaged over the entire lifespan, were stable for deaths between age 50 and 90, so that lifelong hospital utilisation for people who died at 50 or later was directly proportional to the number of years lived.

Seshamani and Gray (2004a) critiqued Zweifel et al's methodology but essentially confirmed their findings. Using English longitudinal data they analysed hospital care to 1999 for people aged 65 and over in 1970 and found that both proximity to death and age had significant effects on cost but the effects of age were much smaller. They concluded that proximity to death was "indeed the main demographic driver of rising health-care costs". In a related study these authors developed an economic model of hospital costs based on patient age and time remaining to death and applied the model to English population projections to predict the effect of demographic changes on hospital expenditures from 2002 to 2026. They found that incorporating in expenditure projections the effect on death-related costs of the postponement of death to later ages due to decline

in age-specific mortality rates gave a predicted annual growth rate at half the rate predicted with a traditional method (2004b).

Zweifel, Felder and Werblow (2004) responded to methodological concerns about collinearity between and endogeneity of explanatory variables in a further study that included surviving individuals to test for the possibility that the relative importance of proximity to death and age differed between the deceased and survivors. They found no significant age effect on health care expenditure of the deceased but found that age might matter for survivors.

Spillman and Lubitz (2000) combined US data from Medicare and other sources to estimate total national spending on health care, including long-term care/nursing home care expenditure, according to age at death. They found that spending from age 65 until death increased substantially with longevity, partially because of steep increases in nursing home expenditures for the oldest old. Spending in the last two years of life also increased with longevity, but reduced Medicare expenditures moderated the effect of increased nursing home expenditures. In common with the McGrail study for Canada, they concluded that in the United States, the effect of longevity on acute care costs differed from its effect on long-term care costs. Acute care costs increased at a reduced rate as age at death increased, whereas long-term care costs increased at an accelerated rate. Increases in longevity after the age of 65 might result in greater spending for long-term care, but the increase in the number of older people had a more important effect on total spending.

Layte (2007) used data from the Living in Ireland survey for the years 1994 to 2001 to analyse expenditures on GP and hospital services for 444 people for whom the year of death was known. He found proximity to death to be a more significant predictor of expenditure on these services than age and identified a significant gradient in costs as death approached. Controlling for proximity to death there was no age gradient in costs.

Sato and Fushimi (2009) analyzed data from the Japanese Survey of Medical-Care Activities in Public Health Insurance for the years 2000-2002 covering over 100,000 patients. They found age of patient had little impact on per capita inpatient health-care expenditures per day. Inpatients aged 40-64 received the most costly care. Among decedents, the cost of care was highest for people of less than 40 years of age.

Weaver et al (2009) in an analysis of US panel data from 1993 to 2002 found that proximity to death, measured by being within two years of death, significantly increased the probability of nursing home use and formal home care use but availability of informal support significantly reduced the effect of proximity to death. Among married older people, proximity to death had no effect on institutionalisation.

2.5 The relationship between acute and long-term care utilisation and expenditure

Studies within and across countries have found evidence that acute and long-term care provision substitute for one another; and that the alternative forms of long-term care substitute for one another. In general, the utilisation or supply of care in one setting influences the utilisation of care in the other. Cross-sectional studies in the UK have found that greater supply of long-term residential care and of informal care is associated with reduced acute care utilisation (Carr-Hill et al. 1994; Martin and Smith 1996) and that additional spending on either residential long-term care or acute hospital care for older people reduces spending in the other setting (Forder 2009). Countries with higher long-term care spending for the oldest old have been observed to have reduced health care expenditures for this grouping in cross-sectional data for EU countries (European Commission 2001). The adoption by Sweden of a policy of reducing acute care provision in the 1990s had pronounced effects on the provision of long-term care in institutions and the community. Following the 1992 ÄDEL Reform which transferred responsibility for LTC provision from county councils to municipalities, hospital bed numbers reduced by over 40 per cent in the years from 1993 to 2003 and numbers of LTC beds in nursing homes increased steeply. The transfer of many ill, older people into their care placed great strains on municipalities, significantly changed the hitherto generous access to home help services and increased informal care demands (Trydegård 2004; Glenngård et al. 2005; Rauch 2007).

If proximity to death is accepted as more important than age in determining rates of health care utilisation or its cost then investigating the question of where people die acquires a new dimension. In the development of my analysis in Section 2 of this thesis which investigates the decedent effect on acute bed utilisation using cross-country data, the issue arises of variation in location at death across countries. I discuss this issue as it pertains to my analysis in Chapter 5. My understanding of location at death developed from a wide

literature review, summarised in Table 2.1, which illustrates the great variability in place of death across countries, within countries and over time. In China, 92% of the oldest old die at home, where it is a matter of "filial piety" to care for old, frail parents (Gu et al. 2007). In Canada in 1994, 78% of deaths occurred in hospital but this rate had fallen to 61% by 2004 (Wilson et al. 2009). In Japan in 1951, 82% of deaths occurred at home but by 2000 home deaths had fallen to under 15% while over 70% of deaths occurred in hospital (Yang et al. 2006). Rates of hospital and home death across countries fall between these extremes.

A common finding in studies of location of death is the much greater likelihood for an older person, who is resident in a long-term care facility, of eventually dying there, whereas older people who are resident and receive care at home, are more likely to be admitted to hospital close to death. A study in one county in Sweden in 2001 that excluded sudden deaths found that the mean age for hospital deaths was 76 while the mean age for deaths in residential care facilities was 84.5; 85% of those who died in hospital had lived at home previously; 91% of those who died in residential care had been living there previously (Jakobsson et al. 2006). Larsson et al (2008) in a study of care in the last year of life in Stockholm for people aged 83 and over, who died in the years 1995-2004, found that the percentage of older people in long-term institutional care increased steadily with a steeper gradient in the last 6 months before death; and the proportion cared for in hospital increased dramatically towards the end of life, with time to death increasing the odds of hospital admission by 75% in the last 9 months prior to death (Figure 2.3). Cohen (2008) confirmed that the peak age of hospital death in Sweden in 2002 was in the 70-79 age range.

Studying place of death in Flanders, Van Rensbergen et al (2006) found that the chance of in-hospital death was 41% lower in locations with a nursing home and decreased with age. An increasing propensity with age to die in a nursing home was observed in the 1980s in Australia (Roder et al. 1987; Clifford et al. 1991) while a multi-variate analysis of deaths in the USA in 1997 found numbers of nursing home beds associated with increased nursing home deaths but numbers of hospital beds associated with deaths in neither location (Gruneir et al. 2007).

Table 2.1 Percentages of deaths occurring in differing care locations, evidence from the literature (*Cancer deaths **Deaths from specified chronic diseases)

Country	Home	Acute hospital/ Hospital	Long-stay facilities	Hospice	Other	Year (s)	Source
Ireland	25	48	20	4	3	2004/2007	Irish Hospice Foundation (2010)
Dublin*	23.7	51.1	3.9	20.2	1.1	1996	Tiernan et al (2002)
UK (England & Wales)	31					1974	Gomes and Higginson (2008):
	19.4	54.3	19.7	4.2	2.4	1999	Long-stay includes non-NHS
	18	57.8	17.8	4.3	2.1	2003	hospitals
England		58.1	17.2			2003	Cohen et al (2008)
Scotland		58.5	18.1				
Wales		62.8	14.1				
Wales	37.6	56.7	5.7			1981	Ahmad and O'Mahony (2005)
	22.1	61.7	16.2			2001	
Belfast*	35	50	13			1977	Davison et al (2001)
	28	42	23			1997	
11 SHARE countries : all	38.5	47.6	13.9			2006	Jurges (2008), figures for West
South: ESP/GRC/ITA	49.9	46.8	3.3				own extrapolation
North: SWE/DNK/NLD	29.1	42.5	28.4				
West: DEU/AUT/CHE/BEL/FRA	35	55	10				
Italy* All	57.9	34.6	6.5	0.7	0.4	2002/2003	Beccaro et al (2006)
South	94	4.6	0.9		0.5		
North-East	28.2	60.2	10.3	1.4			
Centre	59.7	33	5.2	1.1	1		
Greece*	50.8	49.2				1995	Mystakidou (2009) calculated from
	44.7	55.3				2005	tables.
Spain*	46.2	50.2				1980s	Jimeno et al (1993)
Sweden:		62.5				2002	Cohen et al (2008)
Sweden: one county.	9.2	46.7	41.9	1.7	0.4	2001	Jakobsson et al (2006)
Norway	35	32	32			1992-1995	Klinkenberg et al (2005)
Netherlands**		31				2003	Van der Velden et al (2009)
	31	28	36		5	2006	
Netherlands		33.9	33.5			2003	Cohen et al (2008)
Switzerland: German speaking	22.7	37.2	33.5			2001	Fischer et al (2004)

Table 2.1 cont. Percentages of deaths occurring in differing care locations, evidence from the literature (*Cancer deaths **Deaths from specified chronic diseases)

Country	Home	Acute hospital/ Hospital	Long-stay facilities	Hospice	Other	Year (s)	Source
Belgium (Flanders)	24.3	51.6	22.2		2.2	2003	Cohen et al (2008)
Belgium (Flanders)		53.7	19.8			2001	Cohen et al (2006)
Belgium (Flanders)	22	50	28				Van Rensbergen et al (2006)
Turkey	c 40	c. 60	few	none		n.a.	Oguz et al (2003)
Poland		55				2000	International Observatory on End of Life Care (2003)
USA		54				1983	Flory et al (2004)
	17		16			1990	
	22	41	22			1998	
USA	21.4	49.6	22.2		6.8	1997	Hansen et al (2002)
USA	24	53	24			1997	Gruneir et al (2007)
Canada	19.3	77.7	3			1994	Wilson et al (2009)
	29.5	60.6	9.9			2004	
Canada: Alberta		53				1992/1993	Wilson and Truman (2001)
		44				1996/1997	
Canada: Ontario, aged 66+	20.3	49.2	30.5			2001/2002	Motiwala et al (2006)
Mexico City	54	46				2003	Cardenas-Turanzas (2007)
Japan	82					1951	Yang et al (2006)
	<15	>70				2000	
China: aged 80-105	92	7	1			1998-2002	Gu et al (2007)
Western Australia	20.2	48.6	17.8	5.5	6.3	2000-2002	McNamara and Rosenwax (2007)
South Australia*	15.8	54.6	9.7	19.9		1990-1999	Hunt et al (2001)
Victoria	21	57	14	2		1988	Clifford et al (1991)
South Australia*	14	67	10	9		1981/1985	Roder et al (1987)
New Zealand	30.8	39	29.5		0.6	1996	New Zealand Palliative Care Strategy (2001)
Maori	53.2	35.5	8.5		2.8		

Figure 2.3 Proportion using home help, institutional care or in hospital preceding death

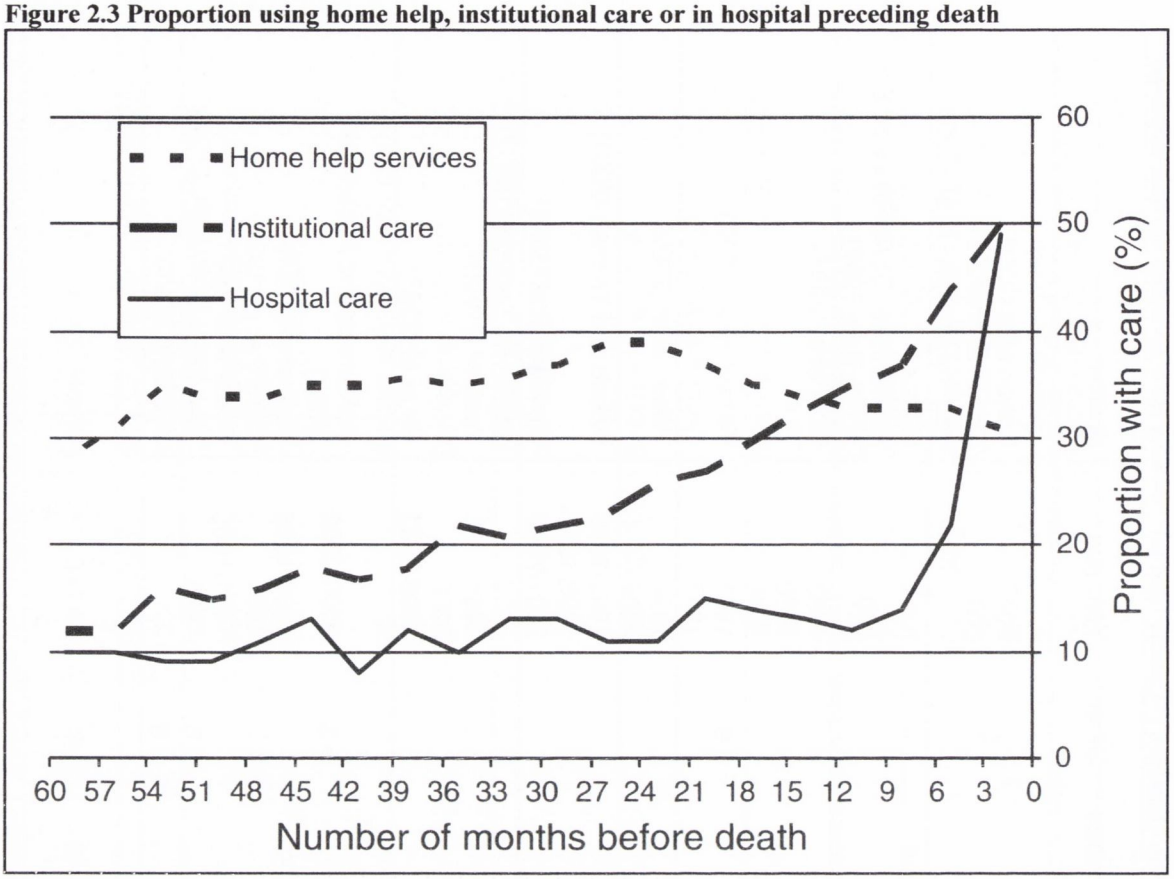


Figure 2 from Larsson et al (2008: 353) Proportion using home help, residing in institutional care facilities or in hospital, per 3-month period preceding death in the Kungsholmen study population, Sweden, 1995–2004. ©Springer-Verlag 2008: With kind permission from Springer Science+Business Media.

2.6 The relationship between informal care supply, female labour force participation and health and long-term care utilisation

Recognition of the effect of utilisation or supply of care in one setting on utilisation of care in another requires analysis of the balance of care to extend to the complex area of the supply of care by informal, unpaid and usually family carers. Informal care and formal home care were found to be substitutes in a cross-sectional study for 11 EU countries (Bolin et al. 2008) while informal care was found to be an effective substitute for formal, home care only when the need was for low, unskilled care (Bonsang 2009).

Availability of informal care is commonly proxied in models of long-term care demand by female labour force participation (Schulz et al. 2004; OECD 2006). However, there is mixed evidence on the effects of female labour force participation on long-term care expenditure and on the association between parental need for care and women's labour

market behaviour. Yoo et al (2004) found an unexpected negative association between the proportion of women in the labour force and LTC expenditures, which could reflect a shift to part-time work by women providing care for older relatives so that a rise in numbers of part-time working women would be negatively associated with formal LTC. This study concluded that projections of future long-term care demand should distinguish between female part-time and full-time work, with the former associated with decreases and the latter associated with increases in LTC expenditures. Crespo and Mira (2008) found that within Europe there was a North-South gradient in the response of women to their parents' care needs following an adverse health shock. Although women in middle age whose parents suffered a health shock were less likely to be in paid employment, this association was stronger in Southern Europe than in Northern Europe. Such studies suggest a heterogeneity in the relationship of female labour force participation, informal care supply and care need, which may reflect the development of formal long-term care services; cross-country variability of rates of part-time employment; and cultural differences in the strength of family ties (Bolin et al. 2008; Reher 1998).

When Schulz (2004) analysed in detail utilisation of health and nursing care by older people in EU countries, she found that most informal long-term care recipients lived in households where care was predominantly given by members of the family – especially daughters, daughters-in-law and spouses, the majority of whom were aged from 30 to 59. Around 68% of caregivers in EU countries were women and 32% men. In most cases women retained primary responsibility for care and provided personal care, emotional support, meal preparation and housekeeping, while care-giving by men mainly included transportation, bills and banking, shopping and general monitoring. Women provided greater amounts of informal caring work than the average gender share represented. Schulz found that in all EU countries family structures were changing, with a fall in the proportion of elderly persons living with their children. Opposing trends were a decrease in the share of widowed people in older age groups but an increase in the share of single and divorced people in younger and middle-aged groups. Numbers of potential caregivers in the oldest age groups might therefore increase due to increasing life expectancy but potential caregivers in the younger and middle-aged groups might decrease.

These opposing trends of increasing female labour force participation and reducing disparity in male and female life expectancy with the potential consequence of older people surviving together longer as couples makes future informal care supply uncertain.

Pickard (2002) found a drop in the provision of care from outside the household over the period 1985-1995 in the UK with a marked decrease in the number of people providing care to parents or parents-in-law but with provision of care to spouses increasing significantly. The total number of carers had declined while there had been an increase in the number of carers providing the most intensive care. Karlsson et al (2006) examined the effects of having male care-giving patterns converge to those of females (and vice versa) and found that under a baseline health improvement scenario there was likely to be a sufficient supply of care to meet demand provided care-giving patterns were sustained but, if female care-giving patterns converged to those of males, there would be a shortage of care. Pickard (2008) found no evidence of any convergence in the probability of people providing intense care to their older parents; rather, the evidence suggested that the likelihood of female care-giving patterns converging to those of males had increased over time.

In analysis of determinants of acute and long-term care utilisation, household composition is a key factor in determining need for formal long-term care. Living alone at older ages has been found to be a significant predictor of acute care utilisation in the UK (Carr-Hill et al. 1994; Martin and Smith 1996). Living alone has also been widely found to be a predictor of formal LTC need because intense care needs can generally only be met informally by co-resident carers. A longitudinal study for the Netherlands found that while age is a very strong predictor of the use of long-term care services, people who live alone are more likely to use formal long-term care services than people who have co-resident carers (Portrait et al. 2000). Living alone has also been found to be a significant predictor of residential long-term care utilisation in Northern Ireland (Connolly and O'Reilly 2009); England (Wittenberg et al. 1998) and Germany (Klein 1996). Yoo et al (2004) in a longitudinal study for 15 countries from 1970 to 2000 found that availability of care by a spouse, proxied by the ratio of men to women at older ages, was associated with substantially reduced long-term care expenditure whereas availability of an adult child caregiver had a much smaller effect. The potential for improved male life expectancy to lead to reduced widowhood and greater care-giving by spouses is, however, tempered by

increases in the proportion of separated and divorced people in developed countries (Kinsella and Velkoff 2001).

2.7 Welfare perspectives on the balance of care

Alternative welfare perspectives on whether it is preferable that care should be delivered in the acute or long-term care sector, either formally or informally, are influenced by differing ways of measuring welfare. If GDP is regarded as an accurate measure of national welfare, then service delivery which reduces the proportion of GDP expended on health and long-term care services for the same health outcome may be deemed an efficient use of resources. The relatively high cost of acute care provision has influenced policy approaches to re-configuring care from the acute hospital setting in many countries, with effects that can be highly variable depending on such factors as initial hospital supply in relation to need and the availability of care in other settings (McKee 2004). While reducing hospital bed numbers did not appear to adversely affect care of older people in Canada; in the UK adverse effects on care were apparent and, because of the cost of alternative care, only about 20% of anticipated cost savings were realised (Beech and Larkinson 1990).

Alternatively a rights-based approach to welfare may encompass a wider measure than health outcomes. Mansell et al (2007a) describe supporting disabled people to live in the community as equal citizens as an issue of human rights, citing the European Parliament's 1996 Resolution on the Rights of Disabled People which called on the European Commission and member states to promote the social inclusion of people with disabilities; proposed that disability rights be treated as a civil rights issue; and that institutionalisation should be avoided. However, this cross-country study of alternatives to institutionalisation concluded that developing appropriate services in the community is a necessary, but not a sufficient, condition for better results.

> "A new care arrangement (such as community-based care) could be more expensive than the arrangement it is replacing (such as long-stay hospital provision) but still be more cost-effective because it leads to better outcomes for service users and perhaps also for their families, and those improved outcomes are valued sufficiently highly to justify the higher expenditure. (Mansell et al. 2007a:8)"

The "new home economics" further extends the measurement of welfare by analysing the household as a unit of production as well as consumption and recognising the increased welfare or utility that can be derived from unpaid activity within the household (Gronau 1973) . A development of this concept is the theory of the "social production of welfare" which provides a framework for the analysis of the consumption of social services and the impact of welfare policies (Netten and Davies 1990). In this framework the unit of consumption is a unit of production of commodities, which with the advent of disability extends from the household to the informal care network. Social care agencies become involved when the informal care network can no longer provide sufficient basic commodities, such as nutrition and personal care, to meet need. Netten and Davies developed a general model of social care in which the motivation for production is to achieve one's own and others' welfare or utility, which is dependent primarily on: commodities produced within the household; the distribution of time across activities; and the welfare of other individuals in the informal care network. Related research developed a normative approach to the provision of long-term care, based on quantitative, preference-based outcome measurement which develops and values social outcomes found to be important to older people (Netten et al. 2002; Netten et al. 2005; Netten et al. 2006).

A welfare perspective that regards increased GDP per capita as an appropriate measure of national welfare would favour the Northern paradigm of formal care in residences or at home and greater female labour force participation over the Southern paradigm of lower female labour force participation, greater provision of informal care and more co-resident home caring. The theory of the "social production of welfare" offers an alternative framework to assess welfare by including non-monetized transactions. A welfare perspective that ignores the welfare contribution of unpaid caring work may mis-calculate the effects of re-configuring the balance of care, if for instance reduced institutional care provision leads to greater demands on informal carers. Conversely, economic incentives designed to increase female labour force participation and GDP may mis-calculate the consequent welfare effect by failing to take into account increased demand for formal care.

Mortensen et al (2004) pointed out that discussion of the social and economic consequences of ageing often conclude that the EU should increase the labour force participation of women and reverse the tendency towards early retirement. Yet in many countries and regions of Europe women, and notably middle-aged women, were involved

in informal care-giving to older people. "In fact, a low labour-force participation rate for women is in many countries associated with a relatively low level of development of formal, institutionalised care-giving for the elderly." This study pointed out that in addition to disparities in labour force participation by women across Europe, there were disparities in part-time employment, which could enhance women's capacity to care for children and older people. Part-time employment accounted for a major part of the total activity rate for women in the Netherlands and in the UK and was also important in Belgium, Denmark, Germany, France, Austria and Sweden, but it was comparatively low in Greece, Spain, Ireland, Italy, Portugal and Finland. Spain, in contrast to most other EU countries did not have "any social provision system to cover catastrophic risks associated with old-age dependency. Consequently, LTC is mainly ensured by the families by means of informal care" (Mortensen et al. 2004: 18)

The relationship between female labour force participation and national income presents particular challenges to models of determinants of acute or long-term care utilisation or spending. Encountering these challenges in my analysis required some review of the literature on measures of national welfare, on imputing value to non-monetized transaction in development economics and on the relationship of female labour force participation to reduced productivity (Sen 1976; Quah 1989; Deaton 1995; Boeri et al. 2005). I discuss this literature and its relationship to my analysis in Chapter 7.

2.8 Projecting the effect of age on future acute and long-term care spending or utilisation

Many studies have projected the impact of ageing on health and social care, although usually separating analysis of the two sectors. Assuming constant age-specific morbidity but differentiating between utilisation by survivors and decedents, Schulz et al (2004) forecast that population ageing in Germany would cause a moderate increase in hospital days but a much greater increase in the number of people receiving long-term care. Changes in the composition of private households and the increasing labour force participation of women would lead to additional demand for professional caregivers at home and in institutions.

The Economic Policy Committee of the European Commission, in its exercise examining the budgetary implications of population ageing across the EU, found that in general countries that were projected to experience the highest overall increases in total public expenditure on both health and long-term care would see the larger part of this increase come from LTC expenditures (European Commission 2001).

When Wanless (2002) provided a detailed examination of the resources required to fund the UK's National Health Service over two decades, the authors conceded that despite the inextricable links between health and social care and the need for whole systems modelling to understand their interactions, they had neither the information nor the resources to develop a whole system model. Wanless described the current balance between health and social care as "wrong" with too much focus on the acute hospital sector where over 10% of patients aged over 75 suffered delayed discharge due to waits for assessment or funding for nursing home or residential care placement. Wanless advocated that future such exercises should consider health and social care together, in a simulation model taking into account the resources required to deliver the most appropriate care in the most appropriate place, including home or care homes (Wanless, 2002).

OECD (2006) forecast public heath and long-term care expenditures in a framework that took into account demographic and non-demographic drivers of spending including death-related costs and the health status of the population. In forecasting long-term care spending, this exercise included the effects of increased labour participation, reduced informal care, and wage inflation. Forecasts for neither health nor LTC sector consider the effect of variations in the supply of care in the alternative sector. The methodological implications of this approach are discussed in Chapter 4. Distinguishing between the effect of ageing on health and LTC expenditures, this study found that the greater pressure on public expenditure would arise from LTC. Whereas under certain assumptions, ageing would increase health care spending on average across the OECD by 0.6% of GDP over the years 2005-2050, this effect would be doubled in the case of LTC spending, which under the same assumptions was projected to increase on average by 1.2% of GDP over the same period. This study forecast greater growth in public spending on LTC for countries such as Ireland, Greece, Italy and Spain, where female labour force participation rates were projected to increase significantly for the 50-64 year old cohort, whose parents were most likely to become disabled by ageing.

Recognition of the importance of understanding the need for long-term care and better planning for its provision has prompted a growing body of research in recent years. A study of long-term care was a major component of the OECD Health Project, carried out during 2001-2004 to explore key issues in improving the performance of health and long-term care systems. OECD (2005) analysed the long-term care sector across OECD countries. The Assessing Needs of Care in European Nations (ANCIEN) project which began in 2009 is currently researching future needs for long-term care for older people in Europe. Huber et al (2009) assembled available data on long-term care in Europe and North America. Wittenberg, Comas Herrera et al (2006) forecast demand for long-term care for older people in England. Batljan and Lagergren (2005) developed forecasts for long-term care demand in Sweden. In general, forecasts of the effect of ageing on LTC demand recognise the importance of taking into account developments in age-specific disability and morbidity rates in older people. This approach informs the analysis in Section 3 of this thesis, which develops forecasts for long-term care demand in Ireland. Appendix B expands on alternative approaches to modelling long-term care need, demand and expenditure; and reviews the data requirements for such models and the data limitations that constrain the modelling approach in Section 3.

2.9 The Irish literature on ageing and health and social care

Interest in the effect of ageing has been stimulated in Ireland by realization that Ireland's relatively youthful age profile is about to change rapidly, with the percentage of population aged 65 and over forecast to rise from 11 per cent to 15.4 per cent and the proportions aged 80 and over and 85 and over to rise respectively from 2.7 per cent to 4.0 per cent and 1.1 per cent to 2.1 per cent in the years 2006-2021 (Morgenroth 2009). Over the last 15 years, analytical opinion has shifted from discounting ageing to perceiving ageing as a central, if not *the* central, driver of health spending.

In 1995, Fahey argued that supply was the main influence on health service consumption, pointing to consumption growth in Ireland over the years 1960 to 1990 when there was no significant population ageing. Consumers constituted "a vast, possibly unlimited, pool of potential demand" (Fahey 1995). Larragy (1995) in contrast countered that ageing was important and would occur at an unprecedented rate in the years to 2026. Postponement or

compression of morbidity would come at a cost to health care utilisation and expenditure. He demonstrated J-curves in inpatient days by age group in the years 1979 and 1994 and urged increased formal social care provision to support informal carers or substitute for their absence.

An influential assessment of demand for long-term care, the Mercer report (Department of Social and Family Affairs 2002) was informed by international evidence of changes in age-specific disability rates and projected long-term care demand based on four possible outcomes for disability: constant disability-free life expectancy (DFLE) as life expectancy (LE) rises; static disability prevalence; optimistic (reducing DFLE relative to LE); and pessimistic (increasing DFLE relative to LE). Published prior to findings on disability in the 2002 Census, Mercer estimated disability prevalence in Ireland by adapting a UK study. Section 3 of this thesis reviews and updates Mercer's work in the light of new evidence on Irish disability rates and more recent demographic projections.

Bennett et al (2003) forecast the impact of ageing on health and long-term care expenditure, assuming that health status and disability-free life expectancy would improve in line with increasing life expectancy. In comparing Irish spending with spending in other EU countries, these authors implicitly assumed that age is the major driver of health care costs. Somewhat inconsistently with their earlier analysis, they assumed that Irish age-cost shares have cross-country validity so that age-specific cost is constant across countries and homogeneous for older and younger people, based on an arbitrary cut-off at age 65. Thus, they created an index of "age related demand" in which each person aged under 65 years contributes one unit of per capita demand compared to 6.8 units for each person aged over 65. This ratio was based on the authors' estimate that the unit cost of health care in Ireland is 6.8 times greater for people aged over 65 than for people aged less than 65 years.

Bennett et al concluded:

> "Ireland has the lowest proportion of its population aged 65 or over of the EU countries [original 15 members]...Therefore on the basis of age profiles alone we would expect that Ireland would currently have the lowest level of demand for healthcare services and, therefore the lowest requirement for such services." (Bennett et al. 2003: 24)

De Buitleir and McArdle (2003) similarly identified that Ireland's relatively low old age dependency ratio should enable "large saving in health spending". They cited a Canadian study (Esmail and Walker 2002) which had estimated that Ireland's favourable demographics was worth 2.5 percent of GDP in a requirement for lower health spending in 1999. Esmail and Walker (2002) had observed that health spending in Canada over the years 1980 to 2001 had increased by 23% in volume while the population share aged 65 and over increased by 33%. They assumed that population ageing was entirely responsible for this 20-year increase in health spending and extrapolated that for every 100% increase in population aged 65 and over, there would be a 69.8% health spending increase. Esmail and Walker (2002) derived a 69.8% age adjustment factor by dividing percentage growth in the share of population aged 65 and over in Canada into percentage growth in the volume of health spending over the years 1980-1981 to 2000-2001. Esmail and Walker applied this 69.8% "adjustment factor" to the difference between Canada's share of population aged 65 and over and the share in Sweden, the country with the greatest population ageing, to calculate how high spending would be in Canada were its age share the same as Sweden's. Application of this formula to Ireland's health spending in 1999 resulted in an estimate that, were Ireland to have the age share of Sweden, Irish spending would be higher by 2.6% of GDP.

Esmail and Walker's attribution of the health spending increase in Canada over the 20 years from 1980 to 2001 purely to population ageing, because these events occurred simultaneously, runs counter to the accumulated evidence about the relationship between ageing and health spending reviewed in this chapter. These authors' further assumption that population ageing in other countries might be expected to have the effect on health spending that they interpret for Canada is equally tenuous. The assumption that Ireland's relatively youthful population should require relatively low health spending rests on this foundation of Esmail and Walker's attribution of higher health spending in Canada entirely to population ageing.

Esmail and Walker's approach to population ageing has been influential in Ireland. The National Economic and Social Council, representing the social partners and nominees of the Irish Government, published a substantial analysis of the Irish welfare state in 2005, which in discussing "why Ireland's social spending appears low in international rankings" cited the work of Esmail and Walker (2002) as well as Bennett et al (2003):

> "... any exercise that seeks to adjust health spending in EU member states for the proportions of elderly people in their populations will see Ireland's ranking for 'health effort' (health spending as a proportion of GDP or GNP) improve notably. Bennett et al (2003: 24), for example, estimate that public health spending in Ireland as a per cent of GDP, when it was 18 per cent below the average for the EU 15 in 2001, could be recalculated as 7 per cent below the EU 15 average when adjusted for the age structure of each country's population. In similar fashion, when a Canadian study adjusted Ireland's relative spending on health in 2001 to reflect its relatively young population, Ireland moved from being ranked the 6th lowest spender among 27 OECD countries to a middle ranking (14th) (Esmail and Walker, 2004) (*sic*)" (National Economic and Social Council 2005: 116)

Barrett and Bergin (2005) in an assessment of age-related pressures on the Irish public finances assumed constant age utilisation rates over time and derived them from acute bed utilisation data showing that people aged 65 years and over used hospital beds six times more intensively than those aged less than 65 years. In projecting health spending, these authors divided total health spending in 2005 by the population aged under 65 years plus six times the population aged 65 years and over to generate "spending per under 65 years equivalent". To project future health spending, following indexation, they multiplied spending per under 65 years equivalent by forecast numbers of people aged less than 65 years plus six times numbers of people aged over 65 years. This exercise therefore rests on a number of assumptions: constant age-specific patterns of utilisation; the applicability of utilisation patterns in acute hospital care to the entire health care budget; and, as in Esmail and Walker (2002), the attribution to age of the role of primary if not exclusive driver of health care costs. Barrett and Bergin forecast spending on long-term care for older people by indexing to changes in the population aged 65 years and over and to nominal earnings.

From publications such as NESC (2005) and Esmail and Walker (2002) a perspective developed of an Irish health care system that was over-endowed relative to Irish demographics, so that evidence of unmet demand must reflect organisational inefficiencies rather than capacity deficiency. The Health Service Executive commissioned a study of the potential for reducing acute care utilisation, PA Consulting Group (2007a), which projected two alternative acute bed capacity requirements, based on current practice or a preferred health system (PHS), which would reduce the role of the acute hospital. From OECD Health Data 2006, PA concluded that Ireland had more beds per inpatient than the

OECD average. However, OECD Health Data 2006 also ranked Ireland as the OECD country with the fifth highest acute care turnover rate, i.e. cases per available bed. The explanation for this contradiction is that PA equated OECD data for surgical inpatients with all inpatients, whereas surgical patients represent a minority of inpatients in Ireland and a varying proportion internationally. With a turnover rate of 48 inpatients for every available bed in 2004, Ireland had 2.1 beds for every 100 inpatients, 34% fewer beds per inpatient than Germany, 28% fewer than Canada and 23% fewer than Australia (OECD 2006b).

Although PA's bed utilisation projections drew on Irish and international epidemiology, it was unclear to what degree such projections took into account potential developments in age-specific morbidity. PA commented, for instance:

> "Citizens aged between 65 and 74 years old are almost three times more likely than average to be in an acute hospital bed. This then rises to between six and eight times more likely as citizens become older than 74 years old. This means that under current practice, the demand for acute hospital beds may rise to unsustainable rates through 2030 to 2050 and beyond as Ireland's current population peak ages past 64 years old." (PA Consulting Group 2007a: 16)

Layte et al (2009b) examined the implications of moving to the Preferred Health System advocated by PA Consulting Group (2007a) and found that the capacity of other health care sectors to absorb a reorientation of care away from acute hospitals was extremely limited and would require substantial and sustained investment. The analysis of LTC provision and needs in Ireland in Section 3 of this thesis contributed to Layte et al (2009a; 2009b). Whereas these LTC projections are based on analysis of new Irish data on the evolution of age-specific disability by age and gender, the Layte et al (2009b) study adopted estimates of morbidity trends from the PA report which were not differentiated by age and other important factors. The study commented that such estimates were "clearly not ideal since disease prevalence may be changing at very different rates across age groups but the simplification is unavoidable. It is also very difficult to know whether this set of indicators gives a reliable measure of the impact of epidemiological change on the different areas of health care" (Layte et al. 2009c: 16)

Layte et al (2009a), the first volume in this series of studies, which analysed the effect of population change on Irish health and social care provision over the years 2001-2006, found evidence of lower age-specific acute discharge rates for people aged 85 and over than for those aged 75 to 84. This finding mirrors European Commission (2001) in qualifying the J-curve. Age-specific acute bed utilisation rates were, however, in line with the J-curve (Figure 2.4).

Figure 2.4 Age-Specific Discharge and Bed Day Utilisation Rates Per 1,000 Population, Ireland, 2004

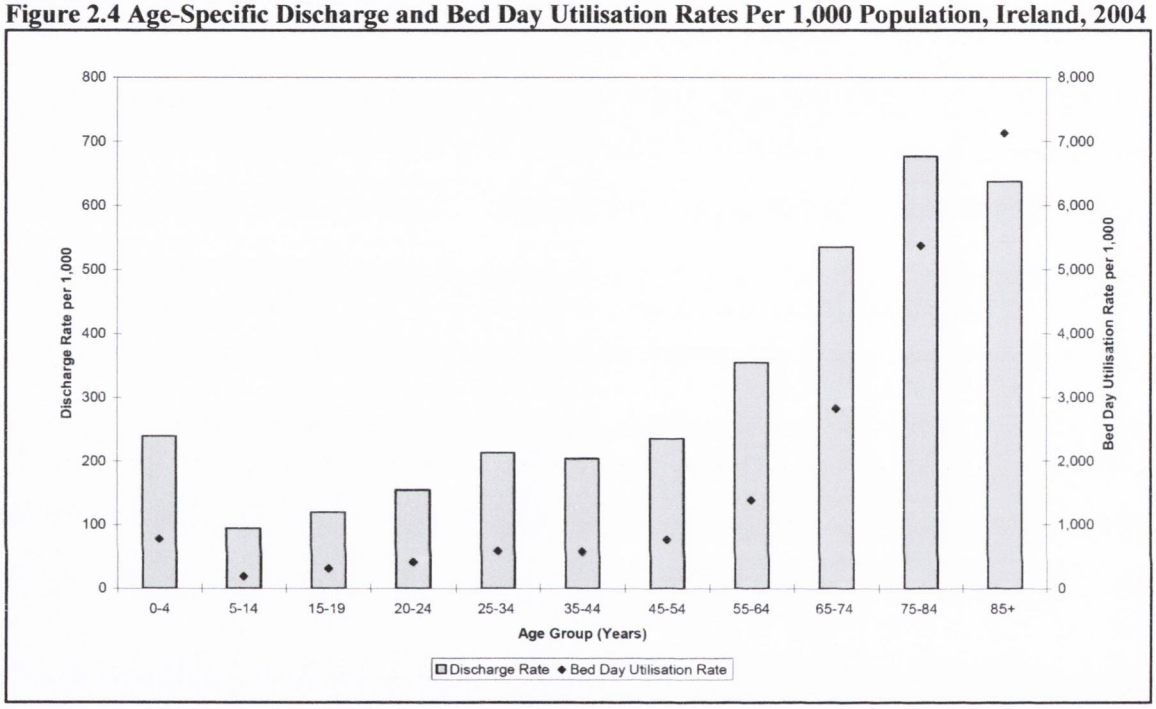


Figure 2.7, reproduced from Layte et al (2009a: 48)

With some exceptions, this review of the Irish literature on ageing and health care demonstrates the degree to which Irish analysis accords ageing a centrality as a driver of health spending and utilisation which is at odds with the international evidence. Few studies of the effect of ageing on Irish health and social care have taken into account trends in age-related disability or the significance of proximity to death costs. A number have assumed constant age-utilisation/cost rates over time and across countries. A hazard of this analysis is that an assumption that all health spending is a function of constant age-specific utilisation becomes an argument for reducing health spending in a country like Ireland, with a relatively low share of population aged 65 and over, in anticipation of an age-related cost explosion in the future. The paradox of this argument is that to act on it by

constraining spending now might ensure an avoidable cost explosion by failing to treat conditions which lead to early onset of age-related disability.

No Irish study reviewed in this section distinguishes between health and LTC spending in cross-country comparisons, with the exception of Layte et al (2009a and 2009b), to which the analysis in this thesis has contributed and which is included here in order to review those aspects of it which do not comprise portions of this thesis. The possibility that the observed relatively high utilisation rates of hospital beds by older people, from which Barrett and Bergin (2005) derive an age-related multiplier for their projections, might be a function of deficiencies in LTC provision or rapid increases in female labour force participation rather than inefficiencies in the delivery of hospital care, hypothesised by PA Consulting Group (2007a), has not been systematically examined. The peaking of hospital discharge rates in Ireland in the 75-84 year old age group is suggestive of heterogeneity in age-specific utilisation rates among people aged over 65, which most Irish analyses reviewed here implicitly discount. Yet, the earlier sections in this chapter reviewing the international literature adduce plentiful evidence of such heterogeneity: in Canada (McGrail et al. 2000); the US (Spillman and Lubitz 2000); Germany (Busse et al. 2002); and across Europe (European Commission 2001). The broad international consensus that the greater demands of ageing are and will be felt by LTC systems rather than the acute care sector casts considerable doubt on a characterization of Irish acute care as over-endowed due to the relatively youthful demographic profile of the Irish population.

2.9 Conclusion

It emerges from this review that the role played by population ageing in determining health spending or utilisation remains a topic of debate. There is consensus, however, that proximity to death is a more important determinant of health spending and utilisation than calendar age; that the effects of population ageing are greater for long-term care than health care; and that rates of evolution of age-specific disability and morbidity should be taken into account in forecasting the impact of ageing. Location at death and the location of care in the months and years prior to death differ across countries. To the degree that long-term care is developed and available it reduces acute care utilisation, especially among the oldest old. Despite a general recognition of these close linkages between health and social care, projecting the impact of ageing on either sector tends to be undertaken separately from the other.

The research and analysis in this thesis has been undertaken from a desire to add to understanding of such issues, in particular of the impact of ageing on health and social care in combination, and of how countries with differing levels of resourcing and forms of organisation of health and social care might experience the effect of ageing differently. Section 2 develops a cross-country model of acute bed utilisation incorporating national income, age, death, female labour force participation and converging life expectancies between men and women; and a cross country-model of long-term care utilisation incorporating age, female labour force participation and converging life expectancies. Section 3 projects Irish demand for long-term care over the period 2007-2021 based on an analysis of the first comprehensive, longitudinal Irish data on disability prevalence. The next two chapters in this Section discuss successively the data and the methodology employed for the cross-country analysis in Section 2.

Chapter 3 Data

3.1 Introduction

A central motivation of this thesis has been to investigate the feasibility of modelling the impact of ageing on health and social care, using available cross-country data. Recognising that it would be helpful to policy-makers if there were a formula relating need for and utilisation of acute care to need for and utilisation of long-term care at different points on the curve of population ageing, I sought in my analysis to investigate whether such a relationship could be discerned across countries and over time. Attempting such an analysis required a prior investigation of whether the available international data were adequate to support it. This chapter describes the sources of data employed in my cross-country analysis of acute and long-term care utilisation in Section 2 of this thesis and the process of data investigation, which led to my choice of these sources. The data sources employed in my analysis of long-term care in Ireland in Section 3 are described in that section.

This chapter reviews the data under the following headings: the rationale for employing macro, country level measures (Section 3.2); the strengths and limitations of the OECD Health Data database as a primary data source (Section 3.3); the rationale for employing health care utilisation rather than expenditure measures and for specific health care utilisation measures (Section 3.4); the rationale for my choice of measures of long-term care utilisation (Section 3.5); the sources of demographic data, specifically age of population, death rates at varying ages, and convergence of male and female life expectancies (Section 3.6); the labour force participation measures employed (Section 3.7); and the national income measure employed (Section 3.8). A final section demonstrates the trends in the key variables over time and across countries; and provides a key to the variables and summary statistics for the variables in the major panels (Section 3.9).

3.2 Rationale for employing macro, country level measures

The nature of the enquiry in this thesis has determined the nature of the data. Since the objective of my analysis has been to understand the balance of care across countries, it is appropriate to employ cross-country macro data. Macro data measure at the level of the country and enable analysis across countries of the relationship between such variables as GDP per capita and acute bed days per capita; whereas micro data measure at the level of the individual or some other unit subsidiary to the state such as companies and enable analysis within or across countries of the relationship between variables such as the income of individuals and their individual acute bed utilisation. These are distinct enquiries and the focus in this analysis has been on the macro relationships.

In choosing a macro, cross-country framework for my analysis, I have been following in the path of earlier studies reviewed in the preceding chapter, which have analysed determinants of health spending (Hitiris and Posnett 1992; O'Connell 1996; Barros 1998; Christiansen et al. 2006). My analysis differs from these studies because it has focused on health and long-term care utilisation measures as dependent variables and has investigated a differing range of determinants, including decedent and converging life expectancy variables.

While there are micro datasets that offer individual-level survey data which are relevant to my enquiry, such as the Survey of Health, Ageing and Retirement in Europe (SHARE) or European Union Statistics on Income and Living Conditions (EU-SILC), these do not offer as wide a spread of countries or years as the OECD Health Data database, which has been my primary data source. A further motive for employing the OECD database is that it is designed to facilitate just such cross-country analysis but has generally been put to use in analysis of health spending rather than utilisation and has only relatively recently supplied separate measures for health and long-term care. Therefore this analysis serves the further purposes of testing to what degree OECD Health Data can now support cross-country analysis of the balance of care; and to what degree an analysis focused on utilisation differs from analyses that examine expenditure.

3.3 Strengths and limitations of the OECD Health Data database

The OECD Health Data database collects and provides data covering a wide range of variables for the 30 OECD member countries from 1960 to the most recent available year. (The OECD added two new member countries - Chile and Slovenia - in May and August 2010.) A new version of the database is published annually and there are mid-year revisions. My analysis in Section 2 sources data from the June 2009 version of the database. Cross-country comparisons in Section 3 source data from the 2007 and 2008 versions of the database, the most recent versions available at that stage of my analysis.

In general, later versions of the database differ primarily in their coverage of data from more recent years, although revisions of definitions or changes in national data collection methodologies may affect some series. In order to provide an internationally consistent measure of spending on health, the OECD published A System of Health Accounts (SHA) in 2000 (OECD 2000). This accounting system excludes spending on social care from the definition of health spending. Since countries' national health budgeting systems differ - Ireland, for instance, aggregates health and social care spending - countries' compliance with SHA has varied (OECD 2002). The OECD depends on national health authorities or statistical institutions to submit data under varying headings according to its definitions. However, the detailed notes in the database on "Sources and methods" make clear the variability in countries' returns.

During the period of my research for this thesis, more recent versions of the database have expanded its coverage. The OECD is working towards developing a comprehensive database which records total health and LTC spending/utilisation and facilitates analysis of the relationship between health and long-term care spending/utilisation within countries, between countries and over time. Although the SHA excludes spending on such social programmes as non-medical/nursing care of older people, versions of the database from 2007 onwards also separately publish expenditure, capacity and utilisation data on the provision of long-term care to older people of both a social and medical character. From the 2007 version, long-term care expenditure data became available, separated into two categories: expenditure on long-term nursing care and expenditure on social services of long-term care. The first category is considered health spending and is included in the OECD System of Health Accounts; the second category is considered social spending. The OECD also now publishes a series for total current health and long-term care expenditures,

which sums current expenditure on health and expenditure on the social services of long-term care. In the 2007 version of the database, long-term care spending data were available for only two countries prior to 2003. Coverage had improved by the 2009 version but only five countries offered data for more than five years. The same limitation applied to coverage of the total health and long-term care spending series.

The 2007 version of the database included data on long-term care beds in nursing homes and, for the first time, tables on long-term care recipients in institutions and at home, data which were available for more countries and longer periods than the LTC expenditure data. In the 2009 version, a maximum of 23 countries supplied data for recipients of institutional LTC for at least one year but only 9 countries supplied data for more than 6 years. Coverage for recipients of LTC at home was more restricted. The definition of total expenditure (on health and long-term care) from the OECD System of Health Accounts includes: services of curative care (HC1); services of rehabilitative care (HC2); services of long-term nursing care (HC3); ancillary services to health care (HC4); medical goods dispensed to outpatients (HC5); prevention and public health services (HC6); and health administration and health insurance (HC7), plus investment in medical facilities. The most visible and conventionally understood health care services, such as acute hospital care and primary care supplied by general practitioners and others, come under the first "services of curative care" heading (OECD, 2000).

Since the 2007 version of the OECD Health Data database, the OECD has broadly defined long-term care as:

> "a range of services required by persons suffering from a reduced degree of functional capacity, physical or cognitive, and who are consequently dependent on help with basic activities of daily living (ADL), such as bathing, dressing, eating, getting in and out of bed or chair, moving around and using the bathroom. This personal care component is frequently provided in combination with basic medical services such as wound dressing, pain management, medication, health monitoring, prevention, rehabilitation or services of palliative care. Depending on the setting in which long-term care is provided and national programme design, long-term care services can also include lower-level care related to help with instrumental activities of daily living (IADL), such as help with housework, meals shopping and transportation." (OECD 2007d)

The further distinction remains between long-term health and social care. The OECD defines long-term health care as:

> "... ongoing health and nursing care given to in-patients who need assistance on a continuing basis due to chronic impairments and a reduced degree of independence and activities of daily living. In-patient long-term care is provided in institutions or community facilities. Long-term care is typically a mix of medical (including nursing care) and social services" (OECD 2000: 118).

The OECD defines social services of LTC as "services of home help and residential care services", predominantly aimed at providing help with instrumental activities of daily living (IADL) to people with a limited ability to perform these tasks on their own. Such social services include assisted living facilities (OECD 2005a). The OECD has been refining its system for distinguishing between the health and social components of long-term care spending and, in 2005, published new guidelines for estimating LTC expenditure. These guidelines advise that, given the potential difficulty in disaggregating medical/nursing and social spending, programs should be reported under the definition reflecting their "dominant character", or where that is not possible to identify, under the social services heading. This OECD analysis concluded that whereas the OECD had formerly focused on long-term care as a component of total health expenditure, "a better understanding of differences across countries requires going beyond the boundaries of the health system" (OECD 2005a).

The definitions of LTC spending in the 2007 and subsequent versions of the database derived from these guidelines, which apply pending the publication of a new edition of the SHA Manual, not expected before end-2010. Meanwhile, the OECD acknowledges that the issue of defining the boundary between health and long-term care remains unresolved and data collection on LTC resources and utilisation requires improvement (OECD 2010). In analysis in 2005 of 12 countries' reporting of their LTC expenditure, the OECD noted that although, in theory, expenditure on LTC services to be included in health expenditure should be only those that required nursing, in fact "countries include spending items on 'Residential care/home help' to a varying extent in data reported to OECD Health Data. This clearly indicates that LTC data in OECD Health Data cover different set of services

in these countries, because countries set borderlines between health and social services in differing ways" (OECD 2005b: 25; Figure 3.1).

Figure 3.1 Percentage of 'Total LTC' reported as Long-Term Care to OECD Health Data

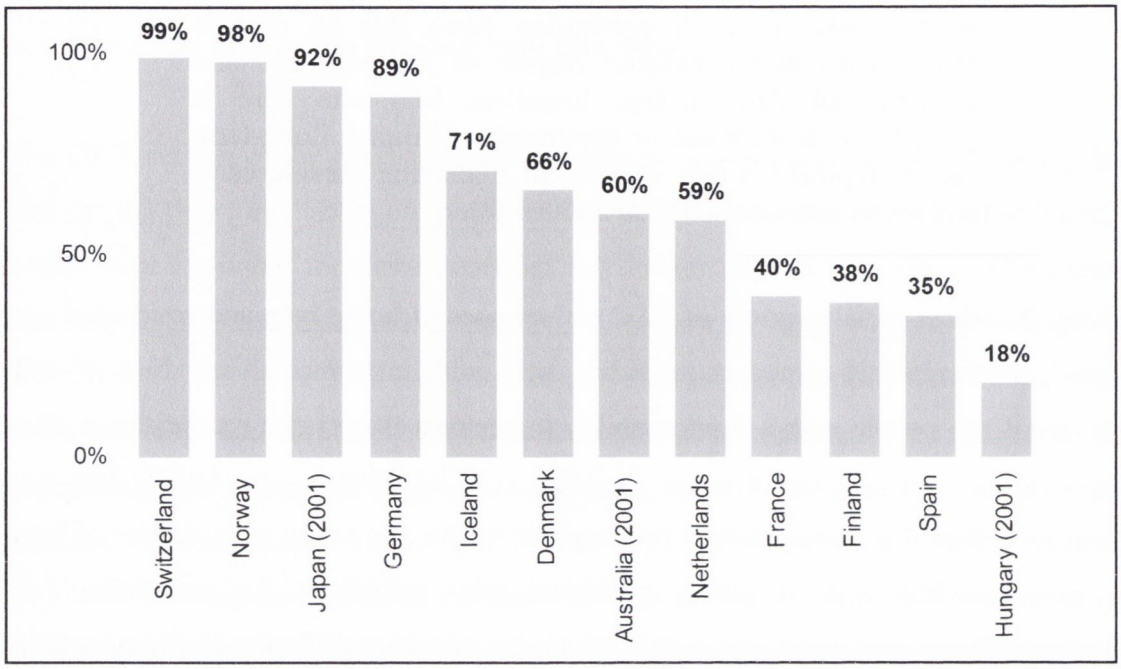
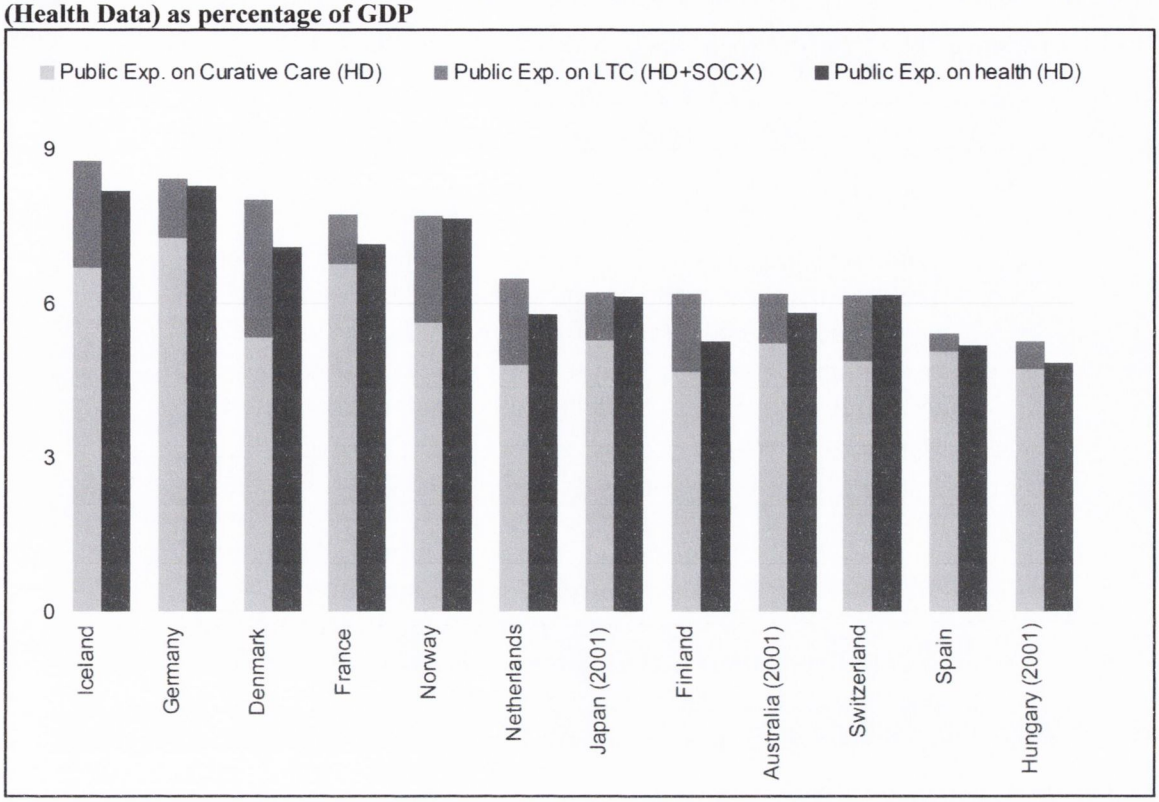


Chart 1 reproduced from OECD (2005b: 26)

This analysis identified two groups of countries: in the first group, total public expenditure on health in OECD Health Data in effect included health and LTC spending; in the second group, it included only a part of public spending on residential care and home help. The first group included Norway, Switzerland, Japan and Germany; and the second group, Denmark, Australia, Netherlands, France, Finland and Spain. In the second group the proportion of total LTC reported as LTC to OECD Health Data ranged from 66% to 35% (Figure 3.2; Table 3.1).

In its 2005 guidelines for estimating LTC expenditure, the OECD observed that different estimation methods of long-term nursing care expenditure might affect total health expenditure by up to 10% or more. Such differences in data on long term care expenditure reflected not only differences in countries' organisation of LTC services but also differences in data availability and interpretation of the SHA Manual, which failed to address some important questions (OECD 2005a).

Figure 3.2 and Table 3.1 'Total Public Expenditure on Health and LTC' vs. Total public expenditure (Health Data) as percentage of GDP



	a Public exp. on health (OECD HD)	b Public exp. on LTC (OECD HD)	c=a-b Public exp. on curative care (OECD HD)	d Total public exp. on LTC (HD+SOCX)	e=c+d Public Total Health and LTC
Iceland	**8.2**	1.5	6.7	2.1	**8.8**
Germany	**8.3**	1.0	7.3	1.1	**8.4**
Denmark	**7.1**	1.8	5.3	2.7	**8.0**
France	**7.1**	0.4	6.8	1.0	**7.7**
Norway	**7.7**	2.0	5.6	2.1	**7.7**
Netherlands	**5.8**	1.0	4.8	1.7	**6.5**
Japan (2001)	**6.1**	0.8	5.3	0.9	**6.2**
Finland	**5.2**	0.6	4.7	1.5	**6.2**
Australia (2001)	**5.8**	0.6	5.2	0.9	**6.2**
Switzerland	**6.1**	1.3	4.9	1.3	**6.2**
Spain	**5.2**	0.1	5.1	0.3	**5.4**
Hungary (2001)	**4.8**	0.1	4.7	0.5	**5.2**

Chart 2 and Table 2 reproduced from OECD (2005b: 27) Total current public expenditure on LTC is the sum of LTC public expenditure (OECD Health Data) and expenditure on Residential care/home help in old age and disability functions (OECD Social Expenditure Database) minus estimated overlap, informed by complementary data collection and consultation with experts.

These OECD exercises in refining definitions and data collection for long-term care reflect an appreciation that cross-country comparisons require an understanding of the resources devoted to both health and social care and achieving this requires identifying care delivered outside the health care system. The OECD seeks to collect basic information

about spending on health and social care for older people and people with physical and mental impairments, regardless of whether an item is recorded in the health or social statistics of member countries. Developments within long-term care provision make this a challenging exercise.

> "Trends of long-term care policy over the last ten to twenty years have resulted in the spread of models of care provision where persons with functional limitations are provided with a continuum of care. This provides for individual choices among an increasing number of combinations between independent living in the community, living in the community with various levels of intensity of (constant) monitoring and increasingly comprehensive packages of care, and finally "hospital at home" or nursing home-type arrangements for those with most severe care needs. These innovations in long-term care policy blur the boundaries between residential services and other long- term care services." (OECD 2005a: 15)

So broad is the scope of the definition of long-term care recommended in the OECD guidelines that it includes all social services expenditure in support of informal care-givers including any special social protection rights, such as pension entitlement for time spent on informal care, and counseling and training of care recipients and informal care-givers.

The challenge of distinguishing between the social and medical aspects of long-term care suggests that in the reality of the "continuum of care" this distinction may frequently be so tenuous as to represent a false dichotomy, which is perhaps the underlying reason for the difficulty and delay in reaching agreement on OECD definitions. Intellectually, such definitions are arbitrary attempts to describe a reality, in which people require services from different points on the care continuum in differing combinations at different times. Many long-term care services - such as home help or personal care for people with disabilities - have multiple purposes, some of which might be regarded as medical and some as social.

The strengths of the OECD database remain: it is the least-worst source of data on a wide range of variables relating to health and social care; it endeavours to ensure comparability; and it clearly states where problems exist in ensuring comparability. Its limitation is that this is a challenging task, particularly with regard to long-term care. While it is appealing

to apply statistical or econometric analysis to cross-country time series on acute and long-term care provision in order to determine the substitutability of one form of care (or expenditure) for the other, this detailed OECD work is cautionary. Useful conclusions about the relationship between acute and long-term care need to be grounded in an understanding of the systems and data of the countries being compared.

3.4 Why and which measures of health care utilisation

The literature review in Chapter 2 explored how cross-country analyses of the influence of ageing on health care typically investigate effects on some measure of the volume of health care spending. However, as the detailed OECD data analysis described above illustrates, health spending is so intricately inter-connected with long-term care spending that to compare or analyse levels of one without taking into account levels of the other, or to analyse the determinants of a measure of health spending, which includes LTC spending in its entirety for some countries but a varying proportion of it for others, may lead to erroneous conclusions about countries' relative spend on caring in the broader sense or the drivers of health spending in the narrower sense.

The difficulties in separating measures of health and long-term care spending in a manner which is compatible across countries represents a strong argument in favour of employing health and long-term care utilisation measures instead of expenditure measures in analysis of the balance of care. Understanding the balance between health and long-term care is of particular relevance in reaching any conclusions about how much of their resources countries devote to care and how that resource allocation is influenced by ageing.

The further possible approach to cross-country comparison or analysis of health and long-term care spending would be to sum health and long-term care expenditures by country and to express these sums either per capita or as a percentage of GDP. The OECD's new series for total current health and long-term care expenditures should eventually facilitate such analysis but, to date, the data available under this heading are very limited. Analysis of long-term care spending is further restricted by differing inter-country definitions. Furthermore, analysis of health and long-term care spending separately or in combination confronts the difficulties that, although such expenditures can be adjusted for currency fluctuations and relative inflation rates (as in the OECD's US$ purchasing power parity

conversion), such adjustments may not fully capture the inflationary forces specific to a country's health care sector; and to sum health and long-term care expenditures assumes that the cost of care in one sector can be equated to the cost of care in the other, when there is evidence that this is not the case.

Such reservations eventually persuaded me to adopt an alternative analysis based on measures of health and long-term care utilisation in order to investigate the balance of care across the OECD. Conceiving the balance of care as comprised of acute care, long-term care in institutions, formal long-term care at home and informal care, I employ acute bed days per capita as the measure of acute care utilisation. I chose this measure of utilisation because, despite some limitations in relation to cross-country comparability, these appeared fewer than those of the available alternatives. OECD Health Data's alternative utilisation measures include discharge rates for all causes and for surgical procedures, and, in the case of surgical procedures, discharge rates for both inpatient and day procedures. For each of these measures, there are important restrictions to cross-country comparability. OECD Health Data warns that the discharge rate from all causes is limited in comparability because although it is formally defined as discharges after inpatient care, a number of countries include under this heading at least some day cases. Countries whose data are therefore comparatively over-stated include: the UK, the US, France, Finland, Austria and Italy (OECD 2009b). Limiting analysis to discharges after surgical procedures would be unrepresentative of hospital activity since inpatient care for patients, whose treatment is medical as opposed to surgical, comprises a sizeable proportion of hospital activity, is required more commonly by older than younger people and accounts for a majority of discharges in many countries.

OECD Health Data defines beddays as "days during which a person is confined to a bed and in which the person stays overnight in a hospital" and, therefore, excludes day cases. Acute care is defined as "curative care" with the principal clinical intent of managing labour, curing or treating injury, performing surgery, relieving symptoms of illness or injury (excluding palliative care), reducing severity of illness or injury, protecting against exacerbation or complication of illness or injury; and performing diagnostic or therapeutic procedures. Although OECD Health Data supplies measures of acute bed days expressed per capita, since I employ an alternative source of demographic data in this analysis,

discussed below, I convert OECD bed days per capita from the OECD population count to the alternative count.

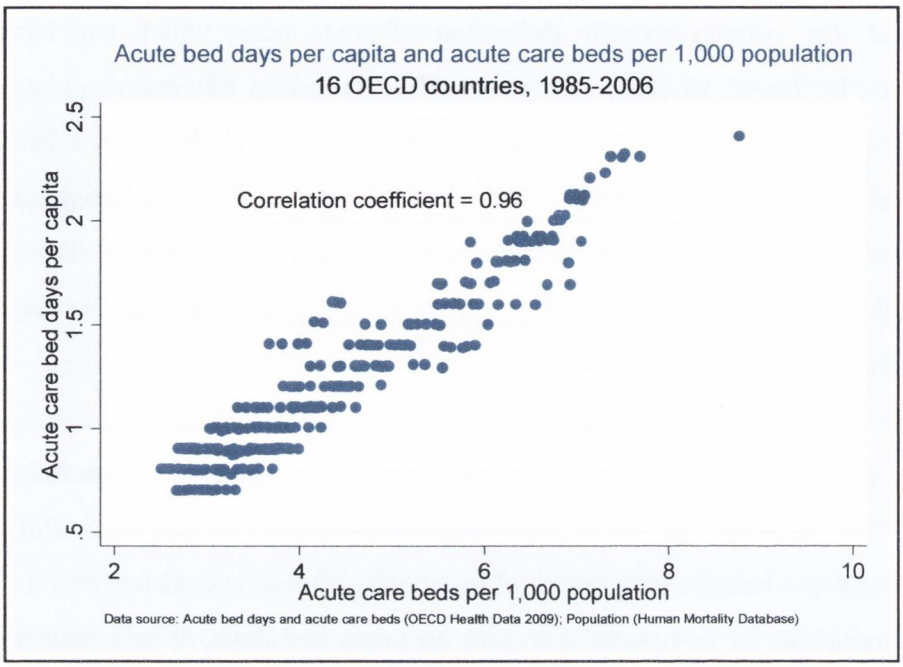
Issues which affect comparability of acute bed day data are: whether or not private hospitals are included; the country-specific definition of acute care, which can have differing cut-off points by length of stay; and the possible inclusion of some long-stay beds. Denmark and Ireland did not include private hospital bed days in the 2009 OECD Health database. Poland and the Czech Republic included bed days in all general hospitals. Spain and the USA consider hospitals where average length of stay is less than 30 days to be acute care hospitals, while Ireland limits its coverage to hospitals where the average length of stay is less than 18 days (OECD 2009b).

While it is apparent that no measure of cross-country health spending or utilisation is without limitations, the measure of acute bed days per capita seems particularly appropriate to analysis of the balance of care for older people. If care is deficient in other settings, it typically manifests as an upward pressure on acute bed days. When informal carers are not available or can no longer cope due to inadequate community care supports; or when there is no longer-term setting offering rehabilitative, palliative or supported residential care, acute hospitals find that their beds are increasingly devoted to the care of people, whose needs are not truly acute. Therefore, despite its limitations as a measure, this is the health care utilisation measure employed in this analysis. There is a very particular relationship of acute bed days to acute bed numbers, which warrants comment. The correlation coefficient of these two measures expressed as ratios to population is generally over 95% (Figure 3.3).

Acute care bed days per capita would have an exact linear relationship to acute care beds per 1,000 population if bed days were merely an expression of available beds to population. However the OECD definition of acute bed days is, in effect, days in which available acute beds are occupied. The concept of an acute bed day has, therefore, three immediate components: firstly, the capital item, the physical bed, which is the product of long-run decisions about investment in health care; secondly, the current spending item, the staffing and resourcing to render this physical bed an available bed, which is the product of more short-term resource allocation decisions; and thirdly, there is a manifestation of demand, the inpatient who occupies the bed overnight. The occupancy

rate is a measure of the rate at which available beds are occupied. Both occupancy and acute bed capacity vary fairly widely across countries.

Figure 3.3



It is possible to postulate a model of the determinants of acute bed utilisation, which expresses acute bed days per capita as a function of acute beds in proportion to population and the occupancy rate. Simple pooled ordinary-least squares econometric analysis of such a model for the countries and years represented in Figure 3.3 shows that available acute bed capacity and the occupancy rate explain 95% of acute bed utilisation, without any provision for country-specific effects to be represented in the model. This, however, is the econometric expression of a tautology or an identity. Occupancy and available acute beds should explain 100% of acute bed utilisation and the fact that they do not indicates that not every country has returned internally consistent data in accordance with OECD definitions. The OECD defines acute bed occupancy as: "Number of acute care beds effectively occupied (beddays) in in-patient institutions divided by the number of available acute care beds and multiplied by 100" (OECD 2009b).

Hence the identity expression of acute bed days as the product of occupancy and available acute beds is simply derived:

$$\text{If} \quad \text{Occupancy} = \frac{\text{Acute bed days}}{\text{Available acute care beds}}$$

$$\Longrightarrow \text{Acute bed days} = \text{Occupancy} \times \text{Available acute care beds}$$

The determinants that are of interest in this analysis are those that drive acute utilisation in a more fundamental way. In other words, these are the determinants both of available acute beds and occupancy, the factors that drive the three components of an acute bed day discussed above: long-run decisions to invest in bed capacity; shorter-run decisions to staff and resource these beds; and the demand factors that determine an inpatient occupies the bed overnight. It is a given in this analysis that acute beds are a driver of acute bed days. Choosing acute bed days per capita as the measure of utilisation is to choose a measure, which by definition encapsulates acute beds and occupancy. The determinants of interest are the drivers of this effectively composite utilisation measure.

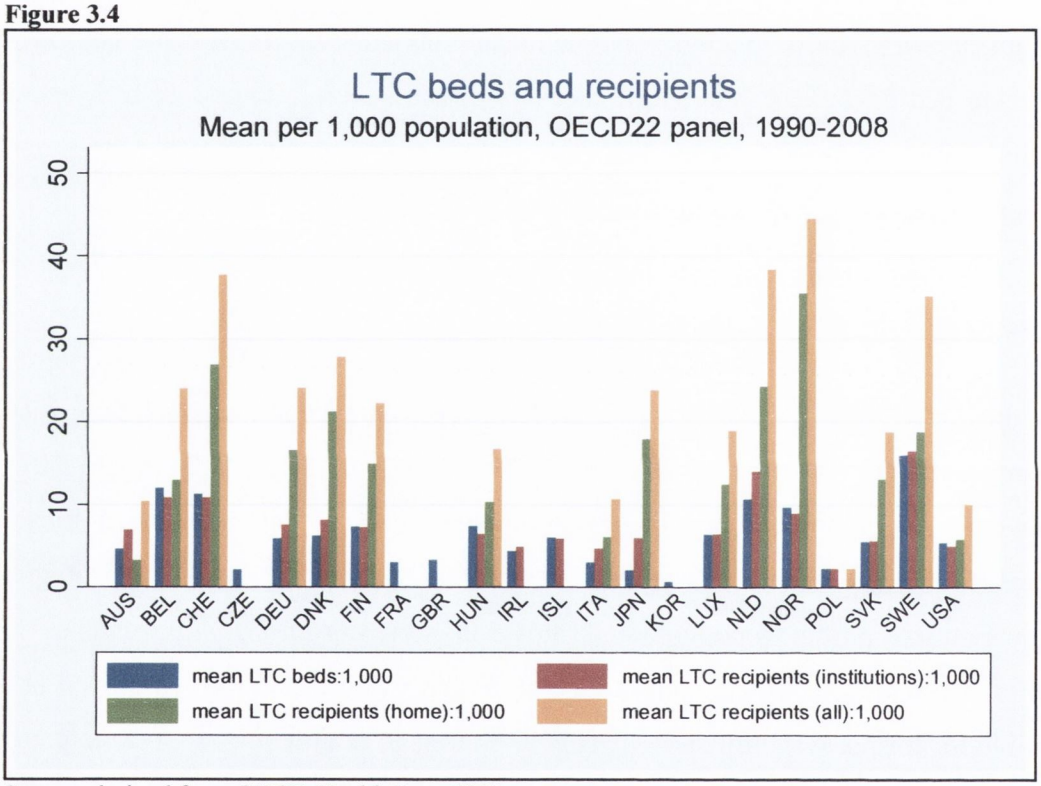
3.5 Measures of long-term care utilisation

OECD Health Data 2009 supplies a range of long-term care variables, including LTC recipients in institutions and at home and LTC beds (Table 3.2). There is great variability in the cross-country composition of LTC supply/utilisation and in data availability for the OECD states (Figure 3.4). The LTC variable with greatest availability is LTC beds, which can be converted into a ratio to population. If this ratio were correlated with trends in the proportion of population receiving formal LTC in all settings, it could be employed as a proxy variable for formal LTC utilisation. While the ratios to population of LTC recipients in institutions and LTC beds are closely correlated, the ratios to population of LTC recipients at home and LTC beds are not. This is so because, whereas in some countries recipients of the two categories of formal LTC have increased in approximate parallel and are positively correlated (Figure 3.5) in other countries, notably Sweden, formal home care has substituted for formal care delivered in institutions and recipients of care in the two loci are negatively correlated (Figure 3.6). LTC bed ratios are not therefore a suitable proxy for formal LTC utilisation.

Table 3.2 Long-term care data in the OECD Health Data 2009 database

Variable	Obs.	States	Years
Long-term care beds in hospitals, number	288	20	14.4
LTC beds in institutions, number	281	22	12.8
Formal LTC workers (nurses, personal carers),FTE, number	32	11	2.9
Informal LTC workers, head count	17	7	2.4
LTC recipients in institutions, total, number	160	20	8.0
LTC recipients at home, total, number	134	18	7.4
LTC recipients in institutions, aged 65 and over	193	24	8.0
LTC recipients in institutions, aged 80 and over	111	16	6.9
LTC recipients at home, aged 65 and over	155	21	7.4
LTC recipients at home, aged 80 and over	92	15	6.1

Figure 3.4



Source: derived from OECD Health Data 2009

Figure 3.5

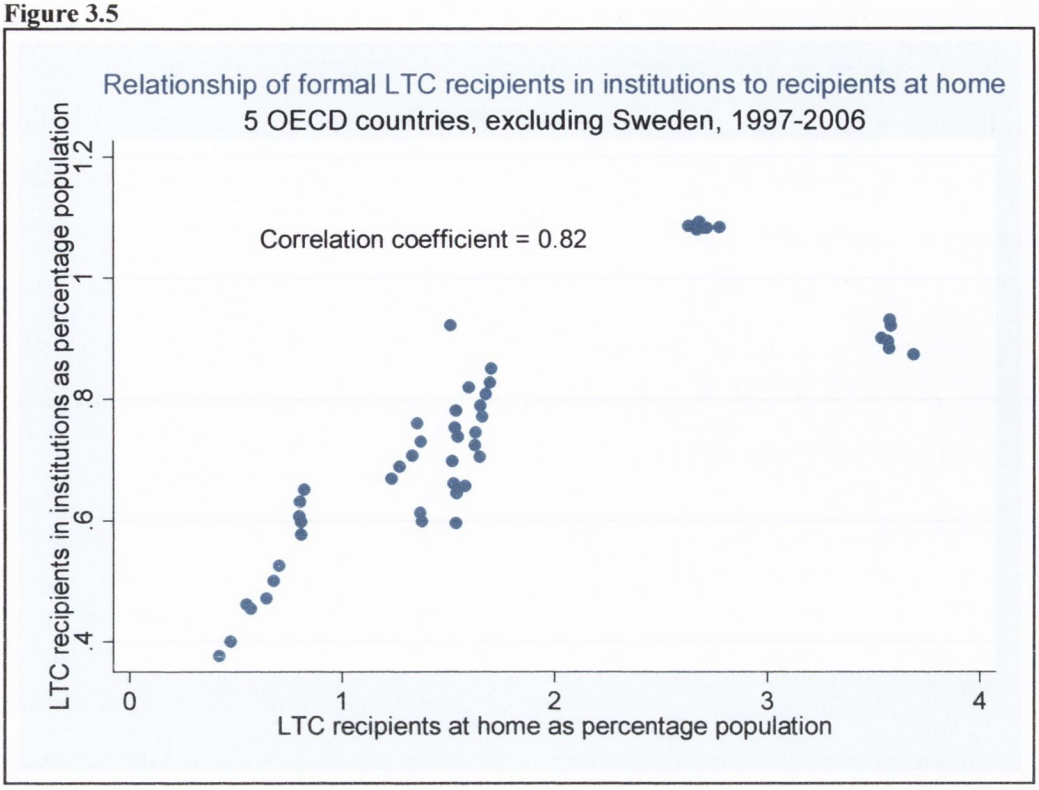
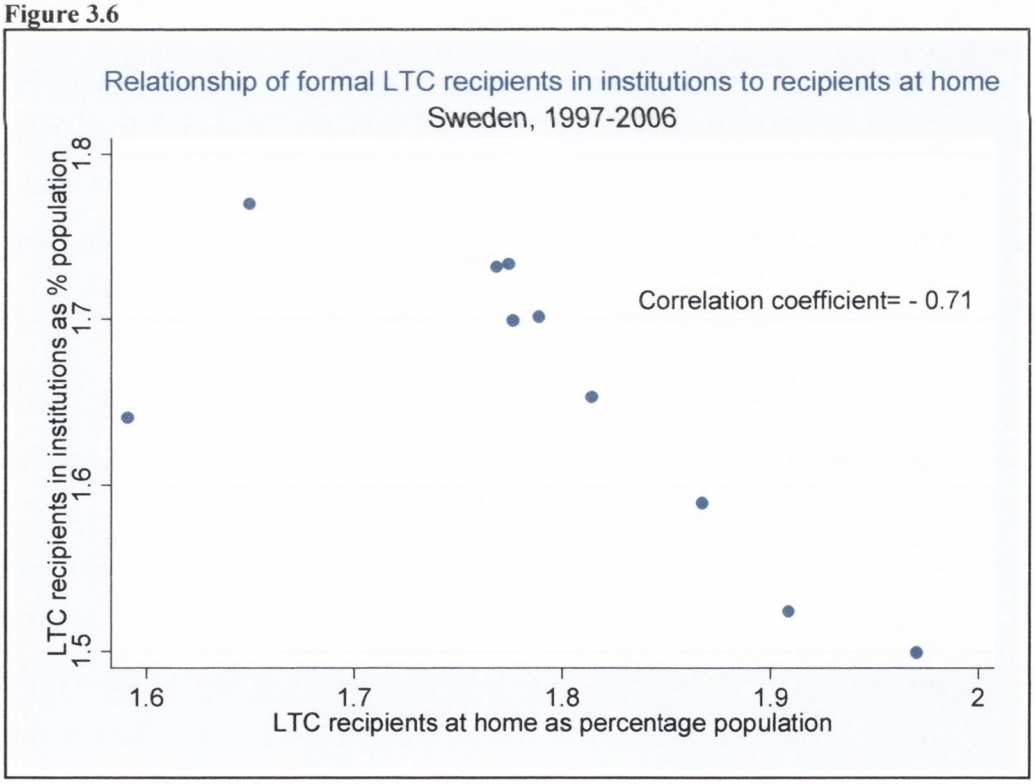


Figure 3.6



For these reasons, I have been obliged to accept that the only approximately representative measure of long-term care utilisation currently supplied by OECD Health Data is achieved by combining LTC recipients in institutions and at home into one variable, expressed as a

ratio to population. The resultant very small panel of observations represents a serious limitation to cross-country analysis of the balance of care. Notwithstanding this limitation, analysis employing this panel to estimate determinants of long-term care utilisation generates some useful, albeit qualified results in Chapter 6. The OECD database excludes from these data LTC recipients, who receive only social care. Although the OECD offers series for LTC recipients aged 65 and over or 80 and over, I have opted to use the series for all LTC recipients since such cut-offs by age are arbitrary and may eliminate useful data especially in countries and during periods where the diseases and disabilities of ageing affect people at ages below 65.

3.6 Alternative sources of demographic data

OECD Health Data supplies demographic variables but these are limited to highly aggregated measures such as total population, total deaths, and population aged 65 and over, also available by gender. The database supplies other variables such as GDP or acute bed days, expressed per capita, based on these population counts. Since in my analysis I wanted to investigate ageing effects, which differentiated between the younger and older old, and the effect of deaths at varying ages, these data were not adequate for my purpose. In early analysis, I sourced population data for five-year age cohorts from the US Census Bureau (US Census Bureau), from which I derived five-year death rates, based on cohort attrition rates. Alternatively, for European countries, I sourced population data and deaths by single year of age from Eurostat (Eurostat).

Subsequently, when I identified that the Human Mortality Database (HMD) could supply population and death data by single year of age for 26 of the 30 OECD member countries (excluding Mexico, Turkey, Korea and Greece), this became my preferred source of demographic data. This database was created and is maintained as a joint project by the Department of Demography at the University of California, Berkeley, USA and the Max Planck Institute for Demographic Research in Rostock, Germany. I accessed the HMD data employed in my analysis in January 2010. Having sourced population and death data by single year of age from birth to 110 years of age for 26 countries over the years 1960 to 2007, I could then generate population and decedent variables for any age cohort of interest. The limiting factor in my analysis has been the availability of health and long-term care data given this rich source of demographic data. HMD data have been employed

in previous studies of the effect of population ageing on health and social care (Pellikaan and Westerhout 2005; Huber et al. 2009).

A further demographic variable in my analysis is the difference between male and female life expectancy. To generate this variable I have employed life expectancy at birth data for men and women from OECD Health Data 2009. These OECD data are sourced from the Eurostat New Cronos Database and national sources. I employ this variable as a proxy measure for the availability of care for one another of older spouses and partners, since as life expectancies converge, fewer older people live alone. Its significance is such that I hypothesise that this variable also proxies to some degree improved health status and reduced disability among older people (Chapters 5 and 6).

3.7. Labour force participation measures

My search has not revealed a source of cross-country macro data on utilisation of informal care. While the converging life expectancy variable is a proxy measure for potential informal care supplied by older people to one another, I also employ female labour force participation rates as a proxy measure for the availability of informal carers among women. I source female participation rates from the World Bank's World Development Indicators (WDI) database. I accessed these data in August 2009. This measure expresses female labour force participation as the percentage of the female population aged 15 and over that is economically active. Other analysis has chosen the labour force participation rate for women aged 50-64 as an informal care proxy (OECD 2006). I use the broader measure in preference because of evidence that about 60% of female care-givers in EU countries in 2001 were aged 30-59 with the share of people looking after the old greatest in the 45-59 year old age group (Schulz 2004). The broader measure also seems appropriate given changes in life expectancy and disability-free life expectancy over the 1985-2006 period, which is relevant to much of my analysis.

I sourced further labour force measures from the WDI database to support my analysis of the relationship of female labour force participation to national income (Chapter 7). These further measures are: total labour force numbers, including the employed and unemployed; unemployment rates, expressed as a percentage of total labour force; the female labour force as a percentage of the total labour force; and male participation in the labour force.

Given evidence that part-time employment among women may facilitate informal care provision whereas full-time employment does not, I investigated the feasibility of differentiating between labour force participation rates for women in full and part-time employment in further research about the determinants of acute and long-term care utilisation. The International Labour Organization's Key Indicators of the Labour Market (KILM) database supplies data on part-time work by women for the countries and years in the HMD7 panel employed in analysis of the determinants of long-term care utilisation in Chapter 6. For the largest panel employed in the analysis of determinants of acute bed utilisation, the HMD17 panel, the data for part-time work is less comprehensive than for overall female labour force participation rates and would reduce the observations for this panel from 355 to 313. Although the ILO cautions that despite efforts to harmonize definitions of part-time work, measurement of part-time work still varies and cross-country comparisons should be made with great care (International Labour Organization 2011), investigation of the effects of part-time working on acute and long-term care utilisation is a feasible further avenue of research.

3.8. Measures of national income/welfare

Given the significance of national income in analyses of determinants of health spending, my models of determinants of acute bed utilisation also employ a measure of national income, which in general is Gross Domestic Product per capita, initially sourced from OECD Health Data 2009 and re-calculated for the HMD population data. I express GDP per capita in constant prices, adjusted for fluctuations in exchange rates and relative prices. This required sourcing two series from OECD Health Data 2009: GDP per capita, in national currency units at 2000 GDP prices; and 2000 conversion rates, employed to convert GDP per capita in national currency units into constant US dollars at purchasing power parity. The conversion formula is:

$$\text{GDPpc} = \frac{\text{GDP per capita, national currency units, 2000 GDP prices}}{\text{2000 conversion rate}}$$

Where:

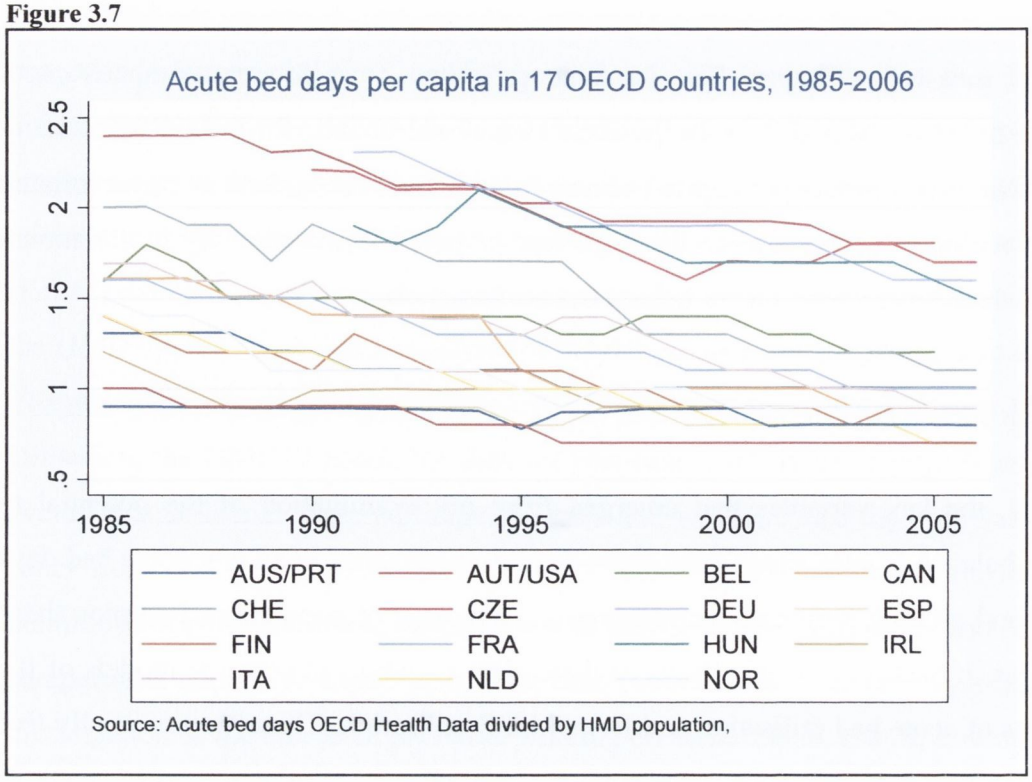
$$\text{2000 conversion rate} = \text{national currency units per US\$, purchasing power parity}$$

From this measure of national income I generate others with adjustment for labour force participation measures (Chapter 7). In some graphical cross-country comparisons, I demonstrate the effect of making an adjustment to national income for Ireland, expressing it as Gross National Product per capita because Irish GDP is recognised to be an inflated measure of national income due to the high rate of profit repatriation by multinational companies which have operations in Ireland but are based elsewhere.

3.9. Trends in the key variables

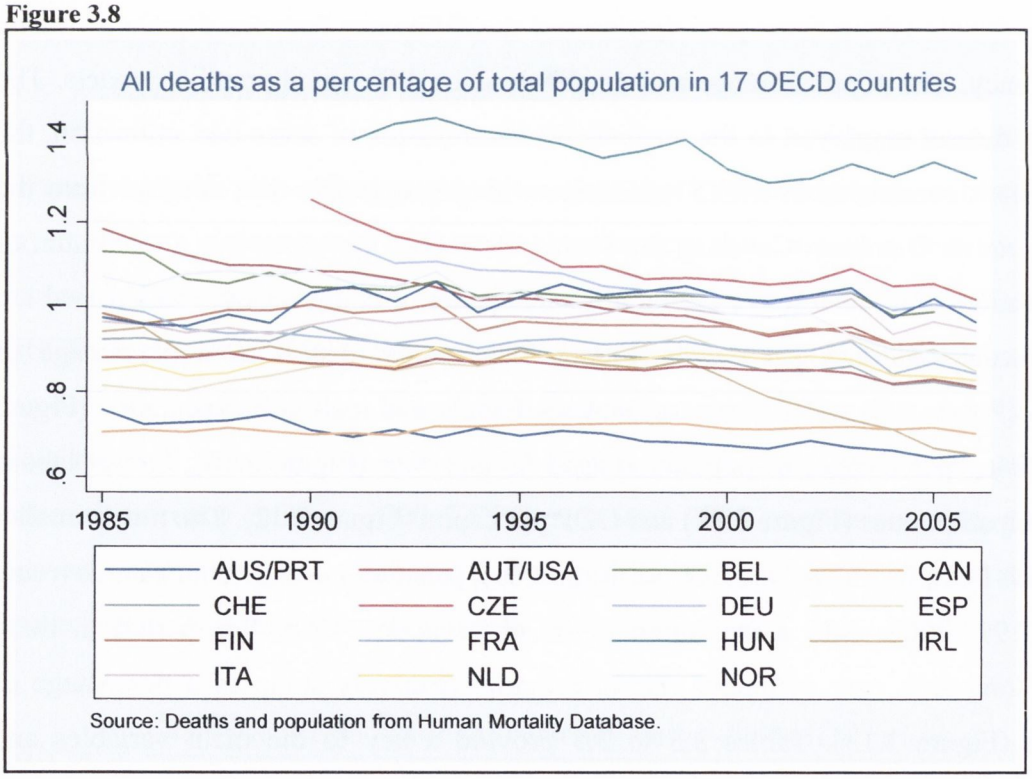
In summary, the key variables that emerged from my examination of the potential to analyse the balance of care, employing cross-country macro measures, are: acute bed days per capita; and all long-term care recipients as a percentage of population. I employ these two variables in Section 2 of this thesis as dependent variables in separate models of the determinants of acute bed utilisation and formal LTC utilisation. There are essentially five co-variates in this analysis: GDP per capita, population age, deaths as a percentage of population, female labour force participation and the difference between female and male life expectancy. The population age and death variables differ in alternative models. The chief panel dataset employed in the analysis of determinants of acute bed utilisation, the HMD17 panel, consists of 17 OECD countries with demographic data sourced from the Human Mortality Database. Covering the years 1985-2006, this panel has a maximum of 355 observations. The features of the data for this panel of countries over this period are declining acute bed days per capita (Figure 3.7), annual deaths as a percentage of population (Figure 3.8) and differences between female and male life expectancy (Figure 3.9); and rising percentages of population aged 65 and over (Figure 3.10), female labour force participation rates (Figure 3.11) and GDP per capita (Figure 3.12). The much smaller panel, which I employ to analyse LTC utilisation, is a panel of 7 OECD countries covering the years 1997-2006, with a maximum of 60 observations. Over this period in these countries, long-term care recipients rise or remain effectively static as a percentage of population (Figure 3.13). Tables 3.3 to 3.5 provide a key to the main variables and summary statistics for these variables in the chief panels employed in this analysis.

Figure 3.7



Source: Acute bed days OECD Health Data divided by HMD population,

Figure 3.8



Source: Deaths and population from Human Mortality Database.

Figure 3.9

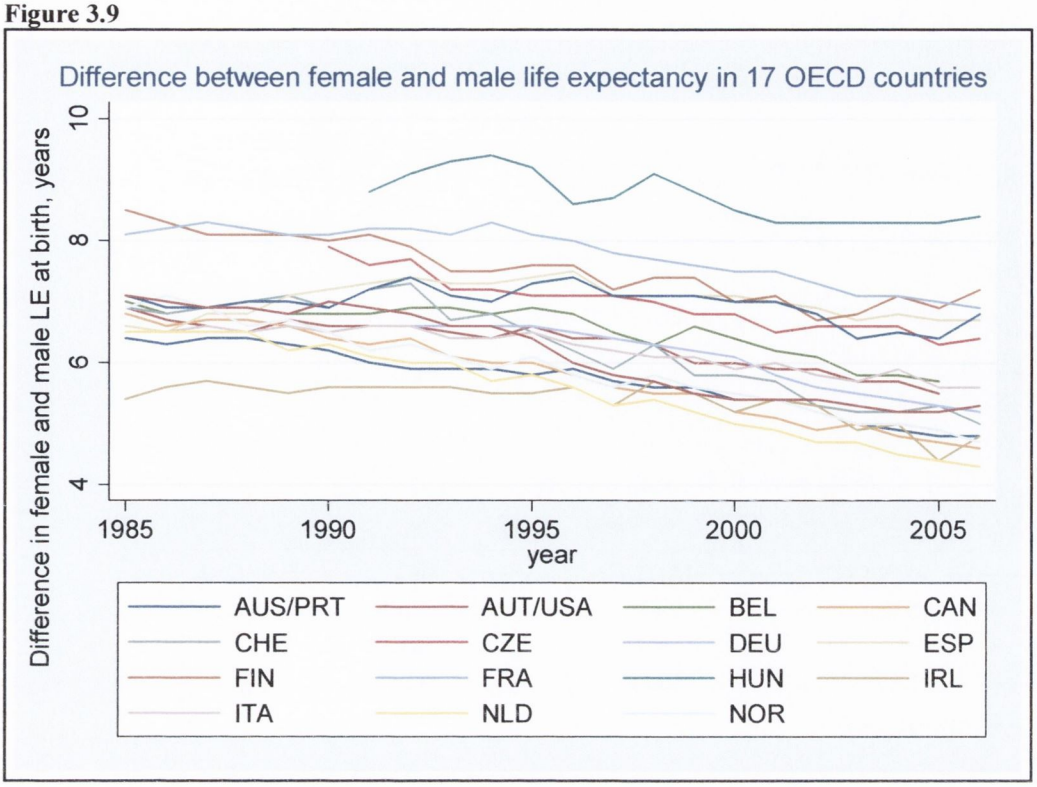


Figure 3.10

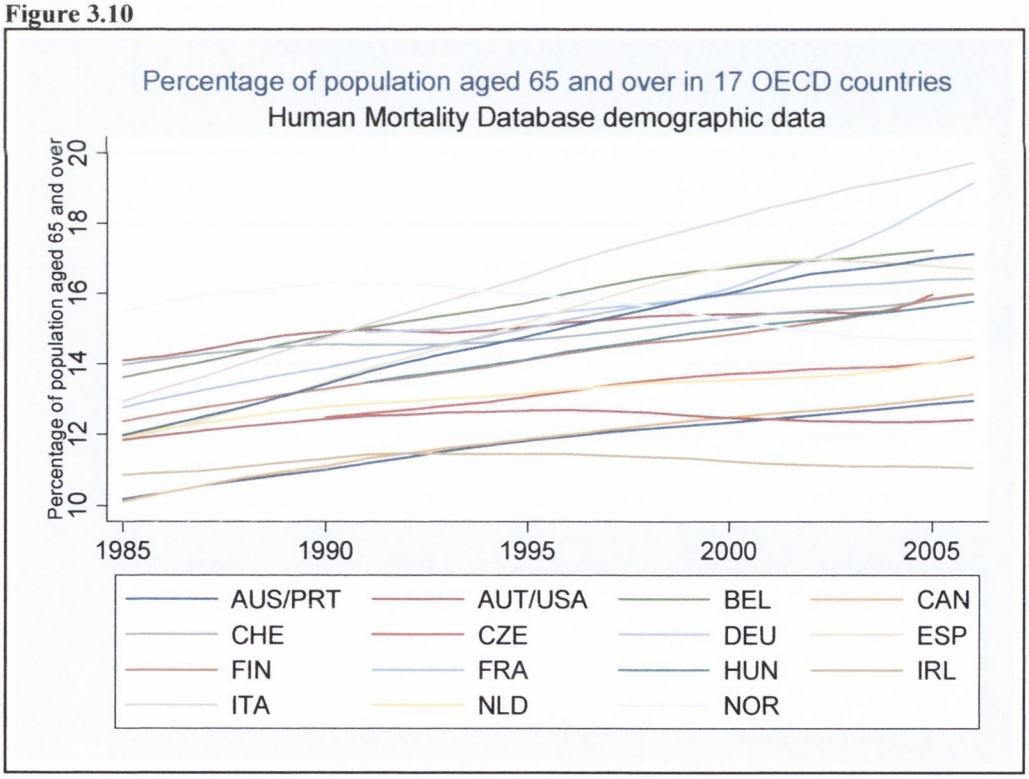


Figure 3.11

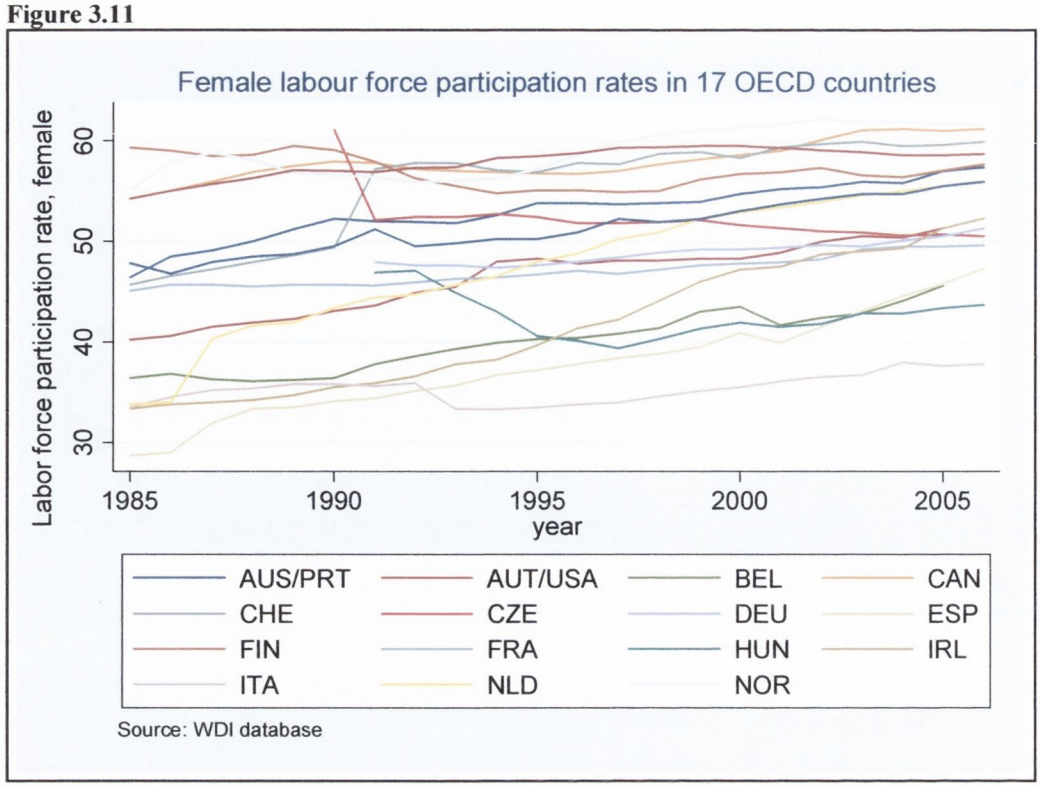


Figure 3.12

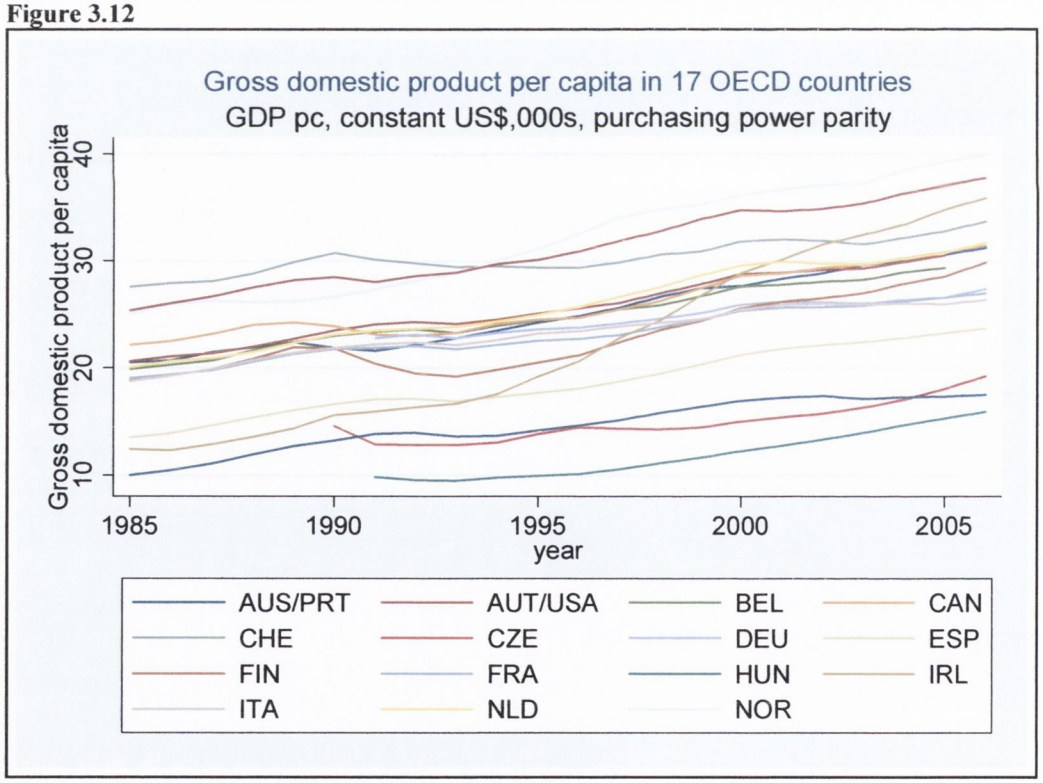


Figure 3.13

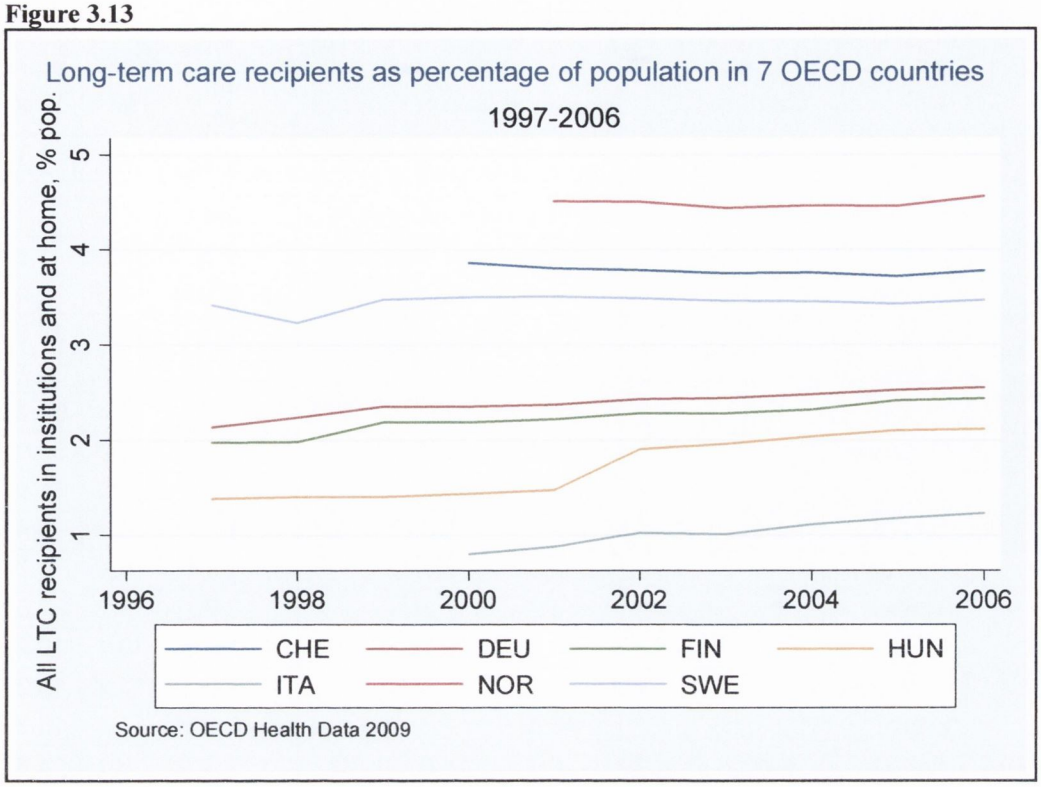


Table 3.3 Key to variables:

acute beddays	Acute care bed days per capita, (HMD)
GDPpc	Gross domestic product per capita(HMD), 2000 GDP prices (000s), US $ 2000 conversion
percent65	Percentage of population aged 65 and over (HMD)
decallpc	Percentage of population who die in the year (HMD)
FLFP	Labour force participation rate, female (% of female population ages 15+)
LEBdiff	Difference between female and male life expectancy at birth
percent80	Percentage of population aged 80 and over (HMD)
percent6579	Percentage of population aged 65 to 79 (HMD)
dec3574pc	Percentage of population who die in the year aged 35 to 74 (HMD)
dec75pc	Percentage of population who die in the year aged 75 and over (HMD)
ltcrepapop	All LTC recipients in institutions and at home as percentage of population
HMD: Population data sourced from Human Mortality Database	

Note: Relationship of all deaths variable to mortality rate. The all deaths variable is calculated by: $\frac{\text{all deaths}}{\text{population}} \times 100$. The crude (non-standardised) mortality rate is calculated by: $\frac{\text{all deaths}}{\text{population}/1{,}000}$. The all deaths variable is therefore equivalent to the crude mortality rate divided by 10. Accordingly, the country with the highest mortality rate in these panels is Hungary where the maximum value for deaths as a percentage of population is 1.4%, which is equivalent to 14 deaths per 1,000 population.

Table 3.4 Summary statistics for HMD17 and HMD14 panels

Panel		HMD17, Obs=355, n=17				HMD14, Obs=289, n=14			
Variable		Mean	Std. Dev.	Min	Max	Mean	Std. Dev.	Min	Max
acute beddays	overall	1.3	0.4	0.7	2.4	1.3	0.4	0.7	2.4
	between		0.4	0.8	2.1		0.4	0.8	2.1
	within		0.2	0.8	1.7		0.2	0.9	1.8
GDPpc	overall	23.7	6.4	9.5	39.9	24.7	6.3	9.5	39.9
	between		5.7	11.9	32.0		5.6	11.9	32.0
	within		3.5	13.7	37.4		3.7	14.8	38.5
FLFP	overall	49.0	8.2	28.7	62.2	50.7	7.2	33.4	62.2
	between		7.5	35.3	59.0		6.5	40.0	59.0
	within		3.4	35.1	59.8		3.5	36.9	61.5
LEBdiff	overall	6.5	1.0	4.3	9.4	6.4	1.1	4.3	9.4
	between		0.9	5.4	8.7		1.0	5.4	8.7
	within		0.5	5.2	7.7		0.6	5.2	7.6
percent65	overall	14.2	1.9	10.1	19.7	13.9	1.8	10.1	19.2
	between		1.6	11.2	16.6		1.6	11.2	16.3
	within		1.1	10.6	17.3		0.8	11.7	16.8
percent6579	overall	10.9	1.4	8.1	14.8	10.7	1.3	8.1	14.8
	between		1.2	8.8	12.7		1.2	8.8	12.4
	within		0.8	8.6	13.3		0.6	9.1	13.0
percent80	overall	3.3	0.7	1.9	5.1	3.2	0.7	1.9	4.7
	between		0.5	2.4	4.0		0.6	2.4	4.0
	within		0.4	2.0	4.6		0.4	2.3	4.1
decallpc	overall	0.9	0.2	0.6	1.4	0.9	0.2	0.6	1.4
	between		0.2	0.7	1.4		0.2	0.7	1.4
	within		0.0	0.8	1.1		0.0	0.8	1.1
dec3574pc	overall	0.4	0.1	0.2	0.8	0.4	0.1	0.2	0.8
	between		0.1	0.3	0.7		0.1	0.3	0.7
	within		0.0	0.3	0.5		0.0	0.3	0.5
dec75pc	overall	0.5	0.1	0.3	0.7	0.5	0.1	0.3	0.7
	between		0.1	0.4	0.6		0.1	0.4	0.6
	within		0.0	0.4	0.6		0.0	0.5	0.6

Note: Overall maxima and minima refer to individual observations. Between maxima and minima refer to country averages. Within maxima and minima refer to deviations from each country's average. For unbalanced data, the between variance is calculated using the mean of the panel means. This may be different from the overall mean. The overall mean is calculated as a weighted mean of the panel means where the weights are given by the number of observations in the panel. The mean of the panel means is unweighted.

Table 3.5 Summary statistics for HMD7 panel

Panel		HMD7, Obs=60, n=7			
Variable		Mean	Std. Dev.	Min	Max
ltcrepapop	overall	2.6	1.06	0.8	4.6
	between		1.22	1.0	4.5
	within		0.16	2.3	3.0
percent65	overall	16.3	1.46	14.5	19.7
	between		1.51	14.8	19.0
	within		0.59	14.9	18.5
percent80	overall	4.0	0.77	2.5	5.4
	between		0.73	2.9	5.1
	within		0.27	3.4	4.6
FLFP	overall	52.0	8.65	35.5	62.2
	between		9.66	36.9	61.8
	within		0.90	49.5	53.8
LEBdiff	overall	6.1	1.35	4.2	9.1
	between		1.34	4.6	8.5
	within		0.28	5.5	6.7
decallpc	overall	1.0	0.15	0.8	1.4
	between		0.16	0.8	1.3
	within		0.03	1.0	1.1

Chapter 4 Methodology

4.1 Introduction

This thesis comprises two separate but related enquiries employing differing methodologies. The methodology is econometric in Section 2 of the thesis, which analyses the determinants of acute and long-term care utilisation across countries. The methodology is statistical in Section 3 of the thesis, which examines long-term care supply and demand in Ireland. This chapter is an overview of the econometric methodology in Section 2, with references to discussion in the chapters where applicable. I explain the statistical methodology in Section 3 in Chapter 10 and in Section 5 in Appendix B. I undertook the econometric analysis using Stata 10 (StataCorp 2007a) and the statistical analysis using Microsoft Office Excel 2003.

The methodology employed in this analysis evolved from a sequence of decisions about: the data relevant to the enquiry; the variables which would best capture the mechanisms of interest; the nature of the models under investigation; and the econometric methods suited to analysing such models. Chapter 3 discussed the first and second of these decisions: the choice to employ cross-country macro data to analyse the balance of care and the identification of the variables of interest. In this chapter, I explain how the nature of the data and theoretical assumptions about the underlying economic relationships of interest determined the econometric methodologies that I applied in my analysis.

The next section expands on the nature of the data and choice of variables in this analysis (Section 4.2). Section 4.3 describes the nature of the models to be estimated and the sequence of analysis. The following sections review with reference to the nature of my data possible alternative approaches to estimation: fixed versus random effects estimation (Section 4.4); pooled ordinary least squares (OLS) versus fixed effects estimation (Section 4.5); occasions when OLS methods are inappropriate under the headings of heteroscedasticity, autocorrelation and cross-sectional dependence (Section 4.6); and

alternative estimations methods, under the headings: fixed effects with a cluster option, feasible generalized least squares estimation (FGLS), and panel-corrected standard errors (PCSE) (Section 4.7).

The next section discusses instances of possible endogeneity in my models under the headings of: simultaneous equations bias, measurement error and omitted variable bias (Section 4.8). I describe methodologies to address endogeneity and my investigation of their potential with my dataset in Section 4.9 The final sections discuss measures of goodness of fit and model specification tests (Section 4.10) and conclude this econometric overview (Section 4.11).

4.2 The nature of the data and variables

The macro variables of interest to this analysis and discussed in Chapter 3 are available from international databases across countries and over time. Collectively they constitute a panel dataset. This feature of the data has implications for the econometric methodologies that can be adopted, which vary depending on the attributes of the model to be estimated using the panel dataset. The full 2009 OECD membership of 30 countries is not represented in the panels in this analysis: some countries are excluded because of data unavailability. For some countries, data for key variables are entirely lacking; for others, the run of years for which data are available is too short relative to the other countries in the dataset. In a balanced panel dataset each country would have all the requisite variables for the same run of years; in an unbalanced panel some countries lack data in some years. Estimation by panel data methods is possible with unbalanced panels but reasonable balance is nonetheless required. It has been a matter of judgment to determine to what degree countries or years should be sacrificed to achieve adequate balance. In this analysis the panel with the largest number of observations (355) covers 17 countries over a 22-year period from 1985-2006.

In early attempts to model the drivers of acute utilisation, I tested models with a range of population age variables. I took this approach because I was aware that limiting my analysis of age effects by using a single-cohort age measure such as population aged 65 and over would implicitly assume a homogeneity of age effects on demand for health and long-term care among people aged 65 and over, when there is evidence of great variation

in ageing effects across older ages, influenced strongly by final year of life in acute care demand and by disability rates in long-term care demand and when life expectancies and disability rates vary across countries, as evidenced in the literature reviewed in Chapter 2.

The desirable inclusion of a range of age variables is, however, hampered by the problem of near-collinearity. This can arise where regressors share a strong time trend, so they are highly correlated; or where there is an approximate linear relationship among regressors. Where this problem of near-collinearity exists, estimated coefficients may have incorrect signs or implausible coefficients (Baum 2006). Routine testing of models for correlation between variables confirmed instances of near-collinearity, which required model re-specification. When testing such correlations, I employed the rule of thumb that a correlation coefficient greater than 0.7 or -0.7 indicated an unacceptable level of near-collinearity and that I should not therefore employ the correlated variables as co-variates (Lind et al. 2005). The problem of near-collinearity between age cohort variables is greater as panels reduce in size due to the selection of fewer years or countries; and the smaller the co-variate age cohorts.

Having initially rejected the use solely of population aged 65 and over as a measure of age of population, I eventually determined to employ it despite its admitted limitations. Its inclusion had attractions for a number of reasons:

- Population aged 65 and over is widely used as a measure of ageing so that there is a value in determining if it has significance for acute or long-term care utilisation.
- Since the literature on proximity to death effects within countries finds these to be more significant than age, there is a value in a model which tests the relative importance of death and age as drivers of utilisation across countries, initially without considering age at death and subsequently taking into account age at death;
- The introduction of a variable for converging male and female life expectancies is a potential proxy measure for improved health status and reduced age-specific disability.
- By modelling with age, death and health status represented by separate aggregate variables, there is a possibility of distinguishing between the effects of pure ageing and the effects of proximity to death and disability. Proximity to death and disability are the aspects of ageing that cause an association between age and

utilisation but they do not have a constant relationship to specific ages because of increases in life expectancy and disability-free life expectancy.

While I adopted a central model with this highly aggregated age variable, percentage of population aged 65 and over, I also estimated model specifications in which age is represented by two separate cohorts: percentage of population aged 65 to 79; and percentage of population aged 80 and over. These variables do not exhibit near-collinearity in the panels using HMD demographic data and employed to estimate models of acute bed utilisation. Chapters 5 and 6 describes the effects on my analysis of substituting these two age cohort variables for the aggregate variable, population aged 65 and over; and the effect of employing quadratic specifications for the single-cohort and the two-cohort age variables.

In this analysis near-collinearity does not only arise in the case of age cohort variables. In the small panel employed for analysis of long-term care utilisation, which is particularly restricted in years and countries, the homogeneity of the panel is reflected in near-collinearity between variables such as female labour force participation and GDP, which restricts the model specification (Chapter 6).

4.3 The nature of the models and the sequence of analysis

This analysis starts with the hypothesis that the balance of care can be broadly represented by the following equation:

$$\text{Acute bed days p.c.} = \beta_1 + \beta_2\text{GDP p.c.} + \beta_3\text{percent65} + \beta_4\text{percentDecedents} + \beta_5\text{FLFP} + \beta_6\text{LEBdiff} + \beta_7\text{LTC recipients} + \beta_i\text{state}_i + \beta_j\text{year}_j \quad (1)$$

Where:

Acute bed days p.c. = Acute hospital bed days per capita;

GDP p.c. = Gross domestic product per capita, constant US dollars(thousands).

Percent65 = Percentage of population aged 65 and over;

PercentDecedents = Decedents as percentage of population;

LEBdiff = LEBF − LEBM expressed in years;

LEBF = Female life expectancy at birth;

LEBM = Male life expectancy at birth;

FLFP = female labour force participation rate (a proxy for informal care supply).
LTC recipients = formal long-term care recipients in institutions and the community as percentage of population;

Limited availability of LTC data prevents estimating this balance of care in a single model, an issue discussed in Chapter 3 and further explored in Chapter 6. Consequently, the analysis in this thesis estimates separate models of the determinants of acute bed and long-term care utilisation, represented by the following equations:

$$\text{Acute bed days p.c.} = \beta_1 + \beta_2\text{GDP p.c.} + \beta_3\text{percent65} + \beta_4\text{percent65}^2 + \beta_5\text{percentDecedents} + \beta_6\text{FLFP} + \beta_7\text{LEBdiff} + \beta_8\text{percent65*LEBdiff} + \beta_i\text{state}_i + \beta_j\text{year}_j \quad (2)$$

$$\text{LTC recipients} = \beta_1 + \beta_2\text{percent65} + \beta_3\text{percentDecedents} + \beta_4\log(\text{FLFP}) + \beta_5\text{LEBdiff} + \beta_6\text{percent65*LEBdiff} + \beta_i\text{state}_i + \beta_j\text{year}_j \quad (3)$$

The development of these models of the determinants of acute and long-term care utilisation takes as its point of departure the substantial literature on the effects of age and proximity to death on health spending and utilisation within countries, which is the motivation for including age and decedent variables in these models. The inclusion of a variable for converging life expectancies between men and women is intended to capture the effects of household composition on health care utilisation; while the inclusion of a variable for female labour force participation proxies for the availability of informal care by younger and middle-aged women of older people. The variable for GDP per capita is included because national income has been found to be a significant driver of health care expenditure in other studies. Its exclusion in the long-term care utilisation model occurs because it is nearly-collinear to the FLFP variable in the panel available for that analysis.

In preliminary analysis of these models, I employed the general-to-specific method of starting with a complex model and progressively excluding variables which appeared to be insignificant, a favoured approach in econometric analysis (Greene 2008; Campos et al. 2005). Such an approach would dictate excluding the female labour force participation

variable in the acute utilisation model, since it is insignificant in estimations for the full HMD17 panel. The nature of these panel data suggested that a further, supplementary path of investigation was also required. The data derive from a heterogeneous group of countries - OECD member states. Depending on which countries are included or excluded in the panel dataset employed in the analysis, the relationships between the variables in these models change. In such cross-country panel datasets, a great deal of analytical interest derives from observing and seeking to understand this heterogeneity. A model may have validity for one sub-set of OECD countries but not for another. If this is so, a variable may be excluded because of apparent insignificance, when changing the states included in the panel would disclose that it has significance for a particular grouping of countries for illuminating reasons. This has been my experience in this analysis. Hence, I developed and report in this thesis analysis for a number of subsidiary panels.

Whereas in Chapter 5 the estimated model for determinants of acute bed utilisation finds the FLFP variable to be insignificant for the full HMD17 panel, Chapter 6 estimates the same model for the HMD14 panel which excludes 3 Southern European states, based on evidence of a North-South gradient within Europe in patterns of informal caring and provision of formal long-term care, and finds the FLFP variable to have a significant negative effect. Chapter 5 analyses the effect of age at death in split-sample panels, constructed based on within-country evidence of differing locations of death derived from a review of the literature on location and age at death.

It might reasonably be argued that varying panels in this manner is not desirable and should not be necessary. Instead, the model should include categorical variables that control for the differences between sub-groups of countries and which could be interacted with regressors to test whether there are regional differences in their effect and significance. In place of split-sample estimation of the effect of location of death on the effect of age at death on acute bed utilisation, or in place of excluding Southern European countries in assessing the effect of female labour force participation on acute bed utilisation, a dummy variable might be included and assigned a value of 1 in one sub-group of countries and of 0 in the remainder of the countries; and this dummy variable could then be interacted with the variables for which regional effects are hypothesised. Although it is possible to construct such categorical variables for location of death or region of Europe, the evidence on location of death is inadequate to supply within country

over time variation in the LOD value and by definition there is no such variation in the regional category. While including these invariant categorical variables would represent a further route to testing the robustness of this analysis, their inclusion would come at the cost of dropping the dummy variables for country-specific effects present in models (1) to (3) above. The methodological limitations to such an approach and alternative methodologies that could be adopted to pursue this analysis are further explored in the methodological discussion in Section 5.4 of Chapter 5.

As in any econometric model, which seeks to demonstrate and estimate a causal association, these models and the panel datasets for which they have been tested, have been informed by theory and evidence. The developing theory on the drivers of utilisation in health and social care continues to evolve in response to evidence, much of it arising from studies of micro-data within countries. This cross-country analysis employing macro data based on micro-studies offers an opportunity to examine the degree to which the drivers of acute and long-term care utilisation are country-specific or common across countries.

4.4 Econometric methods: fixed versus random effects

In econometric analysis the models in equations (1) to (3) are described as fixed effect models. They are a specific form of the standard panel data model. The standard panel data model can be represented by the equation:

$$y_{it} = \sum_{k=1}^{k} x_{kit}\beta_{kit} + \epsilon_{it}, i = 1, ..., N, t = 1, ..., T$$

(Baum 2006)

In this model:

N = number of individuals/groups (countries in this analysis)
T = number of time periods (years in this analysis)
y_{it} = the dependent variable
x_{kit} = a set of independent variables
β_{kit} = the estimated coefficients of the independent variables
i = a group identifier
t = the time period e.g. years
k = the number of independent variables
ϵ_{it} = the disturbance or error term

In panel data analysis, the appropriate methodology critically depends on assumptions about the inter-relationship between the groups and the variables in the model; and between time and the variables in the model. A one-way fixed effects model assumes that it is necessary to control for omitted and unobserved variables that differ between the N groups, are not independent of the regressors but are constant over time. This can be achieved by generating dummy variables for each country. The coefficients for these variables estimate the unobserved country-specific effects that are not accounted for by the other variables in the model but are not independent of those variables. Such effects can be thought of as the attributes of those countries that determine the impact of the variables in the model. In geometric terms, this model assumes that the countries in the panel have differing intercepts but share the same slopes, i.e. coefficients for the variables in the model. Such a fixed effects model, or one-way error component model, to use an alternative terminology (Baltagi 2008) has a specific error structure, represented by:

$\epsilon_{it} = \mu_i + \nu_{it}$

$\mu_i =$ unobservable, time invariant, individual/group-specific effects

$\nu_{it} =$ the usual regression disturbance term

The decision about the nature of the time invariant individual/group effects is a key methodological assumption. While the precise nature of the distinction between fixed and random effects remains a topic of debate (Baltagi 2008), for the purpose of this analysis the distinction is sufficiently clear. If all unobserved individual effects are assumed to be distributed independently of the other variables, an alternative random effects methodology is appropriate. Critically, this methodology requires that the N individuals in the panel are drawn randomly from a large population.

Such an assumption can be tested by estimating the model by fixed and random effects methodologies and employing a Hausman test to see whether the estimated coefficients show significant differences. In the presence of heteroscedasticity (discussed below) the Hausman test is inappropriate but an alternative test recommended by Wooldridge can be implemented. This robust form of the Hausman statistic has been implemented in STATA by Schaffer and Stillman using the *xtoverid* command, implemented after a random effects regression. This procedure treats a test of fixed versus random effects as a test of overidentifying restrictions, more usually applied to test the validity of instruments in

instrumental variables estimation (further discussed below). In this case the restriction imposed by random effects estimation that the regressors are uncorrelated with the group-specific error is treated as an overidentifying restriction. The test uses an artificial regression approach, described in Wooldridge (2002: 290-291). The original regressors are transformed into deviations from their means and added to a random effects equation of the original model. A Wald test tests their significance (Wooldridge 2002; Schaffer and Stillman 2010).

However, in a panel of countries such as in this analysis, the very nature of the panel dictates that fixed effects is the more appropriate *a priori* assumption (Baltagi 2008). As Dougherty observes:

> "One precondition [for using random effects] is that the observations can be described as being drawn randomly from a given population. This ...would not be a reasonable assumption if the units of observation in the panel data set were countries and the sample consisted of those countries that are members of the Organization for Economic Cooperation and Development (OECD). These countries certainly cannot be considered to represent a random sample of the 200-odd sovereign states in the world." (Dougherty 2007: 419)

In fixed effects models, as represented by equations (1) to (3) inference from the model is restricted to the behaviour in the groups in the panel. In this analysis this means that the conclusions about the drivers of acute or long-term care utilisation deriving from these models should not be assumed to hold for countries which are not in the panels. It is probably not unreasonable to hypothesise, however, that where countries have been excluded from the panel because of data inadequacy but share similar relevant attributes, such as level of wealth, and systems of formal and informal caring and health care, the findings from the model may apply to them also. In the absence of data to test it, this remains a hypothesis. Regrettably, one such country in this analysis is the UK, for which the 2009 version of the OECD Health database employed here supplies acute bed and bed utilisation data only from the year 2000.

The fixed effects model can be extended into a two-way model in which it is further assumed that it is necessary to control for omitted variables that vary over time, are not

independent of the included regressors but are constant between the groups. This can be achieved by generating dummy variables for each time period, years in this analysis. The coefficients for these variables estimate the time-varying effects that are not accounted for by the other variables in the model. Baltagi instances such effects as strike year effects that disrupt production, implicitly in a model where all the groups are similarly affected (Baltagi 2008). In geometric terms, this model assumes that the intercepts differ over countries and years. Inference is now restricted to the specific time periods observed as well as to the countries in the panel. The error structure in this two-way error component regression model can be represented by the following equation (Baltagi 2008):

$$\epsilon_{it} = \mu_i + \lambda_t + \nu_{it}, i = 1, ..., N, t = 1, ..., T$$

μ_i = unobservable, time invariant, individual/group-specific effects

λ_t = unobservable, group-invariant, time-specific effects

ν_{it} = the usual regression disturbance term

If there are unobserved/omitted factors that influence acute utilisation, are correlated with the included regressor variables and are sufficiently variant across groups or time that they are not captured in the fixed effects, these would be present in the error term, ν_{it}, and would cause omitted variable bias, a form of endogeneity discussed below.

4.5 Econometric methods: pooled OLS, within and LSDV estimators

Theoretically, it could be the case in a panel dataset with a large number of individuals drawn randomly from a population that a model could be estimated by pooled ordinary least squares (OLS), where there is no individual-specific unobserved disturbance or error term. This proposition can be tested after fixed effects estimation by an F test of the null hypothesis that the constant terms are equal across groups within the panel. In all models and panels in this analysis, this hypothesis is rejected, indicating that pooled OLS estimation would produce inconsistent estimates (Baum 2006), a confirmation which strictly speaking is not required given the nature of the panels.

Models exhibiting fixed effects can be estimated in a number of different ways. The "within groups" fixed effects estimator subtracts the mean values of the variables in the observations for a given individual/group from the data for that group, which has the effect of removing the unobserved individual-specific effect. The model is then estimated by OLS on these "within-transformed data". An alternative estimation method is supplied by the Least Squares Dummy Variable (LSDV) regression model. This is the model in equations (1) to (3). In this model the unobserved effects are made explicit by the introduction of dummy variables for the groups and, in the case of two-way fixed effects, the time periods. The unobserved effects are estimated as the coefficients of the group variables (countries in these models) and, in the case of two-way fixed effects, the coefficients of the year variables (Baum 2006; Dougherty 2007; Baltagi 2008). With the introduction of these dummy variables, the model can then be estimated by OLS.

This methodology is attractive for the type of cross-country panels in this analysis. There is considerable evidence from the literature on acute utilisation of country-specific differences that are linked to the variables being estimated. In Chapter 5, for instance, the dummy variables for unobserved country-specific effects offer an opportunity to investigate whether in a model of the effect of age and death on utilisation, differences between countries accord with differences in location at death. Location at death is one such country-specific effect. Although critical in determining the impact of deaths on acute utilisation, which is estimated in the coefficient for the all deaths variable, a time-varying variable for location at death cannot be included because there are no time series data available for cross-country differences in location at death.

By construction, country-specific factors are assumed to be time invariant. Yet there is evidence that location at death changes over time within countries. To the degree that this is so over the time periods covered in the panels, this effect will not be captured by the country coefficients. The fixed-effects model assumptions are of course simplifications since no model can be an exact representation of reality. Only if sufficient data were available to include a continuous variable for location at death could this effect be fully captured. Insofar as it is not, the estimates for the model will capture variations over time in location at death in the error term and in the differences in the error variance across countries.

The LSDV method requires that one country or year should not be represented by a dummy variable. Its choice, which is arbitrary in the case of the countries and clearest when chosen as the first year in the case of the years, determines which country/year will be a comparator for the others. In the case of the countries, the constant term becomes the mean of the values for the excluded country. The coefficients for the other countries' dummy variables represent the differences between their means and the mean of the country represented by the constant. If their coefficients have significant values, this indicates that these differences are significant. Observing the coefficients thus affords an opportunity to discover to what degree the countries in the panel differ in their utilisation due to unobserved country-specific factors and to examine whether there is a pattern in these coefficients that might assist in identifying what these factors might be, an exercise undertaken in Chapter 5. In the case of the year dummy variables, the exclusion of the first year in the panel affords the opportunity of examining to what degree unobserved or omitted variables cause a difference between utilisation in that year and subsequent years, reflected in the sign and significance of the other years' dummy coefficients. In each model and panel, the appropriateness of including these fixed effects is confirmed by testing separately for the collective significance of the country and year coefficients. The test is a joint test of hypothesis that the dummy variable coefficients equal zero. If this proposition is rejected, they are collectively significant. The progressive diminution and eventual insignificance of time effects with the addition of regressors is a further useful analytical tool.

4.6 Econometric methods - failure of OLS assumptions

Estimation by OLS using the LSDV method to include fixed effects may not provide consistent estimates, if the model does not fit the assumptions underlying OLS. Since this can arise in a number of ways, my analysis of these models routinely tested for heteroscedasticity, auto-correlation and cross-sectional correlation. The presence of any of these features requires methodological adjustment.

4.6.1 Heteroscedasticity

Ordinary least squares regression rests on an assumption that the errors are independent draws from an identical distribution (i.i.d.). If the errors have the same dispersion (equal

variance) they are described as homoscedastic. If their dispersion is not the same (unequal variance) or, in other words, the errors are not identically distributed, they are described as heteroscedastic. In panel data analysis, when there is evidence of heteroscedasticity between groups, the error variances differ between the groups. Heteroscedasticity can arise for many reasons, not least the varying size of the countries in an analysis such as this, which alone may cause differing variations (Baltagi 2008). In this analysis the models invariable exhibit so-called groupwise heteroscedasticity, which means that despite the groups sharing the same slope coefficient, which estimates the effect of a regressor on the dependent variable, their error or disturbance variance differs. To test for this form of heteroscedasticity I employ a modified Wald test with the null hypothesis that the error variance is the same for all the groups (Baum 2001). (This test is implemented in STATA by the *xttest3* routine after an *xtreg, fe* regression.) The modified Wald test statistic is distributed χ^2 under the null hypothesis and is defined as:

$$W = \sum_{i=1}^{N_g} \frac{(\hat{\sigma}_i{}^2 - \hat{\sigma}^2)^2}{V_i}$$

Where:

$\hat{\sigma}_i^2 = T_i^{-1} \sum_{t=1}^{T_i} \epsilon_{it}^2$

$=$ the estimator for the ith unit's error variance based on the T_i residuals ϵ_{it} for that unit

$V_i = T_i^{-1}(T_i - 1)^{-1} \sum_{t=1}^{T_i} (\epsilon_{it}^2 - \hat{\sigma}_i^2)^2$

$=$ the estimated variance of $\hat{\sigma}_i^2$

The null hypothesis specifies that:

$\sigma_i^2 = \sigma^2 \quad \text{for} \quad i = 1, ..., N_g$

$N_g =$ the number of cross-sectional units (Baum 2001)

Rejection of the null hypothesis indicates the presence of groupwise heteroscedasticity.

4.6.2 Autocorrelation

The i.i.d assumption also fails if the errors or disturbances are not independently distributed. This occurs in a time series if observations that are close in time are correlated, which gives rise to autocorrelation in the disturbance term. Persistent effects of excluded variables frequently cause autocorrelation. In acute utilisation, it might be hypothesised that custom and practise in acute bed utilisation is one such omitted effect. If average length of stay after particular procedures is standardardised - so many days for appendectomy, Caesarean section etc - this may change slowly, notwithstanding the effect of the variables included in the model. Apparent autocorrelation may also arise because of misspecification of the model's functional form or because the dependent variable is, in some sense, a function of its previous values or of the previous values of regressors. In either of these cases, the remedy differs: the first requires testing different model specifications; the second requires a dynamic model which includes lagged values of the dependent variable or the regressors. If the apparent autocorrelation reflects the omission of a time-varying factor which is correlated with the included regressors, this is an instance of endogeneity, discussed below.

I have adopted the approach of testing for serial correlation of the fairly general kind, i.e. an AR (1) model, employing a test suggested by Wooldridge (Wooldridge 2002: 283; Drukker 2003). This involves first differencing the model which removes fixed effects and the constant:

$$y_{it} - y_{it-1} = (X_{it} - X_{it-1})\beta_1 + \epsilon_{it} - \epsilon_{it-1}$$

$$\Delta y_{it} = \Delta X_{it}\beta_1 + \Delta\epsilon_{it} \qquad \text{(Drukker 2003)}$$

By regressing this first-differenced model the estimated residuals are obtained, which are then regressed on their lags. Since Wooldridge proves that if the error terms are not serially correlated, $\mathrm{Corr}(\Delta\epsilon_{it}, \Delta\epsilon_{it-1}) = -.5$, the test for the absence of serial correlation is that the coefficient on the lagged residuals is -.5. (This test is implemented in STATA as the *xtserial* command.)

In this analysis, this test invariably rejects the null hypothesis of no first-order autocorrelation in the models. Monte Carlo simulations suggest that in fixed effects models with heteroscedasticity, reliance on this test requires samples exceeding 500

observations, which is greater than the number of observations in any panel in this analysis (Drukker 2003). (Monte Carlo simulations employ datasets artificially constructed to exhibit the attributes to be tested.) For this reason and also because apparent autocorrelation may reflect misspecification, I have therefore routinely also run regressions without this assumption. Greene (2008: 655) observes that: "An orthodox (perhaps somewhat optimistic) purist might argue that autocorrelation is always an artifact of misspecification."

Dropping the autocorrelation assumption does not in general significantly alter the results but increases the significance of the variables and the size of their coefficients. (Appendix A reviews the consequences of estimating with alternative assumptions and by alternative methodologies.) The possibility that the real issue is omitted variable bias would suggest applying dynamic methods of estimation or other methods designed to overcome endogeneity. The nature of the panel datasets in this analysis restricts application of such methods, discussed below.

4.6.3 Cross-sectional dependence

If the errors are dependent across panels this is a further failure of the i.i.d. assumption. Cross-sectional dependence arises from the effect of common unobserved factors, manifest in the disturbance term but uncorrelated with the included regressors (Pesaran 2004; De Hoyos and Sarafidis 2006). Such factors differ from time varying effects that are correlated with the included regressors and can be captured by time fixed effects. Cross-sectional dependence could arise in this analysis because the countries experience common shocks, which have an impact on acute utilisation simultaneously across panels. Described as spatial correlation when it is a consequence of contiguity, such dependence might reflect the spillover effect of innovations in medical technology in one country, the USA for instance, on others. In this analysis I have employed the test developed by Pesaran which is based on an average of all pair-wise correlation coefficients of the Ordinary Least Squares (OLS) residuals from the individual regressions in the panel. For unbalanced panels this test estimates:

$$CD = \sqrt{\frac{2}{N(N-1)}} \left(\sum_{i=1}^{N-1} \sum_{j=i+1}^{N} \sqrt{T_{ij}} \hat{\rho}_{ij} \right)$$

Where

$\hat{\rho_{ij}}$ = pairwise correlation coefficient (Pesaran 2004)

Pesaran finds that the test is likely to have good small sample properties (for both N and T small). In STATA the command *xtcsd, pesaran* performed after running an *xtreg, fe* regression estimates the CD statistic which is normally distributed under the null hypothesis:

$$H_O : \rho_{ij} = \rho_{ji} = cor(u_{it}, u_{ti}) = 0 \quad \text{for} \quad i \neq j$$

If this hypothesis is rejected, this is evidence of cross-sectional dependence. The desirability of performing this test is one of the reasons why it is necessary to achieve reasonably balanced panels since there must be sufficient cross-sectional units with common points in time to implement it (De Hoyos and Sarafidis 2006). In this analysis, Pesaran's test confirms the presence of cross-sectional dependence in some but not all models and panels.

4.7 Alternative methodologies when the i.i.d. assumption fails

Confirmation in these models of the presence of groupwise heteroscedasticity, probable first-order autocorrelation and, possibly but not always, cross-sectional correlation, requires further decisions with regard to estimation methods. I generally implemented three alternative methods and some variants of them but report the estimations by the preferred method. These methods are:

(1) Fixed effects with a cluster option;
(2) FGLS (feasible generalized least squares) estimation with fixed effects;
(3) PCSE (panel-corrected standard errors) estimation with fixed effects.

4.7.1 Fixed effects with a cluster option

This methodology is an adaptation of the "within groups" fixed effects estimator described above, which subtracts the mean values of the variables in the observations for a given individual/group from the data for that group, with the effect of removing the unobserved

individual-specific effect. The model is then estimated by OLS on these "within-transformed data" with the model now represented by this equation:

$(y_{it} - \bar{y}_i) = (x_{it} - \bar{x}_i)\beta + (\epsilon_{it} - \bar{\epsilon}_i)$

This is implemented by the command *xtreg, fe* in STATA. Specifying *vce (cluster state)* at the end of this command causes the Huber/White/sandwich variance estimator to be calculated for the coefficients in the regression (StataCorp 2007b). This variance matrix estimator is represented by:

$Var[\hat{\beta} \mid X] = (X'X)^{-1} \left(\sum_{i=1}^{N} \hat{u_i}^2 x_i' x_i \right) (X'X)^{-1}$ (Wooldridge 2002: 57)

When the errors are clustered within groups, the centre of this sandwich estimator becomes:

$\left(\sum_{k=1}^{M} u_k^{(G)'} u_k^{(G)} \right)$

Where there are M groups: $G_1, G_2, ..., G_M$. (Baum 2006: 139)

This estimator provides standard errors that are robust to within panel serial- correlation and cross-panel heteroscedasticity. While the point estimates of the coefficients do not change when compared to the non-robust fixed effects estimator, the standard errors do and are much more conservative. This estimator requires that there should be many groups and that disturbances should be uncorrelated across the groups (StataCorp 2007b). It is therefore not the estimation method of choice when there is cross-sectional correlation or when the number of groups in the panel is relatively small, which is the case in this analysis (Wiggins 2009).

4.7.2 Feasible generalized least squares estimation with fixed effects

An alternative estimation method is Feasible Generalized Least Squares (FGLS). In general, GLS methods involve transforming a model with an error covariance matrix (Ω) that does not fit the i.i.d. assumption into another linear equation where the error covariance matrix does fit the assumption and which can then be estimated by OLS (Kmenta 1986). Feasible GLS requires assumptions about how the errors deviate, in the

absence of precise knowledge of Ω. Whereas the robust estimator of the variance discussed above accepts the OLS point estimates and makes the variance estimator robust to non-i.i.d. disturbances, FGLS estimators change the structure of the estimation method leading to differing point estimates and consistent estimators of the variance. In the case of groupwise heteroscedasticity, GLS employs panel-weighted least squares, an OLS regression of a transformed equation, with variables weighted according to the estimated variance of each state's residuals obtained from an initial OLS regression of the untransformed data (Baum 2006). The theoretical justification for this weighting is that disturbances that come from distributions with a smaller variance provide better information about the regression line than those from distributions with a larger variance (Kmenta 1986).

In general, the GLS estimates of β are given by:

$(X^{-1}\hat{\Omega}^{-1}X)^{-1}X'\hat{\Omega}^{-1}y$ (Beck and Katz 1995; StataCorp 2007b)

Where

Ω = the covariance matrix of the errors.
Ω is estimated from the residuals obtained from an initial OLS regression.

When the model exhibits autocorrelation, contemporaneous correlation and heteroscedasticity, two sequential FGLS transformations are required, first eliminating serial correlation of the errors and then contemporaneous correlation and heteroscedasticity (Beck and Katz 1995).

In the first step, the residuals from an OLS regression of the model are used to calculate ρ which is the unit-specific coefficient of correlation between sequential error terms, such that:

$\epsilon_{i,t} = \rho\epsilon_{i,t-1} + \nu_{i,t}$

If the serial correlation is assumed to be homogeneous across the panels,

$\Longrightarrow \rho_i = \rho$

Depending on which assumption is adopted, the estimate of ρ_i or ρ is used to transform the data, by means of the Prais-Winsten transformation (Kmenta 1986; Baum 2006): the first observation is multiplied by $\sqrt{1-\rho^2}$ and subsequent observations are quasi-differenced, so that:

$$Y_t^* = Y_t - \rho Y_{t-1} \quad \text{and} \quad X_t^* = X_t - \rho X_{t-1}$$

Beck and Katz argue that in the context of the typical cross-national panel with relatively small N and T, which are close in size, it is preferable to adopt an assumption of a common ρ across panels on the basis that unit-specific ρ_i are calculated from autoregression based on only T observations and a single ρ is less likely to estimate variability inaccurately. On theoretical grounds, they suggest that if the parameters of the model,β, do not vary across units, why should not ρ, the length of time it takes for prior shocks to be removed from the system, also pool across units? Using Monte Carlo experiments, Beck and Katz find that when T is under 20, estimation assuming a common ρ is always more efficient than estimation assuming unit-specific ρ_i (Beck and Katz 1995). In this analysis, T is never greater than 22 and frequently well below 20.

In the presence of contemporaneous correlation of the errors i.e. cross-sectional dependence, the second FGLS transformation corrects for contemporaneous correlation and this automatically corrects for panel heteroscedasticity. The residuals from a second OLS estimation of the variables that have been transformed to remove auto-correlation are used to estimate the contemporaneous correlation of the errors, by means of which the data are again transformed. Following the second transformation, a final OLS estimation can then be performed on the transformed data.

The second transformation requires estimating all the pairwise contemporaneous covariances. Beck and Katz have pointed out that this correction requires T to be at least as big as N and may be problematic unless T is considerably larger than N:

> "Each element of the matrix of contemporaneous covariances of the errors is estimated using on average, 2T/N observations. Many cross-national panel studies have ratios

> of T to N of close to 1, so covariances are being estimated with only slightly more than two observations per estimate! Studies on the political economy of advanced industrial nations seldom have T to N ratios that exceed 3." (Beck and Katz 1995: 637)

Based on Monte Carlo experiments, Beck and Katz conclude that this methodology to address contemporaneously correlated errors is better avoided unless the ratio of T to N is "well above three, a situation not normally seen". These authors propose an alternative methodology, panel-corrected least squares (PCSE), for models exhibiting cross-sectional correlation, autocorrelation and heteroscedasticity, when N is close to T, which is invariably the case in this analysis, with panels ranging in size from a maximum of N=17 and T=22. PCSE is discussed in the next section.

It is no coincidence that methodological issues addressed by political scientists like Beck and Katz should have relevance for this analysis. Cross-country studies of health care systems in developed countries draw from a pool of data which has great similarities to the data available to political scientists: typically OECD member states in the post-war years. Even when the 30 OECD countries are reduced to 20, a full run of years from 1950-2010 would still have a ratio of T to N of 60/20 or 3. In OECD Health Data the spread of countries with data available on acute bed days does not exceed 11 countries before 1980. The panels used most frequently in this analysis cover the 22 years from 1985-2006 and have T to N ratios of 22/17 and 22/14 or 1.3 and 1.6. For the purpose of this analysis, the Beck and Katz argument is a persuasive reason to eschew this version of GLS estimation, when the model exhibits cross-sectional correlation.

In this analysis when the model does *not* exhibit cross-sectional correlation, I estimate by FGLS to address heteroscedasticity with and without an assumption of first-order auto-correlation. Recognising the validity of the Beck and Katz argument for a common correlation coefficient for the autocorrelation, I adopt this assumption in these FGLS estimations. (In STATA these estimations are implemented by an *xtgls* command followed by *panels (heteroskedastic)* and *corr (ar1)*, if autocorrelation is assumed.) Therefore when assuming autocorrelation, this methodology performs two transformations of the data: the first a Prais-Winsten transformation to eliminate auto-correlation, as described above: the second a transformation with variables weighted according to the estimated variance of each state's residuals from an OLS regression of the data after the Prais-Winsten

transformation. The final estimation is an OLS regression using these weighted variables. As in the case of LSDV estimation, this regression includes dummy variables for the countries and years to estimate the two-way fixed effects. When not assuming autocorrelation, the first step is not required.

4.7.3 Panel-corrected standard errors estimation with fixed effects

In this analysis when the model *does* exhibit cross-sectional correlation, I estimate by OLS with panel-corrected standard errors, the method proposed by Beck and Katz for small N and similar T panels, when estimation must address heteroscedasticity, first-order auto-correlation *and* cross-sectional correlation. If autocorrelation is assumed, this methodology begins in the same way as FGLS i.e. with an initial Prais-Winsten transformation of the data to eliminate serial correlation of the errors. After this point the methods differ. The transformed variables are then estimated by OLS without further transformation to address cross-sectional correlation or groupwise heteroscedasticity. Instead, the OLS standard errors are corrected to take into account the contemporaneous correlation of the errors and heteroscedasticity. If autocorrelation is not assumed, the first step is this OLS estimation, followed by correction of the standard errors for contemporaneous correlation and heteroscedasticity.

The covariance of the OLS or Prais-Winsten coefficients is:

$$Var(\beta) = (X'X)^{-1}X'\Omega X(X'X)^{-1}$$

This is a sandwich estimator in the Huber/White style but with a different estimate of Ω.

Where:

$\Omega = \sum_{m \times m} \otimes I_{T_i \times T_i}$

$\hat{\sum}_{ij} = \frac{\epsilon_i' \epsilon_j}{T_{ij}} =$ m x m panel-by-panel covariance matrix of disturbances;

ϵ_i and ϵ_j = residuals for panels i and j that can be matched by time period;

T_{ij} = the number of residuals that can be matched by time period between panels i and j

(Beck and Katz 1995; StataCorp 2007b)

Since this estimator improves as the number of time points increases and time points in common across panels are required to compute covariances, this is a further reason to endeavour to assemble a panel dataset which, albeit unbalanced, has the maximum attainable common periods across countries. In this analysis I use the option of employing the casewise variant of this methodology, i.e. only residuals that are common to all panels are used to compute the error covariance matrix. As in the case of LSDV and FGLS estimation, this regression includes dummy variables for the countries and years to estimate the two-way fixed effects. In common with FGLS, when not assuming autocorrelation, the first step involving a Prais-Winsten transformation is not required.

To summarise the discussion about these alternative methodologies:
1*) Fixed effects with a cluster option:* requires N (number of countries) to be significantly greater than T (number of years).
2) FGLS (feasible generalized least squares) estimation with fixed effects: if there is cross-sectional correlation, requires T to be significantly greater than N, and the panel to be balanced.
3) PCSE (panel-corrected standard errors) estimation with fixed effects: is a better estimator for cross-national panel studies where T is close to N, and there is cross-sectional correlation (Beck and Katz 1995; Wiggins 2009).

Since this analysis employs unbalanced panels comprising 7 to 17 countries over a range of between 10 to 22 years, the third method is preferable if there is cross-sectional correlation. When cross-sectional correlation is absent, the second method is preferable. FGLS, when its underlying assumptions are correct, is the more efficient estimator, whereas OLS (employed in methods (1) and (3)) is consistent but not fully efficient (Wiggins 2009). In econometrics, consistent or unbiased estimates are those where the expected value is equal to the population characteristic, with bias expressing the degree to which this is not the case. An unbiased estimator has a mean equal to the value of the population parameter to be estimated. The more efficient estimates are those with the smallest variance or the highest probability of giving a close estimate of the population characteristic. There can be trade-offs between these attributes and definitions of efficiency differ (Kmenta 1986; Dougherty 2007).

The methodology pioneered by Beck and Katz has been challenged. Chen et al (2006) present alternative Monte Carlo studies that offer differing outcomes for the relative efficiency of the Beck and Katz and FGLS methods in the presence of cross-sectional correlation. However, even this challenge concedes that the PCSE method is more efficient when the number of time periods is close to the number of cross-sections, which is the case in the panels at the centre of this analysis. Table 4.1 summarises the characteristics of the data and models which determined my methodological choices in this analysis.

Table 4.1 How characteristics of data and models determined choice of methodology

Characteristics of data	Methodological implications
Panel dataset	Panel data methods
Country-specific factors invariant with time	Fixed effects
Time-varying factors common across countries	Two-way fixed effects
N (countries) close to T (years), Heteroscedasticity, Autocorrelation	Feasible Generalized Least Squares with 2-way fixed effects
N (countries) close to T (years), Heteroscedasticity, Autocorrelation, Cross-sectional correlation	Panel-Corrected Standard Errors with 2-way fixed effects

4.8 Endogeneity

A further assumption that is required if OLS estimates are to be consistent is that the disturbance term is distributed independently of the regressors, which can be re-stated as that the disturbance has a zero conditional expectation or mean:

$$E(\epsilon_{it} \mid X_{it}) = 0$$

This assumption can be violated in a number of circumstances: if there is measurement error in the regressors; bias due to omitted variables or simultaneous determination of the response variable and the regressors. While some authors would only define the third of these instances as endogeneity (Baum 2006), Wooldridge regards each as an instance of endogeneity because his definition of endogeneity is any instance of correlation between a regressor and the error term (Wooldridge 2002). In this analysis, it is conceivable that

endogeneity arises in all these instances: simultaneity, measurement error and omitted variable bias.

4.8.1 Endogeneity due to simultaneous equations bias

When endogeneity arises in an economic relationship due to simultaneous equations bias, this may be because the dependent variable causes one of the co-variates, or there is simultaneous determination of the response variable and regressors. The endogenous regressor is correlated with the error term so that conventional estimation methods will produce inconsistent estimates.

In the hypothesised full balance of care model, endogeneity would arise because of simultaneity. My hypothesis is that the balance between acute bed utilisation and long-term care utilisation is in effect a set of simultaneous equations: acute bed utilisation is influenced by long-term care utilisation and vice versa. Causality runs in both directions. Acute bed utilisation can be represented as a function of LTC utilisation and informal care supply in a single composite equation:

$$\text{Acute bed days p.c.} = \beta_1 + \beta_2 \text{GDP p.c.} + \beta_3 \text{percent65} + \beta_4 \text{percentDecedents} + \beta_5 \text{FLFP} + \beta_6 \text{LEBdiff} + \beta_7 \text{LTC recipients} + \beta_i \text{state}_i + \beta_j \text{year}_j \quad (4)$$

Equally, LTC utilisation can be represented as a function of acute bed utilisation and informal care supply:

$$\text{LTC recipients} = \beta_1 + \beta_2 \text{GDP p.c.} + \beta_3 \text{percent65} + \beta_4 \text{percentDecedents} + \beta_5 \text{FLFP} + \beta_6 \text{LEBdiff} + \beta_7 \text{Acute bed days p.c.} + \beta_i \text{state}_i + \beta_j \text{year}_j \quad (5)$$

In the balance of care equations (4) and (5) a variable on either side of the equation drives a variable on the other (acute bed days and LTC recipients). Furthermore, both sides share at least one known driver, the convergent life expectancy variable, and depending on the panel employed, may share others. There are a number of methodological approaches to overcoming this aspect of the challenge of endogeneity in a balance of care model, such as the two-stage least squares approach successfully applied in UK studies to estimate the substitutability of acute and LTC expenditures (Forder 2009) and the effect of the supply of care in alternative settings on acute utilisation (Carr-Hill et al. 1994; Martin and Smith

1996). This method and others which are designed to address endogeneity are discussed in greater detail in Section 4.9 below. Applying such an approach requires identifying instrumental variables (IV) for the endogenous regressors.

In this analysis any attempt to apply such a methodology encounters the obstacle of inadequate data. Estimation of either equation (4) or (5) is infeasible because of the very small panel of states and years for which both LTC and acute care utilisation variables are available; and because of the collinearities within that panel between GDP per capita and female labour force participation. The near-collinearities in the small dataset would prevent inclusion of determinants of interests. Sourcing suitable IV for the endogenous regressors in addition represents an insurmountable challenge to pursuing this methodological approach. Insofar as this analysis is an investigation of the degree to which OECD macro data can support cross-country analysis of the balance of care, it is evident that in this respect - the estimation of a comprehensive model - the investigation reveals that up to the publication of the 2009 version of the OECD Health Data database the data are inadequate to do so.

4.8.2 Simultaneous equations without endogeneity

Within branches of economics, the definition of endogeneity differs. This difference has methodological implications. Woolridge distinguishes between endogeneity as traditionally understood in economics and as defined in econometrics:

> "An explanatory variable x_j is said to be endogenous... if it is correlated with u [the error term]... In traditional usage, a variable is endogenous if it is determined within the context of a model. The usage in econometrics, while related to traditional definitions, is used broadly to describe any situation where an explanatory variable is correlated with the disturbance. If x_j is uncorrelated with u, then x_j is said to be exogenous..." (Wooldridge 2002: 50)

Kmenta, on the other hand, expresses a wider and more traditional definition of endogeneity:

> "A model is said to constitute a system of simultaneous equations if all the relationships involved are needed for determining the value of at least one of the endogenous variables included in the model. This implies that at least

> one of the relationships includes more than one endogenous variable..."
>
> "Although the concepts of causality and exogeneity are not identical, it is nevertheless possible to conclude that if a variable Y is - in some sense - caused by a variable X, Y cannot be considered to be exogenous in a system in which X also appears." (Kmenta 1986: 652)

Greene acknowledges that the distinction between exogenous and endogenous variables is "a subtle and sometimes controversial complication", leading to recognition of degrees of exogeneity and distinction based on statistical grounds (Greene 2008: 357). The Wooldridge definition makes this distinction.

These conceptual and semantic distinctions have direct application in this analysis. In the acute utilisation model, when LTC utilisation is not included as a regressor, a causal relationship still exists between two other regressors. The dependent variable (acute bed days per capita) is a function of both GDP per capita and female labour force participation (FLFP) plus other variables. In the classic production function GDP is a function of capital and labour (with other factors such as technology). Since female labour force participation is a measure of labour, GDP is causally related to FLFP (a relationship explored in greater detail in Chapter 7). Therefore, if one were to adopt Kmenta's definition of endogeneity, GDP cannot be considered to be exogenous in a system in which FLFP also appears.

When endogeneity arises because of reverse causality as in the cases of acute bed utilisation and LTC utilisation, it is a straightforward exercise to demonstrate that each of the endogenous variables in a system of two linear simultaneous equations can be expressed in their reduced forms as a function of all of the error terms and all of the exogenous or predetermined variables in that system. This is the standard proof that each endogenous variable is correlated with the error term in the equation in which it is a right-hand side variable, the attribute that prevents the estimation of this equation by OLS (Davidson and Mackinnon 2004).

When, as in the case of GDP and FLFP in this analysis, a regressor can be expressed as a function of another regressor, its correlation with the error term of the equation, in which it

appears as a right-hand side variable, cannot be so readily proven. The simplified system of simultaneous equations is:

$$Y = \beta_1 X + \beta_2 Z + \beta_3 Q + \nu \qquad (6)$$

$$X = \gamma_1 Z + \gamma_2 W + \mu \qquad (7)$$

Where:

Y = Acute bed days per capita (endogenous)
X = GDP per capita (endogenous)
Z = Female labour force participation (exogenous)
Q = exogenous variables
W = exogenous variables

This is a triangular system of simultaneous equations, in which the joint determination of the variables is said to be recursive (Greene 2008). One endogenous variable, X, is completely determined by exogenous factors, Z and W in equation (7). Given (7), the second variable is likewise determined as in equation (6). In (7), X is already expressed in its reduced form. Substituting (7) into (6) gives a reduced form equation for Y:

$$Y = \beta_1(\gamma_1 Z + \gamma_2 W + \mu) + \beta_2 Z + \beta_3 Q + \nu$$

$$\implies Y = (\beta_1\gamma_1 + \beta_2)Z + \beta_1\gamma_2 W + \beta_3 Q + \beta_1\mu + \nu \qquad (8)$$

The reduced form shows that the endogenous dependent variable Y is dependent on the exogenous variables, Z, W and Q, and the disturbances of the system. Thus neither reduced form equation demonstrates the endogeneity of X in equation (6) in the econometric/Wooldridge sense, which would be a correlation with the error term in that equation. Such a correlation would exist, however, and would cause X to be endogenous in (6) if the error terms in (6) and (7) - μ and ν - were correlated. There is no apparent reason to assume this in this analysis.

There remain difficulties in estimating either equation (6) or its reduced form, equation (8). If the exogenous variables represented by W, the disturbance term represented by μ , and the γ coefficients both from equation (7) are known, they are new exogenous variables in equation (8). They can only be known in this system of equations, if equation (7) has been estimated. This would require data to estimate a model of the determination of GDP, with FLFP as a driver, which we do not have. When Y is expressed as in equation (6), the information necessary to estimate the effect of variable Z (FLFP) is incomplete because the equation does not model the relationship of FLFP to GDP, as in equation (7). The coefficient for Z in the reduced form equation (8) shows the total effect of Z (female labour force participation) on Y (acute bed days per capita). This combines β_2 , the coefficient of Z in equation (6), which is the direct effect of female labour force participation on acute bed days; and the indirect effect through GDP given by $\beta_1\gamma_1$.

According to the traditional definition of endogeneity as expressed by Kmenta, GDP could be considered to be endogenous in the acute utilisation model but it does not meet the econometric definition, as expressed by Wooldridge. The challenge remains to separate the effect on acute bed utilisation of variation in national income from variation in female labour force participation. I seek to address it by a combination of adopting alternative measures of welfare and parallel regressions in Chapter 7.

4.8.3 Endogeneity due to measurement error

Endogeneity due to measurement error could conceivably arise in this analysis because although FLFP is a reasonable and conventional inverse proxy for the availability of informal carers, it cannot be an exact measure of informal care supply or utilisation. In econometrics, a case of "errors in variables" is said to arise if the discrepancy between a variable (FLFP) and the variable it is designed to measure (availability of carers/AVC) is a function of the included variable. Conceptually in this analysis such a case would arise if variation in FLFP were independent of variation in AVC, if for example such variation reflected an upsurge in unemployment which preponderantly affected people without informal caring roles. In such a case the error in measurement, which appears in the error term, is correlated with the included variable, rendering this variable endogenous for this reason.

4.8.4 Endogeneity due to omitted variable bias

If endogeneity were not present due to simultaneity or measurement error, the acute and LTC utilisation models in Chapters 5 and 6 can still be conceived as exhibiting endogeneity due to omitted variable bias. The paucity of data on formal LTC utilisation means that this important variable remains missing from the acute utilisation model. If the omitted variable, LTC utilisation, were time-invariant, it could be captured by the country-specific fixed effects. But because it is time varying, it is present in the idiosyncratic error term in these models. LTC utilisation is also correlated with the included regressors, demonstrably in this analysis with FLFP, age and converging life expectancies, and conceivably also with GDP. This correlation establishes a correlation between these covariates and the error term in this equation, making them endogenous according to the Wooldridge definition. A similar potential for omitted variable bias exists in the LTC utilisation model due to the omission of a variable for acute utilisation or supply.

4.9 Econometric methods to address endogeneity

The traditional econometric method employed to overcome the challenge of endogeneity is two-stage least squares (2SLS) estimation. This method requires the identification of one or more instrumental variables (IV) which are highly correlated with the endogenous regressor but uncorrelated with the error term. Further, they must not appear in the equation in their own right. If the endogeneity arises due to measurement error, then the IV must be highly correlated with the mismeasured variable, which in this analysis would require identifying an IV for the availability of carers, rather than for FLFP. The 2SLS method involves two sequential OLS estimations: the first provides estimates of the reduced form equations of the endogenous variables which express them as a function of the exogenous variables and the IV. The second OLS estimation uses the fitted values of the endogenous variables from the first equation. Finding appropriate IV can be difficult and, even if satisfactory IV exist, this method may have substantial bias in small samples (Baum 2006).

Fixed effects estimation methods can be extended to IV estimation for endogenous regressors. A number of such estimation methods have been developed. In the case of models exhibiting fixed effects, a typical path is: firstly, to use first differences to transform the equation, thereby removing fixed country-specific effects because they do

not vary over time; secondly, to choose instruments for the endogenous variables in the transformed equation, which can be estimated by pooled OLS; and thirdly, if the model exhibits heteroscedasticity or serial correlation, to correct the standard errors (Wooldridge 2002; Baltagi 2008). There are a number of variants of such estimation methods. Critically they require identification of appropriate instruments. As discussed above, estimating the balance of care as a system of simultaneous equations would require finding suitable IV for the long-term care utilisation measure in the acute utilisation model and vice versa. Such IV cannot appear in the model equation in their own right. My inability to find such IV combined with the very small size of any dataset which is restricted by the availability of observations for LTC utilisation prevented my estimation of the balance of care by a 2SLS methodology. In this analysis, if the endogeneity is conceived as a case of omitted variable bias due to the omission of a variable for LTC utilisation or supply in the acute utilisation model or the reverse, then arguably all or at any rate most of the covariates are endogenous and require identification of suitable IV. This is the second point at which my attempts to overcome endogeneity in modelling the balance of care have failed because of my inability to source suitable IV to facilitate employing a variant of 2SLS estimation to address omitted variable bias.

A further path of analysis remains open, at least theoretically. Dynamic panel data estimators are frequently employed to estimate panel data models, which exhibit heteroscedasticity, autocorrelation, endogeneity and time and group fixed effects. These are generalized method of moments (GMM) type estimators that use lagged values of endogenous variables as their instruments, which is useful when instruments are difficult to find. Instrumenting the endogenous variables with their lags makes them pre-determined and therefore not correlated with the error term. Difference GMM also uses first differences to transform the equation and remove fixed country-specific effects (Arellano and Bond 1991; Blundell et al. 1992; Baltagi 2008; Roodman 2008). These dynamic panel data (dpd) methods developed using micro-datasets with many panels and few periods. Arellano and Bond, in their seminal paper, applied their estimators to a model of dynamic labour demand employing a dataset with 140 groups (companies), a maximum of 6 observations per group and 611 observations in all (Arellano and Bond 1991). These estimators require a relatively large number of groups/panels to supply large sample properties, while the time period is required to be short. In contrast, this analysis employs macro-datasets with 7-17 groups, a maximum of 22 observations per group and 355

observations. In dynamic models the number of instruments increases quadratically with the number of periods, so they are not suited to panels with a long T (Baltagi 2008; Roodman 2008). It is generally recommended that the number of instruments should not exceed the number of groups. There are therefore particular methodological challenges in applying dpd estimation methods to this analysis of acute utilisation when limited to macro measures in cross-country panels.

In this analysis I tested the applicability of such methods. This required an initial re-examination of the dataset with a new objective: to identify a panel which would be sufficiently balanced to allow estimation of the model of acute bed utilisation but which would be designed so that the number of countries would exceed the number of years (N>T). There are a number of further considerations in selecting such a dataset: reducing the number of years increases the likelihood of near-collinearity between variables; by definition, the period under review changes and the complex inter-relationship of variables such as converging life expectancies, age, female labour force participation and acute utilisation may not be fully captured or may differ over a shorter time period; and inevitably, it reduces sample size. The least-worst panel that I could achieve has 20 countries, is limited to the 10-year period from 1990 to 1999 and has 195 observations. This panel includes the countries in the HMD17 and HMD14 panels that are used most frequently in this analysis with the addition of Sweden, Denmark and Poland - dropped in other panels because of the limited run of years for which data were available (Table 4.2).

These methodologies offer a number of routes to creating potentially very large numbers of instrumental variables to address endogeneity. Employing too many instruments can create its own difficulties, however (Roodman 2008). I adopted a necessarily minimalist approach in applying such methodologies because of the small sample size and small number of groups. The estimation method I employed is so-called "difference GMM", developed by Arellano and Bond, in which the data are transformed by their first differences to remove the country-specific, time-invariant fixed effects. Time dummy variables are included to remove universal time-related shocks. The endogenous variables are instrumented by their own lags. The exogenous regressors are instrumented by their first differences. The dependent variable, acute bed days per capita, can also be instrumented by its own lags if the earlier identification of apparent first-order auto-correlation is instead interpreted as an indication that the model is dynamic, with values of

acute bed days in any time period influenced by their values in the preceding period. A robust option is appropriate because of groupwise heteroscedasticity (Roodman 2006).

Table 4.2 Comparison of more generally used panels and wider, shorter panel designed for estimation by dynamic panel data methods.

		HMD14 1985-2006	HMD17 1985-2006	HMD20 1990-1999
Australia	AUS	22	22	10
Austria	AUT	21	21	10
Belgium	BEL	21	21	10
Canada	CAN	22	22	10
Switzerland	CHE	22	22	10
Czech Rep.	CZE	17	17	10
Germany	DEU	16	16	9
Denmark	DNK	-	-	10
Spain	ESP	22	22	10
Finland	FIN	22	22	10
France	FRA	22	22	10
Hungary	HUN	16	16	9
Ireland	IRL	22	22	10
Italy	ITA	22	22	10
Netherlands	NLD	22	22	10
Norway	NOR	22	22	10
Poland	POL	-	-	10
Portugal	PRT	22	22	10
Sweden	SWE	-	-	7
USA	USA	22	22	10
Observations		289	355	195
Countries		14	17	20
Years		22	22	10

To keep instruments to the minimum, I instrumented the regressors only by their second lags. In this hypothesis of endogeneity due to the omission of a variable for LTC utilisation the only exogenous co-variates are the year dummy variables which I instrumented by their first differences. (The Arellano and Bond "difference GMM" estimator is implemented in STATA by the *xtdpd* command, with its *dgmmiv* and *div* options.) Even this minimalist approach generates 50 instruments, a number greatly exceeding the number of groups (20 countries). The effective impossibility of achieving the requirement that the number of instruments should not exceed the number of groups in this panel effectively precludes employing such methodologies for this model when applied to this dataset.

Furthermore, the Arellano-Bond test for auto-correlation in the disturbance term in the first-differenced equation, which if present restricts the lags that may be employed, depends on the assumption that there are a large number of groups, certainly larger than in

this panel (Roodman 2006). When estimating by means of instrumental variables, it is desirable to test whether the instruments are valid. When employing GMM methods a Sargan test tests the null hypothesis that the IV are proper instruments. Two difficulties arise with this test in this instance: STATA does not compute it if the errors are robust because it has been shown to over-reject when the errors are heteroscedastic (Arellano and Bond 1991); and it is not considered reliable, if the number of instruments exceeds the number of groups.

Roodman, who has developed applications of the dpd methodologies, observes:

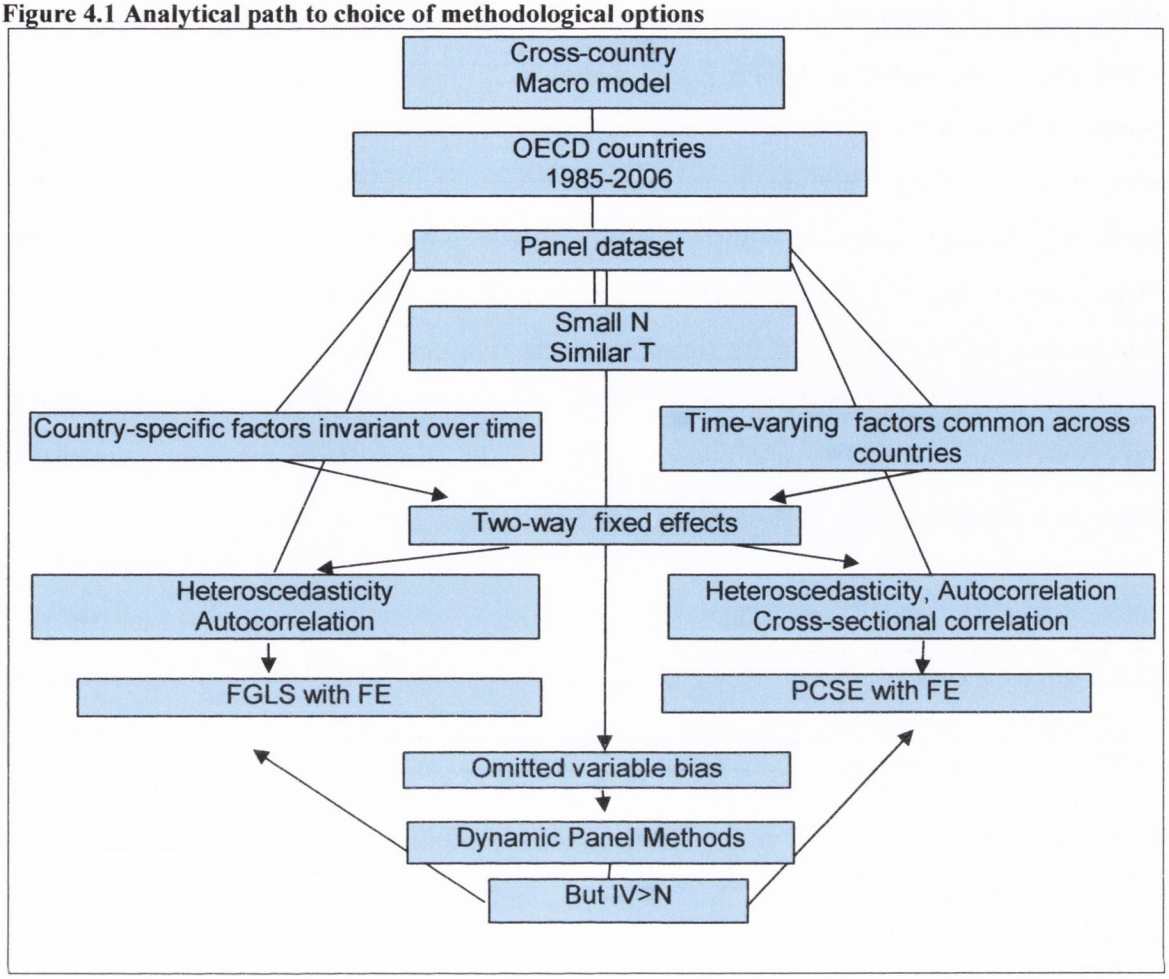
> "...internal instruments, though attractive as a response to endogeneity, have serious limitations. There is also a larger reminder here about the dangers of automated sophistication." (Roodman 2008: 28)

The obstacles to the successful application of GMM methods to estimating this model are primarily a consequence of the limited number of countries in the dataset. The strength of these estimation methods is in their application to large N (large cross-section) panels with a small T (Roodman 2006; Wooldridge 2002). My inability to apply these methods because of the nature of my dataset necessitated my accepting the alternative methodological route of estimating by either FGLS or PCSE with fixed effects, interpreting these estimations in the awareness of potential omitted variable bias. The sequence of decisions and investigations that brought me to this choice of methodologies is illustrated diagrammatically in Figure 4.1.

4.10 Goodness of fit and model specifications

Assessing how well a model fits the data is not straightforward in fixed effects panel data models. In a pooled OLS regression, goodness of fit is typically assessed by the magnitude of the coefficient of determination or R^2 which measures the proportion of the variation in the dependent variable that is explained by variation in the regressors. The adjusted R^2, Akaike Information Criterion (AIC) and Schwartz or Bayesian Information Criterion (BIC) are alternative measures, that penalize models to an increasing degree when the addition of a further explanatory variable does not compensate for the consequent loss of

Figure 4.1 Analytical path to choice of methodological options



degrees of freedom, or increase in parameters to be estimated relative to numbers of observations (Greene 2008).

When a two-way fixed effects model is estimated with the fixed effects captured by the inclusion of dummy variables, by construction the model assigns a very high proportion of the variation in the dependent variable that remains unexplained by the non-dummy regressors to the unobserved fixed effects captured by the dummy regressors. Typically in this analysis, regressions by panel-corrected standard errors of these two-way models report values of R^2 which assess that 93% to 97% of the variation in the dependent variable is explained by the included regressors. In this context, when comparing the effects of adding new regressors, assessment of goodness of fit cannot rely solely on the R^2 and may be better achieved by analysing the degree to which the new variables reduce the magnitude of the unobserved effects. When the dummy variable regressions are by feasible generalized least squares methods, it is not possible to compute an R^2 in the sense of a measure of goodness of fit for the original untransformed equation (Greene 2008).

While much of the interest in this analysis derives from testing how additional regressors diminish the unobserved effects, I also compare estimations by a range of methods for models with additional regressors and/or differing functional forms. Although the "within groups" fixed effects estimator is not the best estimator for the models in this analysis, it offers an alternative approach to their estimation, which reports values for R^2 , AIC and BIC, that reflect only the included regressors and not dummies representing the fixed effects. In general, the values for these measures assess improvements in goodness of fit compatibly with the R^2 in the dummy variable regressions and with the diminution of unobserved effects. There are occasions, however, when these measures suggest an improved fit but the unobserved effects increase.

When assessing goodness of fit based on the information criteria, I rely more on AIC than BIC. Both criteria measure fit and complexity of models. BIC weights the parameters being estimated by N, which usually denotes the number of observations. However, in a fixed effects setting with groupwise heteroscedasticity, where observations are clustered within groups, BIC in STATA equates N to M, the number of observations in the groups, which is a conservative measure that may overweight complexity (StataCorp 2007b).

The nature of the fixed effects models in this analysis further limits tests of specifications. Maximum likelihood estimation employing the Box-Cox transformation proposed by Box and Cox in 1964 is a popular means of testing the propositions that the relationships between the independent and dependent variables are linear, exponential (i.e. taking a log form) or multiplicative inverse. The straightforward Box-Cox procedure is complicated in the fixed effects models in this analysis by the presence of groupwise heteroscedasticity. The Box-Cox transformation was originally intended to remove suspected heteroscedasticity. It can be misleading in the presence of heteroscedasticity, autocorrelation or cross-sectional dependence (Kmenta 1986; Baltagi and Li 2001). While I have applied the Box-Cox method to the models in this analysis, I have interpreted the results with caution and have only introduced non-linear specifications, when they also appeared supported by a theoretical hypothesis about the underlying causative mechanism and/or fairly unambiguous graphical evidence. A further test of specification is the MacKinnon, White and Davidson test (Gujarati, 2003) which supports a diminishing returns function for the effect of rising female labour force participation on formal long-term care recipients - and prompted me to re-examine and re-interpret apparent graphical

evidence of an exponential function. A hypothesis of causation and graphical evidence also support a power function that expresses the initial increase but eventual decrease in productivity in response to rising female labour force participation. Variation over time in the sign and significance of the coefficients for the age variable in the acute utilisation model suggests that age might be better represented by a quadratic function.

4.11 Conclusion

In the novel "Three Men In A Boat" the narrator takes to reading a medical encyclopaedia and discovers that he suffers from all the complaints therein apart from, to his chagrin, Housemaid's Knee (Jerome 1889). His friends take him boating. The litany of afflictions suffered by the balance of care model encompasses virtually the entire econometric encyclopaedia: heteroscedasticity, serial correlation, cross-sectional dependence, endogeneity from multiple causes and data deficiency. A number of econometric remedies are not feasible, due to inadequate data, or data available in the wrong shape. In the following chapters, I have been obliged to apply those methodologies - FGLS and PCSE - that are feasible. This should not be seen, however, as the econometric equivalent of going boating: a remedy based on a rejection of the diagnoses.

Although my analysis and conclusions from it must be qualified by an acceptance of its methodological and data limitations, I have followed as robust an approach as is possible within the limitations of the data. Employing fixed effects estimation by either feasible generalized least squares or panel-corrected standard errors are approaches commonly adopted by political scientists who also face the limitations of small N and T datasets. In the similarly-constrained economics literature on the determinants of health spending, these methodologies have been adopted in a wide range of analyses. Insofar as the omission of a variable for long-term care in the acute utilisation model occasions endogeneity, cross-national studies of health care spending and utilisation generally face this pitfall. The literature reviewed in Chapter 2 contains no example of a cross-country model of acute utilisation or spending that includes rates of LTC utilisation or spending as a determinant. In its most recent econometric, cross-national analysis of the drivers of health and long-term care spending, the OECD modeled the drivers of each sector separately and neither conceptualized them nor attempted to estimate them in the same

model as drivers of one another (OECD 2006; and Figure 4.2). The Wanless review recognised that its analysis was incomplete without such a whole systems model (Wanless 2002).

It is a central hypothesis of this thesis that the balance of care is a simultaneous relationship in which acute and long-term care utilisation and spending are inverse drivers of one another. The infeasibility in this analysis of estimating this simultaneous relationship across countries is primarily a consequence of the current limitations in the availability of comparative cross-country long-term care utilisation data. Consequently, in the following Chapters 5 and 6 this thesis investigates the determinants of acute and long-term care utilisation in separate models. Addressing the endogeneity caused by the omission in each model of a variable for the alternative form of utilisation has not proven possible due to my inability to source suitable instrumental variables to support a 2SLS approach. Although it remains the case that the omission of an explicit variable for long-term care utilisation in an acute utilisation model and vice versa are serious deficiencies, provided inference from such models takes that deficiency into account, it is nonetheless possible to gain some interesting, albeit qualified, insights into the determinants of each form of utilisation and the balance between them.

Figure 4.2 Drivers of total health and long-term care spending: key components

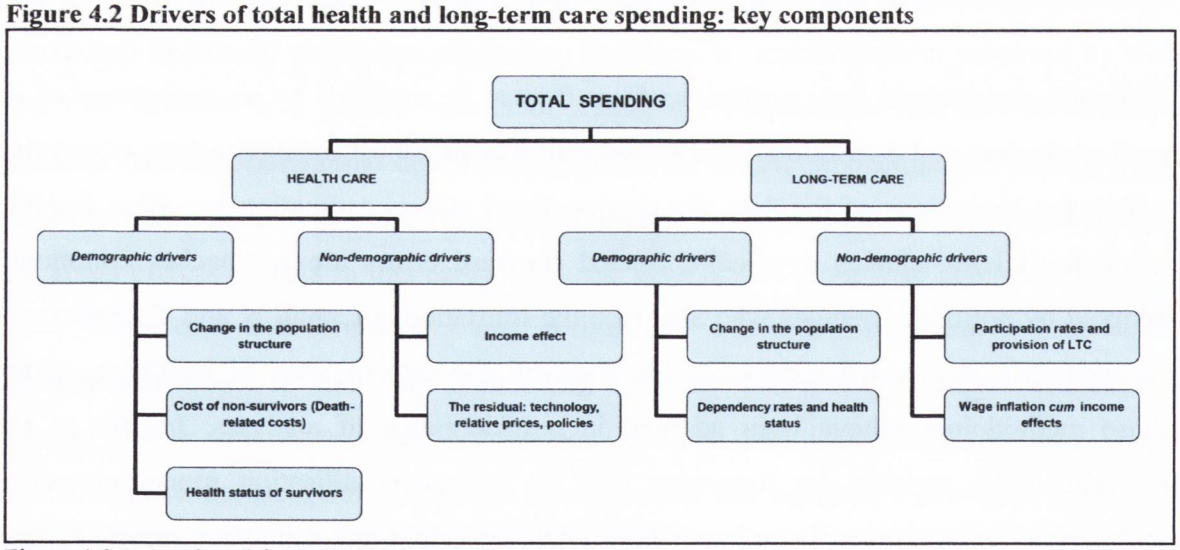


Figure 1.3 Reproduced from OECD (2006: Page 43)

SECTION TWO: CROSS-COUNTRY ANALYSIS OF ACUTE AND LONG-TERM CARE

Chapter 5 The roles of age, death and converging life expectancies in determining acute bed utilisation

5.1 Introduction

This chapter is an examination of the determinants of acute bed utilisation using panel data for 17 OECD countries over the 22 years from 1985 to 2006. Acute bed utilisation, measured by acute bed days per capita, is the dependent variable and the drivers of utilisation examined are measures of population age, deaths, convergence between male and female life expectancies, female labour force participation and GDP per capita.

The hypotheses tested in this chapter and the findings in relation to these hypotheses are:

1) Whether population ageing is an upward driver of acute bed utilisation;

Age, represented by the population share aged 65 and over, is found to have been an upward driver of utilisation in the 1980s but, as the age share of population has increased and life expectancies have converged across these OECD countries, age has become insignificant to or a downward driver of acute bed utilisation, with its effect varying due to the moderating influence of convergence in male and female life expectancies. When this panel is restricted to the years 1990-2006, the effect of age is more generally negative, where it is significant.

2) Whether national income (GDP per capita) is an upward driver of acute bed utilisation;

GDP per capita is included as a covariate, since in other studies it has shown significance as a driver of health spending. In this analysis it has a positive and significant relationship to acute bed days per capita.

.

3) Whether the finding in within-country studies that proximity to death is a more important upward driver of health spending and utilisation than calendar age holds for acute bed utilisation across countries;

A variable for all deaths as a percentage of population is found to be a significant upward driver of acute bed utilisation.

4) Whether cross-country variation in acute bed utilisation reflects the within-country evidence on alternative locations of death particularly at older ages - the balance of care at the end of life;

Acute bed utilisation across countries is found to reflect within-country evidence of location of death. Deaths of people aged 35 to 74 are found to be significant upward drivers of acute bed utilisation while deaths of people aged 75 to 84 are insignificant for a panel restricted to countries where there is evidence that most deaths at older ages occur outside hospitals; whereas deaths of people aged 75 to 84 are found to be significant upward drivers of acute bed utilisation while deaths of people aged 35 to 74 are insignificant for a panel restricted to countries where there is evidence that most deaths at older ages occur within hospitals;

5) Whether increased female labour force participation which proxies for reduced supply of informal carers has the effect of increasing acute bed utilisation;

Female labour force participation is found to be insignificant to acute bed utilisation across this panel of 17 OECD countries.

6) Whether convergence in male and female life expectancy which could be expected to reduce numbers of older people living alone and increase care of older people for one another reduces acute bed utilisation;

Convergence between male and female life expectancies is found to have a significant reducing effect on acute bed utilisation at most values for population age. The significance of the variable for converging life expectancies suggests that as life expectancies converge so that fewer older people live alone, this has the effect of

reducing acute utilisation. This variable is also hypothesised to capture the effect of improvements in health status which are not captured in any other variable in the model but are likely to be correlated with convergent life expectancies. Improved health status would be expected to reduce acute bed utilisation at any population age.

7) Whether convergence in life expectancies moderates the effect of population ageing on acute bed utilisation

A significant interaction effect between age and convergent life expectancies supports a fundamental conditional hypothesis that the effect of either age or convergent life expectancies on acute bed utilisation is contingent upon or moderated by the other. Convergent life expectancies have a reducing effect on acute bed utilisation at most values for age in this panel of countries but the effect of age on acute bed utilisation is only significant and positive at higher values for convergent life expectancies and lower values for population age; and is only significant and negative at the lowest values for convergent life expectancies and highest values for population age.

The findings in this chapter are consistent with the relative significance of proximity to death over age, demonstrated for health care expenditure or utilisation within countries in earlier studies and suggest that this significance holds true for acute utilisation across countries. Whereas earlier studies of the effect of proximity to death have been based on micro data within countries, this analysis employs macro data across countries. Unlike earlier studies employing expenditure or utilisation data for individual hospital patients, this study employs a measure of all deaths in a population, which may or may not occur in hospital. The finding that death is a significant driver of acute bed utilisation, whereas age is not, implies that as life expectancy increases, the age at which acute bed demands will be most challenging is the age at, or close to which, death occurs. This cross-country finding of the importance of proximity to death as a driver of acute bed utilisation suggests that further analysis of the determinants of location at death will enhance understanding of differences between countries' acute utilisation. Proximity to death emerges from this analysis as a policy driver: a well-managed place of death policy has potential not only to improve the lives of the terminally ill but also to reduce utilisation of acute beds.

To seek an explanation for differences between countries in acute bed utilisation, which remain after controlling for national income, age, deaths, female labour force participation and converging life expectancies, this chapter employs evidence from the literature on location at death to separate the original panel into two panels. From parallel split-sample estimation of models with variables for deaths at alternative ages it emerges that the effect of age at death on utilisation differs depending on whether most deaths or most deaths at older ages occur in or outside hospital. Tests of the significance of the differences in coefficients in these split-sample estimations find significantly differing decedent variable coefficients: in a panel of countries where most older deaths occur outside hospital, deaths at ages 35 to 74 are significant drivers of acute bed utilisation whereas older deaths at ages 75 to 84 are not; and in a panel of countries where most deaths occur within hospital, older deaths at ages 75 to 84 are significant drivers of acute bed utilisation whereas deaths at ages 35 to 74 are not.

The chapter is structured as follows. Section 5.2 reviews evidence from the literature on ageing and health care and on location of death that informs the hypotheses in this chapter. Section 5.3 outlines the data employed in this analysis. Section 5.4 explains the methodological approach. Section 5.5 reports and discusses the findings under a number of sub-headings: (i) the central estimation results; (ii) alternative age specifications; (iii) the interaction between age and converging life expectancies; (iv) predicted effects; (v) unobserved time effects; (vi) and the relationship between the effects of death and location of death and unobserved country effects. Section 5.6 examines and applies evidence from the literature on location of death at differing ages to support estimation using split-sample panels, which tests the significance of location of death on the effect of age at death on acute bed utilisation. Section 5.7 summarises and concludes the chapter.

5.2 Literature

The choice of hypotheses to be tested and of variables to include in a model of determinants of acute bed utilisation is informed by evidence from the within-country literature on the roles of age and death in determining health spending and utilisation; and from the literature on the inter-related effects of household composition, marital status and supply of informal care in determining utilisation of acute care. Chapter 2 reviewed national studies of the costs of care for people close to the end of life (decedents) and for

survivors, which illustrated that health care costs were more closely related to proximity to death than calendar age. Evidence of this decedent effect has been demonstrated within: Switzerland (Zweifel et al. 1999; Felder et al. 2000; Zweifel et al. 2004); Canada (McGrail et al. 2000) ; Ireland (Layte 2007) ; the US (Lubitz and Riley 1993; Spillman and Lubitz 2000); and Japan (Sato and Fushimi 2009). A study in Germany demonstrated that acute hospital bed utilisation is also driven by proximity to death not age. Acute bed utilisation peaks in the last year of life but persons who die young have higher acute bed utilisation in their last years of life than persons who die older (Busse et al. 2002). Cross-country analysis of age-specific health services utilisation employing micro-data for the pre-enlargement EU-15 member states has established that, while states have a similar pattern of increasing health services utilisation as age increases, much of this variation is removed when differences in socio-economic characteristics and health status are taken into account (Layte et al. 2005).

Whereas previous studies of ageing and health spending employing cross-country macro data did not include the decedent effect, and previous studies of decedent effects employed micro-data for individual countries or across countries, this chapter extends the analysis by employing a cross-country macro model incorporating decedent effects. Since the decedent variable is all deaths as a percentage of population in a year, and the model tests the effect of age and proximity to death on acute utilisation, a key consideration is the extent to which deaths occur in acute hospitals. Location at death differs between countries and varies by region and over time within countries, demonstrated from evidence in the literature in Table 2.1 in Chapter 2 (Beccaro et al. 2006; Flory et al. 2004; Cohen et al. 2008; Gomes and Higginson 2008; Jürges 2008; Wilson et al. 2009; Yang et al. 2006). Cross-country analysis of acute utilisation, controlling for the decedent effect, affords an opportunity to examine whether location at death may contribute to understanding differences between countries in acute care utilisation. Location at death is unlikely to provide a full explanation, however, since this model takes into account not only acute utilisation deriving from terminal illness but also all utilisation in the last year of life. By capturing all deaths in a year in the decedent variable, the model incorporates the effect on acute bed utilisation of inpatient hospital care not only for those people who die in hospital but for all people who are admitted to hospital in their last year of life wherever they eventually die. In split-sample estimations in this chapter, the countries in the panel are divided according to evidence from the literature, which supplies point in time data and

some individual country time trends on location at death and location at death at varying ages (Table 2.1 Chapter 2). This evidence is further discussed and applied in Section 5.6.

Some studies of location at death have found acute bed numbers to be a significant predictor of the proportion of deaths occurring in hospital (Hansen et al. 2002; Wilson and Truman 2001; Yang et al. 2006). A multi-variate analysis of predictors of the rate of hospital death in the USA found that the hospital day rate (analogous to acute bed days per capita) explained almost all variance in place of death, while hospice spending and nursing home use had a lesser but negative effect on the hospital death rate (Pritchard et al. 1998). Conversely, other studies have found acute bed numbers to be insignificant or inversely related to the proportion of deaths in hospitals, or have found numbers of nursing home beds to be significant (Cohen et al. 2006; Gruneir et al. 2007; Menec et al. 2010; Van Rensbergen et al. 2006).

This study's measure of acute utilisation - acute bed days per capita - equates to available acute bed capacity multiplied by the occupancy rate (OECD 2009). As discussed in Chapter 3, this measure by definition encapsulates acute beds and occupancy. The concept of an acute bed day has three immediate components: the capital item, the physical bed, which is the product of long-run decisions about investment in health care; the current spending item, the staffing and resourcing to render this physical bed an available bed, which is the product of more short-term resource allocation decisions; and a manifestation of demand, the inpatient who occupies the bed overnight. The determinants that are of interest in this analysis are those that drive acute utilisation in a more fundamental way, the determinants of both available acute beds and occupancy, the factors driving long-run decisions to invest in bed capacity; shorter-run decisions to staff and resource these beds; and the demand factors that determine an inpatient occupies the bed overnight. It is a given in this analysis that acute beds are a driver of acute bed days. The determinants of interest are the drivers of this effectively composite utilisation measure. From the finding that deaths drive acute bed days, it follows that they also in some manner drive the decisions that determine available acute bed numbers and their utilisation.

Living alone at older ages has been found to be a significant predictor of acute care utilisation (Carr-Hill et al. 1994; Martin and Smith 1996). Living alone has also been widely found to be a predictor of formal LTC need because intense care needs can

generally only be met informally by co-resident carers (Wittenberg et al. 1998; Portrait et al. 2000). There is evidence that convergence in the life expectancies of men and women has reduced numbers of widowed people and given rise to an increase in care-giving by spouses (Pickard 2002; Schulz 2004). Yoo et al (2004) found that availability of care by a spouse, proxied by the ratio of men to women at older ages, was associated with substantially reduced long-term care expenditure. This analysis includes a variable for convergence in life expectancies to capture the effect of household composition on acute care utilisation. Although, as in Yoo et al (2004), this is a variable designed to proxy for marital status and household composition, the converging life expectancy variable is a broader measure than the variables for ratios of men to women in selected age cohorts and conceivably captures some of the effect of improved health status as well as household composition.

The mixed evidence on the relationship of female labour force participation to the supply of informal care was reviewed in Chapter 2 (Schulz 2004; Yoo et al. 2004; Crespo and Mira 2008; Bolin et al. 2008). Female labour force participation is included in the model of acute bed utilisation in this chapter to test the hypothesis that increased female labour force participation by reducing informal care supply increases acute bed utilisation.

5.3 Data

This analysis employs a primary panel of 17 OECD countries over the years 1985-2006 which has 355 observations (Table 5.1). This HMD17 panel sources population and decedent data from the Human Mortality Database (HMD panel) and was described in Chapter 3. OECD Health Data 2009 database supplies health care and macroeconomic variables. These are: acute bed days per capita; life expectancy at birth of men and women; GDP per capita, in national currency units at 2000 GDP prices; and 2000 conversion rates, employed to convert GDP per capita in national currency units into constant US dollars at purchasing power parity. The World Bank's World Development Indicators database supplies labour force participation rates for all women aged 15 and over. The data are limited by the availability of country observations for acute bed days per capita. Excluding years in some iterations reduces the number of observations. The panel is unbalanced. It has been a matter of judgment to determine to what degree observations and heterogeneity should be sacrificed to achieve greater balance and better estimation.

In order to investigate the effects of location of death at varying ages, the evidence from the literature supports division of the countries within the dataset into four regions: in two of which most deaths occur in hospital; and in two of which most deaths or most deaths at older ages occur outside hospital. The first two regions approximate to Western and Eastern Europe; the second two regions approximate to Northern and Southern Europe, in which respectively deaths occur to a greater degree in a long-term care setting or at home. The evidence from the literature supports including Canada and the USA with the latter two regions. Since there is inadequate evidence to assign Australia and Ireland to a category, they are included with the Western European countries. Splitting the HMD17 panel based on evidence from the literature on location of death therefore gives two sub-panels, HMD9 and HMD8, where HMD8 includes Northern European and Southern European countries with the addition of the USA and Canada; and HMD9 comprises the remaining countries from the HMD17 panel, i.e. those from Western and Eastern Europe with the addition of Australia (Table 5.1). The panels resulting from splitting the sample in this manner cover the same years and almost the same number of observations

Table 5.1 Full panel and split-sample panels: states, years and observations

Panels	HMD17		HMD9		HMD8	
Years	1985-2006		1985-2006		1985-2006	
States		Obs.		Obs.		Obs.
Australia	AUS	22				
Austria	AUT	21	AUT	21		
Belgium	BEL	21	BEL	21		
Canada	CAN	22			CAN	22
Switzerland	CHE	22	CHE	22		
Czechoslovakia	CZE	17	CZE	17		
Germany	DEU	16	DEU	16		
Spain	ESP	22			ESP	22
Finland	FIN	22			FIN	22
France	FRA	22	FRA	22		
Hungary	HUN	16	HUN	16		
Ireland	IRL	22	IRL	22		
Italy	ITA	22			ITA	22
Netherlands	NLD	22			NLD	22
Norway	NOR	22			NOR	22
Portugal	PRT	22			PRT	22
USA	USA	22			USA	22
	Total	355	Total	179	Total	176

5.4 Methodology

The central model is:

$$\text{Beddays} = \beta_1 + \beta_2 \text{GDP p.c.} + \beta_3 \text{Percent65} + \beta_4 \text{Percent65}^2 + \beta_5 \text{PercentDecedents} + \beta_6 \text{LEBdiff} + \beta_7 \text{Percent65*LEBdiff} + \beta_8 \text{FLFP} + \beta_i state_i + \beta_j year_j$$

Beddays = Acute hospital bed days per capita;

GDP p.c. = Gross domestic product per capita, constant US dollars(thousands).

Percent65 = Percentage of population aged 65 and over;

PercentDecedents = Decedents as percentage of population;

LEBdiff = LEBF − LEBM expressed in years;

LEBF = Female life expectancy at birth;

LEBM = Male life expectancy at birth;

Percent65*LEBdiff = interaction term for age and converging life expectancies;

FLFP = female labour force participation rate (a proxy for informal care supply).

In the split sample estimations, in alternative models the single death variable is replaced by variables for deaths at varying ages.

This is a two-way fixed effects model specification, with intercepts that vary over countries and over time. This heterogeneity renders pooled ordinary least squares (OLS) estimation inappropriate. Including dummy variables for each state and year enables estimation of country and time fixed effects. Although in some panels and iterations (i.e. differing states, years or covariates), tests of overidentifying restrictions support random over fixed effects estimation, this is not generally the case (Wooldridge 2002; Schaffer and Stillman 2010). Given that the panels of OECD states employed in this analysis cannot be considered random samples of all states, so that inference is restricted to their behaviour, and there is in any event considerable evidence for country-specific effects, fixed effects estimation is appropriate to the data (Baltagi 2008; Dougherty 2007). Joint tests confirm the significance of such fixed effects, which justifies the inclusion of these dummy variables, to capture country-specific unobserved factors that are not independent of the regressors and are time invariant; and time-variant unobserved factors that the countries have in common and are also not independent of the regressors.

In each specification, a modified Wald test confirms groupwise heteroscedasticity, i.e. the countries have not only different intercepts but different error variances (Baum 2006). A Wooldridge test also consistently confirms first-order autocorrelation, i.e. correlation between observations that are close in time giving rise to autocorrelation in the disturbance term (Drukker 2003). Less consistently, Pesaran's test for cross-sectional dependence indicates contemporaneous correlation of errors, suggesting the presence of a common shock or shocks, in some but not all panels and iterations (De Hoyos and Sarafidis 2006; Pesaran 2004). Chapter 4 discussed alternative estimation methods which are appropriate when groupwise heteroscedasticity, first-order autocorrelation and possibly cross-sectional correlation, are present. If cross-sectional correlation is not present, FGLS (feasible generalized least squares) estimation with fixed effects is appropriate: if it is present, the appropriate methodology is PCSE (panel-corrected standard errors) estimation with fixed effects.

I estimated the model in each panel, with and without assumed cross-sectional dependence and/or auto-correlation. The tables in this chapter show results employing the preferred method, as indicated by the Pesaran and Wooldridge tests. Appendix A of Section 5 of this thesis compares estimates employing a range of methodologies. The alternative estimations generally differ little to the estimations by the preferred method. The Pesaran test's confirmation of a common shock or shocks in some but not all estimations and panels raises the issue of how to interpret such shocks in the context of international health care systems and demographic change. Cross-sectional dependence arises from the effect of common unobserved factors, manifest in the disturbance term but uncorrelated with the included regressors, which in this analysis implies that some countries experience common shocks, which have an impact on acute utilisation. Such shocks are found to be absent in this chapter only in the estimations in Section 5.6 which substitute variables for deaths at varying ages for the all deaths variable; and in estimations employing the smallest HMD8 panel. Such cross-sectional dependence might reflect the spillover effect of innovations in medical technology or hospital organisation in one country on others.

In this discussion the converging life expectancy variable measures differences in life expectancies in years so that it reduces as life expectancies converge. The consistently positive effect of this variable on acute bed utilisation represents a consistently reducing effect of converging life expectancies and is generally discussed in those terms. The

analysis in this chapter of the relationship of age, converging life expectancies and their interaction to acute bed utilisation follows the approach to testing conditional hypotheses in interaction models outlined by Brambor, Clark and Golder (2006) and developed in greater detail in Kam and Franzese (2007).

The theoretical justification for the hypothesis that converging life expectancies condition or moderate the effect of age on acute bed utilisation and, conversely, that age moderates the effect of converging life expectancies on acute bed utilisation is based on the premise that the variable for converging life expectancies is capturing two effects: the first is the survival of older couples for more years together, with the consequence that discharge home from acute hospital is more easily achieved or admission more easily avoided because of the presence of a spouse/partner to provide informal home care; the second is that this variable is correlated with improved health status at older ages, not otherwise represented in the model, and that the effect of age on acute bed utilisation will change with changes in health status. Both effects of the converging life expectancy variable can be plausibly hypothesised to moderate the effect of age on acute bed utilisation. Conversely, the inter-relationship of the variables equally plausibly suggests that the effect of convergence will be moderated by population age and will be greater as population age share increases.

Following the methodology advocated by Kam and Franzese (2007) this analysis employs Wald tests: initially of the joint hypothesis that age, converging life expectancies and their interaction have significant effects on acute bed utilisation in a range of models; and then of the separate hypotheses that age or converging life expectancies affect acute bed utilisation in these models. The test of the fundamental conditional hypothesis that a conditioning relationship exists in which the moderating variable affects the effect of the moderated variable on the dependent variable is the t-test of the coefficient on the interaction term.

Where there is confirmation of this fundamental conditional hypothesis, further tests are required to establish the significance or direction of the marginal effect of either variable on acute bed utilisation across a range of values of the moderating variable and, in quadratic specifications, of the moderated variable itself. Where significant interaction effects exist, the analysis therefore employs the alternative methodologies suggested by Kam and Franzese (2007). These are:

1. Graphical demonstration of the marginal effect of the moderated variable on the dependent variable across a range of values of the moderating variable, with confidence intervals: such graphs demonstrate the direction of the moderating effect (the slope of the marginal effect line); the direction of the marginal effect; and the range of values of the moderating variable at which the null hypothesis that the marginal effect is zero can or cannot be rejected.
2. t-tests and tabulation of p-values: this approach requires calculating the relevant marginal effect, its variance, its standard error and generating a t-statistic from which to calculate p-values for tests of alternative hypotheses of the significance and direction of the marginal effect at a range of values of the moderating variable(s).

Split-sample estimation of the effect of location of death on the effect of age at death on acute bed utilisation is employed because of the data inadequacy and methodological limitations which prevent estimation of the effect of location of death within a pooled sample country-specific fixed effects model. Were there continuous or regularly recorded data for variation in location of death within countries over time, it would be possible to include either a continuous variable for the proportion of deaths occurring in hospital within countries; or an indicator variable with sufficient within-country variation to allow its inclusion in a fixed effects model. The data assembled for this thesis from evidence in the literature on location of death is insufficient to support constructing either such variable. Although it is possible to construct a categorical variable for location of death (LOD) and assign it a value of 1 for countries in which most deaths or most deaths at older ages occur outside hospital; and a value of 0 for countries where most deaths occur in hospital, or where there is insufficient evidence from the literature to assign a category, despite evidence for some countries of variation in LOD over time, this is inadequate to supply within country over time variation in the LOD value.

The methodological limitation which prevents the inclusion of such a time-invariant categorical variable for location of death with country-specific fixed effects arises because the unobserved country-specific effects are correlated with the covariates so that it is not possible to distinguish the effect of a time-constant observable variable such as LOD from the time-constant unobservable variables, the country-specific fixed effects (Wooldridge 2002). In practice, attempting to include LOD with the country-specific fixed effects gives

rise to a particular case of the "dummy variable trap" (Dougherty 2007). Inclusion of the LOD variable has the same effect as omitting to exclude a reference category from the country or year fixed-effects dummy variables. The practical effect in STATA estimation by two-way LSDV is that either the intercept coefficient (which is in effect the coefficient of the omitted FE categories) or one of the other dummy variable coefficients is dropped from the estimation.

If the country-specific fixed effects are dropped from the model to enable estimation with an LOD categorical variable by random effects or pooled ordinary least squares this will lead to biased estimation of the time-varying variables (Plumper et al. 2005; Plumper and Troeger 2007). A further method which allows estimation of time-invariant variables in the presence of country-specific fixed effects is the Hausman-Taylor estimator. The limitation of this method of estimation is that it requires the identification of instrumental variables for the regressors which are uncorrelated with the errors or the unobserved country-specific effects. The challenge of identifying such IV has been an obstacle to applying Hausman-Taylor estimation in this analysis. Substituting country-specific age at death variables for a single age at death variable is another possible route to examine further the evidence for the hypothesis that in countries where the majority of deaths or of older deaths occur outside hospital, the effect on acute bed utilisation of older deaths is of lesser magnitude and significance than in countries where the majority of deaths occur within hospital.

In the split-sample estimations of the effect of age at death on acute bed utilisation, t-tests of the significance of differences in the coefficients estimated for the split samples are employed. In each case this is a t-test of the null hypothesis that the estimated coefficients in the alternative samples are equal, which is a test that their difference is statistically significant. This requires constructing a t-statistic where the standard error of the estimated difference between the two coefficients is the square root of the sum of the estimated variances of the two coefficients. To test the null hypothesis that:

$$H_0 : \hat{\beta}_{n/s} = \hat{\beta}_{w/e} \implies \hat{\beta}_{n/s} - \hat{\beta}_{w/e} = 0$$

Where:

$\hat{\beta}_{n/s}$ = Estimated coefficient for North-South panel

$\hat{\beta}_{w/e}$ = Estimated coefficient for West-East panel

The t-statistic is given by:

$$(\hat{\beta}_{n/s} - \hat{\beta}_{w/e}) / \sqrt{V(\hat{\beta}_{n/s}) + V(\hat{\beta}_{w/e})}$$

(Kam and Franzese 2007: 108)

This calculation therefore requires squaring the standard errors for the coefficients in the sub-sample estimations to yield their variances and calculating the square root of the sum of the variances, which is the standard error of the difference between the estimated coefficients in the two sub-samples.

Since this model does not contain a variable for long-term care utilisation or supply, and it is the understanding in this thesis that acute bed utilisation and long-term care utilisation are simultaneously determined, there is the possibility of omitted variable bias in the estimated coefficients, a form of endogeneity. To some degree, the effects of omitted variables will be captured by the fixed effects dummy variables. To the degree that such effects are variant over time and across countries, they will remain in the error term. For the reasons discussed in Chapter 4, this cross-country dataset cannot support employing methodologies that directly address this potential endogeneity and the findings are consequently qualified.

A further possible cause of endogeneity, reverse causation, could be an issue in a model in which acute utilisation is estimated as a function of deaths that occur in hospital, with the availability of staffed beds a potential determinant of deaths in hospital and, conversely, deaths in hospital being a potential determinant of bed utilisation. This issue does not arise in this model because the decedent variable is the overall death rate in a population. As in the case of population ageing, the death rate is the product of too many independent and, in many cases, historical factors (such as fertility rates, lifestyle choices, epidemics and war) to be regarded as determined by numbers of available or occupied acute beds, and is clearly exogenous. While location at death or the hospital death rate is a probable explanation for some variations in utilisation between countries that this model does not explain, the cross-country finding that the death rate is an upward driver of acute bed utilisation, is independent of variations in place of death.

5.5 Analysis and discussion

5.5 (i) Central estimation results

Table 5.2 compares progressively more complex acute utilisation models applied to the HMD17 panel of 17 OECD countries for the years 1985-2006. The final model with a quadratic age specification and an interaction term for age and converging life expectancies, is the preferred model. National income and deaths are found to have a positive and significant effect on acute bed days per capita. Since female labour force participation is found to be insignificant, it is not included in the final model. In the model without an interaction term, convergence in life expectancies reduces acute utilisation, reflected in a positive sign for the coefficient for the difference in life expectancies. In the preferred final model the effects of age and converging life expectancies on acute bed utilisation are each moderated by the effect of the other variable. The effect of age varies with the level of the converging life expectancy variable and with age itself. The significance of the effects of age and converging life expectancies are therefore variable and are examined further below.

By adding regressors the models have a progressively better ability to explain variations in the dependent variable (Table 5.3). The significance of the additional regressors in the more complex models indicates that they supersede the less complex models, which by definition suffer from omitted variable bias. Most measures of goodness of fit improve with the complexity of the model. As discussed in Chapter 4, my assessment of goodness of fit in this chapter does not solely rely on the magnitude of the coefficient of determination or R^2, since by construction in two-way fixed effects models, the model assigns a very high proportion of the variation in the dependent variable that remains unexplained by the non-dummy regressors to the unobserved fixed effects captured by the dummy regressors. In comparing estimations that add regressors, assessment of the explanatory power of a model may be enhanced by analysing the degree to which the new variables reduce the magnitude of the unobserved effects. Although the "within groups" fixed effects estimator is not the best estimator for the models in this analysis, it offers an alternative approach to their estimation, which reports values for R^2 , the Akaike Information Criterion (AIC) and Schwartz or Bayesian Information Criterion (BIC), that reflect only the included regressors and not dummies representing the fixed effects. AIC and BIC are alternative measures of goodness of fit that penalize models to an increasing

degree when the addition of a further explanatory variable does not compensate for the consequent loss of degrees of freedom, or increase in parameters to be estimated relative to numbers of observations. When assessing goodness of fit based on the information criteria, I use AIC rather than BIC for reasons explained in Chapter 4.

Table 5.2 Acute utilisation models, HMD17, 1985-2006
Dependent variable: acute bed days per capita

	Age & Death	Age, Death & FLFP	Age, Death, FLFP & LEBdiff	Age as quadratic, interactive	Age as quadratic, interactive, ex FLFP
GDPpc	0.030***	0.031***	0.027***	0.026***	0.026***
	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]
Percent65	0.017	0.017	-0.008	-0.019	-0.019
	[0.214]	[0.215]	[0.524]	[0.860]	[0.846]]
%Decedents	0.432**	0.457**	0.624***	0.499***	0.480**
	[0.005]	[0.003]	[0.000]	[0.001]	[0.002]
FLFP		-0.002	-0.003	-0.001	
		[0.491]	[0.136]	[0.740]	
LEBdiff			0.095***	-0.162	-0.171*
			[0.000]	[0.064]	[0.044]
Age-squared				-0.003	-0.003
				[0.227]	[0.208]
pc65byconv				0.017**	0.018**
				[0.005]	[0.003]
Observations	355	355	355	355	355
R^2	0.94	0.94	0.95	0.96	0.95

p-values in brackets * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$ Source: HMD17 panel. Estimation by PCSE. Country and year dummy variable coefficients not shown.

Table 5.3 Measures of fit, acute utilisation models, HMD17, 1985-2006

R^2 *(PCSE)*	0.94	0.94	0.95	0.96	0.95
R^2 *(FEC)*	0.65	0.65	0.79	0.80	0.80
AIC (FEC)	-556.4	-559.8	-742.7	-749.5	-746.3
2006 coefficient	-0.841	-0.837	-0.564	-0.670	-0.685
Sum of state coefficients	11.89	11.48	10.57	9.70	10.68

Table 5.3 compares five measures of goodness of fit for these models: two values of R^2, for estimation by PCSE and "within groups" fixed effects with the cluster option (FEC); the AIC for this FEC estimation; the coefficient for the final year dummy variable in the PCSE estimation, which is a measure of the unexplained time fixed effect; and the sum of the absolute values of the coefficients of the state dummy variables in the PCSE estimation, which is a measure of the unexplained country-specific fixed effect. These measures judge fit - or the explanatory power of the model - to have improved if R^2 has a

higher value, and the other three measures have a lower value. In the case of AIC, a lower value is a larger negative value, while for the year dummy coefficient a lower value is a lower absolute value. Four measures concur in judging the quadratic, interactive model to have better explanatory power than the preceding models. Although the model without a quadratic or interactive term performs better in reducing unexplained time effects and omission of the female labour force participation (FLFP) variable disimproves some of the measures of fit, the significance of the quadratic and interaction terms and the insignificance of the FLFP variable dictate favouring the final model.

5.5 (ii) Examination of age specifications in acute utilisation model

The adoption of a quadratic specification for age is informed by prior analysis testing alternative specifications for age. Table 5.4 compares the effects of representing age in the model by: a single aggregate age variable: a quadratic specification for population aged 65 and over; two age cohorts representing ages 65-79 and ages 80 and over; and quadratic specifications for those two age cohorts. Table 5.5 compares measures of fit for these alternative models. While it is apparent that the specification with two age cohorts does not add significant explanation, the quadratic specifications are significant for population aged 65 and over and population aged 80 and over, with most measures of fit marginally favouring the latter but with the former removing marginally more of the unobserved country-specific effects. In the two-age cohort quadratic specification the younger cohort for population aged 65 to 79 is insignificant.

Although the differentiated effect of the two cohort age specification offers a potential alternative route to modelling age effects, I employ the single age cohort in this analysis because it is the most generally applied measure of age in the literature on ageing effects on measures of health care utilisation or expenditure. Comparing estimations with the single-age cohort quadratic specification and a linear specification for age for varying runs of years for this panel, suggests that this is a measure of a change in the effect of age on acute bed utilisation over the period covered by this panel (Table 5.6). When the years before 1989 are excluded, this quadratic specification is not significant and age is negative and progressively more significant in effect. Only when the panel includes years prior to 1989 does the quadratic specification hold. The conclusion from this comparative analysis

is that over the period covered by these data, the relationship of age to acute bed utilisation changed across these countries.

Table 5.4 Acute utilisation models with alternative age variables, HMD17, 1985-2006, dependent variable: acute bed days per capita

	Aggregate Age	Aggregate Age as Quadratic	Two Age Cohorts	Two Age Cohorts as Quadratics
GDPpc	0.027***	0.028***	0.027***	0.018***
	[0.000]	[0.000]	[0.000]	[0.001]
%Decedents	0.624***	0.498**	0.578***	0.407*
	[0.000]	[0.001]	[0.000]	[0.010]
FLFP	-0.003	-0.003	-0.003	-0.001
	[0.136]	[0.232]	[0.198]	[0.617]
LEBdiff	0.095***	0.094***	0.095***	0.110***
	[0.000]	[0.000]	[0.000]	[0.000]
Percent65	-0.008	0.207***		
	[0.524]	[0.001]		
Percent65-squared		-0.007***		
		[0.000]		
Percent6579			-0.010	-0.119
			[0.437]	[0.216]
Percent6579-squared				0.004
				[0.274]
Percent80			0.016	0.488***
			[0.650]	[0.000]
Percent80-squared				-0.065***
				[0.000]
2006	-0.564***	-0.665***	-0.599***	-0.567***
Constant	-0.561*	-2.103***	-0.557*	-0.537
	[0.016]	[0.000]	[0.016]	[0.305]
Observations	355	355	355	355
R^2	0.95	0.96	0.95	0.96

p-values in brackets * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$ Source: HMD17 panel Estimation by PCSE. Country and year dummy variable coefficients not shown.

Table 5.5 Measures of fit, acute utilisation models with alternative age variables, HMD17, 1985-2006

R^2 *(PCSE)*	0.95	0.96	0.95	0.96
R^2 *(FEC)*	0.79	0.80	0.79	0.81
AIC (FEC)	-742.7	-741.9	-740.8	-767.2
2006	-0.564	-0.665	-0.599	-0.567
Sum of state coefficients	10.57	10.34	10.60	10.54

Table 5.6 Acute utilisation models comparison, aggregate age variable alone and as quadratic, HMD17 panel, Years from 1994-2006 to 1988-2006 ; dependent variable: acute bed days per capita

Age variable Years	Age 94-06	Quad. 94-06	Age 93-06	Quad. 93-06	Age 92-06	Quad. 92-06	Age 91-06	Quad. 91-06	Age 90-06	Quad. 90-06	Age 89-06	Quad. 89-06	Age 88-06	Quad. 88-06
GDPpc	0.019**	0.019**	0.019**	0.019**	0.020**	0.020**	0.022***	0.023***	0.024***	0.025***	0.025***	0.025***	0.028***	0.029***
	[0.008]	[0.008]	[0.004]	[0.004]	[0.001]	[0.001]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]
percent65	-0.047**	0.038	-0.036*	0.056	-0.029	0.094	-0.020	0.106	-0.024	0.125	-0.022	0.093	-0.014	0.154*
	[0.001]	[0.643]	[0.018]	[0.494]	[0.054]	[0.243]	[0.175]	[0.171]	[0.086]	[0.100]	[0.124]	[0.219]	[0.287]	[0.030]
percent65-squared		-0.003		-0.003		-0.004		-0.004		-0.004		-0.003		-0.005*
		[0.316]		[0.269]		[0.132]		[0.107]		[0.051]		[0.130]		[0.018]
%Decedents	0.785***	0.738**	0.572**	0.527*	0.506*	0.451*	0.557**	0.497*	0.565**	0.487*	0.509**	0.455*	0.596***	0.507**
	[0.001]	[0.003]	[0.010]	[0.021]	[0.016]	[0.036]	[0.004]	[0.013]	[0.002]	[0.011]	[0.003]	[0.012]	[0.000]	[0.004]
FLFP	0.004	0.004	0.001	0.002	-0.001	0.000	-0.000	0.001	-0.005	-0.004	-0.003	-0.003	-0.004	-0.003
	[0.480]	[0.368]	[0.841]	[0.714]	[0.835]	[0.989]	[0.937]	[0.846]	[0.119]	[0.211]	[0.242]	[0.331]	[0.156]	[0.265]
LEBdiff	0.030	0.029	0.047	0.046	0.074*	0.073*	0.076*	0.074*	0.087**	0.085**	0.082**	0.080**	0.082***	0.080**
	[0.372]	[0.385]	[0.158]	[0.165]	[0.020]	[0.022]	[0.011]	[0.013]	[0.001]	[0.002]	[0.001]	[0.002]	[0.001]	[0.001]
Observations	219	219	236	236	253	253	270	270	285	285	299	299	313	313
R^2	0.97	0.97	0.96	0.96	0.96	0.96	0.96	0.96	0.96	0.96	0.96	0.96	0.96	0.96

p-values in brackets * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$ Source: HMD17 panel Estimation by PCSE. Constant and country and year dummy coefficients not shown.

5.5(iii) Analysis of interaction between age and converging life expectancies in acute utilisation model

Examination of alternative interactive models supports a preference for a quadratic specification with an interaction term for age and converging life expectancies. Table 5.7 compares estimations for the linear age specification, the quadratic age specification and for linear interactive and quadratic interactive models. The quadratic (M2) and quadratic-interactive (M4) models have a higher R-square than the linear (M1) and linear-interactive (M3) models. The final model (M5) is the quadratic interactive model without a variable for female labour force participation, which is insignificant. Although the quadratic model without an interaction term (M2) is most successful in reducing the cross-country differences captured by the country coefficients, the significant interaction term in the quadratic interactive model means that a model without such a term would be mis-specified making M4 and by extension, M5, the preferred models.

Wald tests of the joint significance of the age, converging life expectancy and interaction variables in each model confirm the basic premise that acute bed utilisation depends in some way on these variables or some combination of them (Table 5.7). The test of the central conditional hypothesis i.e. that the converging life expectancy variable moderates the effect of age on acute utilisation and the age variable moderates the effect of converging life expectancies on acute bed utilisation is the test of significance for the coefficient of the interaction term in these models: β_{xz}. The significant p-values for the coefficients of the interactive terms in the models with interaction effects in Table 5.7 confirm the conditional hypothesis and indicate that a model without such a term is mis-specified. The coefficients of the interaction terms measure the cross-derivative i.e. the effect of the moderating variable on the effect of the moderated variable on acute bed utilisation.

Implementing one-tailed t-tests of the significance of the coefficients for the interaction terms is a means to confirm the direction of the conditional effect of the moderating variable on the moderated variable's effect on acute bed utilisation. Table 5.8 demonstrates the resulting p-values which support the directional hypothesis that the effect of the moderating variable is to increase the marginal effect of the moderated variable in M5. These tests confirm that in this model the marginal effect of age on acute bed utilisation increases with greater divergence in life expectancies or reduces with greater convergence.

Similarly, the marginal effect of divergent life expectancies on acute bed utilisation increases with greater population age. This can be re-stated as that as population age share increases, converging life expectancies reduce acute bed utilisation at a greater rate.

Table 5.7 Estimation of five alternative acute utilisation models, HMD17 panel Dependent variable: acute bed days per capita, 1985-2006

	M1	M2	M3	M4	M5
X: percent65	-0.008	0.207***	-0.137***	-0.019	-0.019
	[0.524]	[0.001]	[0.000]	[0.860]	[0.846]]
Z: LEBdiff	0.095***	0.094***	-0.226**	-0.162	-0.171*
	[0.000]	[0.000]	[0.001]	[0.064]	[0.044]
X^2: age-squared		-0.007***		-0.003	-0.003
		[0.000]		[0.227]	[0.208]
XZ: age*LEBdiff			0.022***	0.017**	0.018**
			[0.000]	[0.005]	[0.003]
GDPpc	0.027***	0.028***	0.025***	0.026***	0.026***
	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]
PercentDecedents	0.624***	0.498**	0.538***	0.499***	0.480**
	[0.000]	[0.001]	[0.000]	[0.001]	[0.002]
FLFP	-0.003	-0.003	-0.001	-0.001	
	[0.136]	[0.232]	[0.814]	[0.740]	
2006	-0.564***	-0.665***	-0.640***	-0.670***	-0.685***
	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]
Observations	355	355	355	355	355
R^2	0.95	0.96	0.95	0.96	0.95
Sum country coefficients	10.57	10.34	10.73	10.60	10.68
Wald test of joint significance of age, LEBdiff and interaction variables	0.000	0.000	0.000	0.000	0.000
Wald test of significance marginal effect of age	0.524	0.002	0.000	0.000	0.000
Wald test of significance marginal effect of LEBdiff	0.000	0.000	0.000	0.000	0.000

p-values in brackets * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$ Wald test P>chi^2 Source: HMD17 panel. Estimation by PCSE. Constant and country and year dummy variable coefficients not shown.

Table 5.8 One-tailed t-tests of directional hypotheses for conditional effect

Model	Coefficient	$Ho: \beta_{xz} >= 0$ $Ha: \beta_{xz} < 0$	$Ho: \beta_{xz} = 0$ $Ha: \beta_{xz} ! = 0$	$Ho: \beta_{xz} <= 0$ $Ha: \beta_{xz} > 0$
	β_{xz}	p-value	p-value	p-value
M5	0.017	0.9983	0.0035	0.0017

In M5, although the significant regression coefficient for the interaction term confirms the existence of a conditioning relationship, this does not confirm the general significance of the effects of age or converging life expectancies on acute utilisation. Further Wald tests of the marginal effects confirm that the marginal effect of age and of converging life expectancy are significant in Model 5 (Table 5.7). It is necessary to go beyond these general tests in the presence of a significant conditional hypothesis to test at what values of the moderating variable(s) there exists a significant marginal effect for the moderated variable, employing the graphical and statistical methods explained in Section 5.4 above and implemented below. These methods allow a closer interrogation of the questions as to whether the effects of age and converging life expectancies on acute bed utilisation are *generally* significant and, if not, across what range of values for these variables they are significant.

In the preferred quadratic interactive model (M5) the marginal effect of age on acute bed utilisation is conditional on the levels of both the age and the convergent life expectancy variables. This model can be formulated as:

$$Y = \beta_0 + \beta_x X + \beta_{xx} X^2 + \beta_z Z + \beta_{xz} XZ + \beta_w W$$

Where:

Y= Acute bed days per capita
X= Percentage of population aged 65 & over (Percent65)
Z= the difference between male and female life expectancies at birth (LEBdiff)
W= All other co-variates (GDP per capita, all deaths as a percentage of population, female labour force participation and dummy variables for the states and years in the panel)

The dependence of the marginal effect of age on both the values of age and converging life expectancies is then given by the derived formula:

$$\frac{\delta y}{\delta x} = \beta_x + 2\beta_{xx} X + \beta_{xz} Z$$

The relationship of age to acute bed utilisation in this model can be conceived of as a series of quadratic functions in parallel planes at alternative levels of Z (LEBdiff). The formula for the top of the quadratic functions is:

$$\beta_x + 2\beta_{xx}X + \beta_{xz}Z = 0$$
$$\Longrightarrow X = \frac{-\beta_x - \beta_{xz}Z}{2\beta_{xx}}$$
$$\Longrightarrow X = \frac{0.019 - (0.017 \times Z)}{-0.006}$$

The top of the age curve increases as LEBdiff increases; therefore at higher values for LEBdiff or greater divergence in life expectancies, the range of population age share across which age exerts an upward effect on acute bed utilisation is greater (Table 5.9). The mean sample value for LEBdiff is 6.5 years while the mean of the age variable is 14.2% (Chapter 3 Table 3.4).

Table 5.9 Top of quadratic age curve across range of LEBdiff values

Difference in male and female life expectancy, years	5.0	6.0	6.5	7.0	8.0	9.0	10.0
Top of quadratic curve: Population age share where marginal effect of age on acute bed utilisation is zero, and above which increased age causes a reduction in utilisation.	12.1	15.2	16.7	18.3	21.4	24.5	27.6

Determining the significance of age in this model requires calculating the significance of the marginal effect of age on acute bed utilisation across a range of values of both age and LEBdiff. As an alternative to the challenge of graphing quadratic functions in 3 dimensions, it is possible to graph the marginal effect of age across LEBdiff for a number of ranges of values of age. In Figure 5.1, where the marginal effect of age is graphed across a range of values of LEBdiff, the marginal effect is further restricted to the range of values of the population age variable at or below 14%. Neither the marginal effect function nor the upper confidence interval is a clean curve because the marginal effect is still varying with levels of age as well as levels of LEBdiff. However, it is clear from the graph that the marginal effect of age on acute bed utilisation is significant and positive when LEBdiff is 7.3 years or greater and is higher at higher levels of LEBdiff but that at lower values of LEBdiff the marginal effect of age is insignificant in this age range. In this and subsequent such graphs, the null hypothesis that the marginal effect equals zero is rejected

for the range of values at which the confidence intervals fall on the same side of the line at which the marginal effects equals zero. This can be seen to occur from the point at which LEBdiff equals 7.3 years in Figure 5.1. The p-values for t-tests of significance of the marginal effect of age across this range confirm the graphical evidence (Table 5.10).

When the marginal effect of age is graphed for the age range which is greater than 14% and lower that 16%, age is only significant and positive when the difference in life expectancies is 7.5 years or greater (Figure 5.2). A further graphing of the marginal effect of age for levels of age in the range between 15% and 16% (Figure 5.3) shows the marginal effect of age to be insignificant at all values for LEBdiff. When the marginal effect of age is graphed for the age range which is greater than or equal to 16%, the marginal effect is at no point positive and significant. There is a very small range within the sample in which the marginal effect of age is negative and significant, which occurs at values of LEBdiff at or below approximately 5.4 years.

Figure 5.1

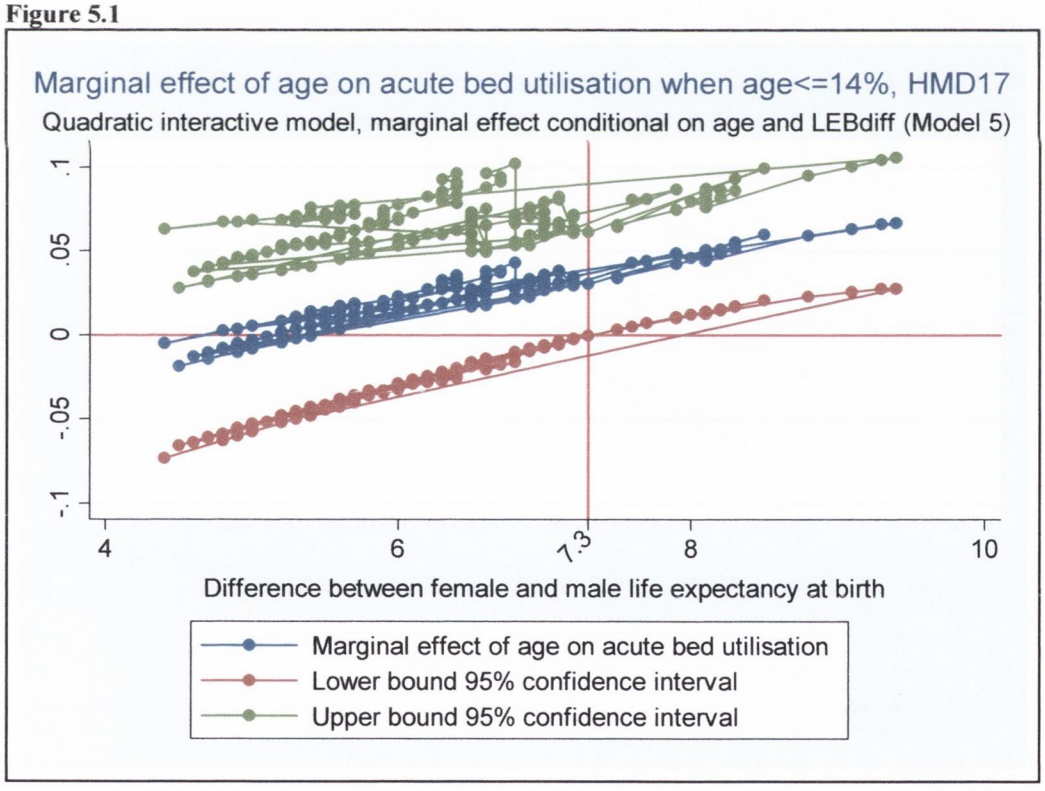


Figure 5.2

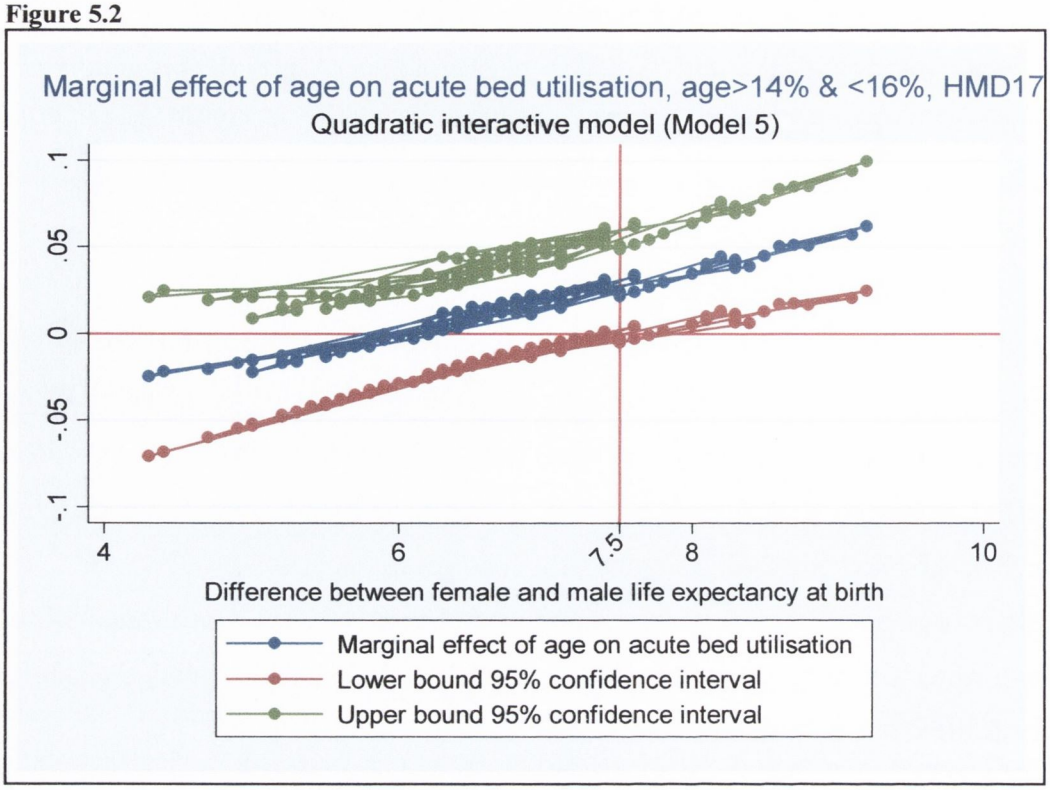


Figure 5.3

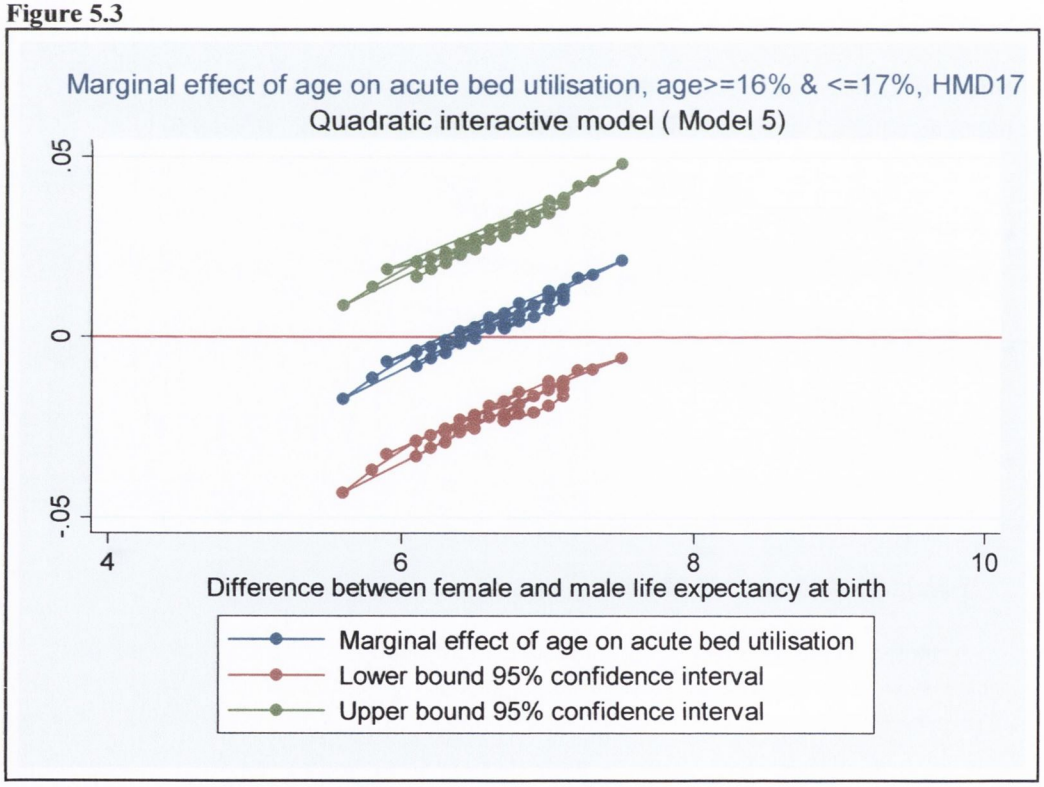
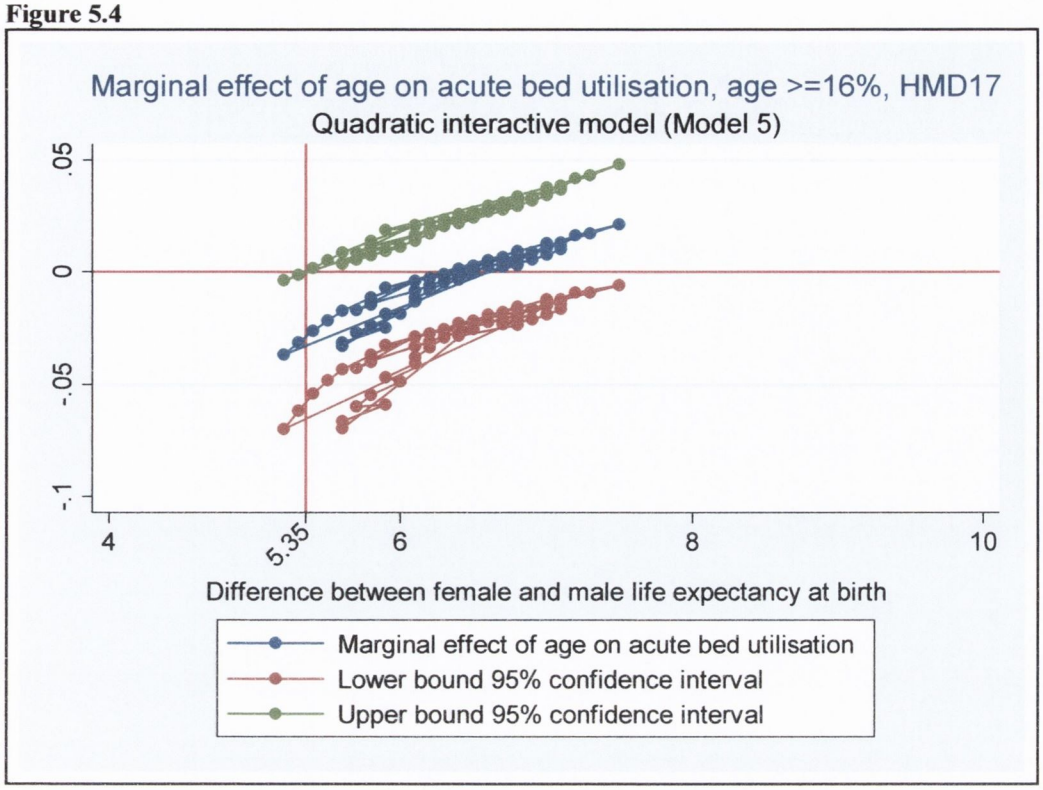


Figure 5.4



The three-dimensional nature of the marginal effect makes relying on graphical demonstration imprecise. Calculating p-values for t-tests of significance of the marginal effect of age at specific age levels and across a range of LEBdiff values is more precise and essentially confirms the graphical evidence (Table 5.10). The hypothesis tests are performed by initially calculating the marginal effect of age on acute bed utilisation at specified age and LEBdiff values, calculating the variance of these marginal effects, their standard errors and t-statistics. P-values are then found for two-tailed tests of significance of the marginal effects; from which one-tailed tests of directional hypotheses of the effects are calculated. The variance for the marginal effect of age on acute bed utilisation in this model is:

$$\hat{\sigma}^2_{\frac{\delta y}{\delta x}} = \text{var}(\hat{\beta}_x) + 4X^2\text{var}(\hat{\beta}_{xx}) + Z^2\text{var}(\hat{\beta}_{xz}) + 4X\text{cov}(\hat{\beta}_x\hat{\beta}_{xx}) + 2Z\text{cov}(\hat{\beta}_x\hat{\beta}_{xz}) + 4XZ\text{cov}(\hat{\beta}_{xx}\hat{\beta}_{xz})$$

The variance and covariance values are extracted from the variance-covariance matrix which is calculated in STATA. The table is generated in Excel.

Table 5.10 Tests of hypothesis of whether age affects acute bed utilisation, Model 5

Percentage of population aged 65+	Difference in life expectancy between men and women, years	Marginal effect of age on acute utilisation	Standard error of marginal effect of age	Test statistic	Test of null hypothesis that marginal effect is positive or zero	Test of null hypothesis that marginal effect is zero	Test of null hypothesis that marginal effect is negative or zero	Confidence intervals	
percent65	LEBdiff	dydx	se(dydx)	t-stat	H0:dydx>=0	H0:dydx=0	H0:dydx<=0	LBdydx	UBdydx
X	Z				HA: dydx<0	HA: dydx!=0	HA: dydx>0	95% CI	95% CI
					p-value	p-value	p-value		
14	6	0.006632	0.016861	0.39	0.652	0.697	0.349	-0.02642	0.03968
14	7	0.024235	0.014928	1.62	0.947	0.106	0.053	-0.00502	0.05349
14	7.3	0.029516	0.014783	2.00	0.977	0.046	0.023	0.00054	0.05849
14	8	0.041838	0.015292	2.74	0.997	0.006	0.003	0.01187	0.07181
15	6	0.000950	0.014091	0.07	0.528	0.944	0.472	-0.02667	0.02857
15	7	0.018553	0.012853	1.44	0.925	0.151	0.076	-0.00664	0.04374
15	7.5	0.027355	0.013255	2.06	0.980	0.041	0.021	0.00138	0.05333
15	8	0.036156	0.014293	2.53	0.994	0.012	0.006	0.00814	0.06417
16	5	-0.022335	0.015207	-1.47	0.071	0.142	0.929	-0.05214	0.00747
16	6	-0.004732	0.012389	-0.38	0.352	0.704	0.648	-0.02901	0.01955
16	7	0.012871	0.012174	1.06	0.855	0.290	0.145	-0.01099	0.03673
16	8	0.030474	0.014675	2.08	0.981	0.038	0.019	0.00171	0.05924
17	5	-0.028017	0.014097	-1.99	0.024	0.047	0.977	-0.05565	-0.00039
17	6	-0.010414	0.012209	-0.85	0.198	0.396	0.802	-0.03434	0.01351
17	7	0.007189	0.013109	0.55	0.709	0.583	0.292	-0.01850	0.03288
17	8	0.024792	0.016343	1.52	0.936	0.129	0.065	-0.00724	0.05682

Table 5.10 cont.- Tests of hypothesis of whether age affects acute bed utilisation, Model 5

Percentage of population aged 65+	Difference in life expectancy between men and women, years	Marginal effect of age on acute utilisation	Standard error of marginal effect of age	Test statistic	Test of null hypothesis that marginal effect is positive or zero	Test of null hypothesis that marginal effect is zero	Test of null hypothesis that marginal effect is negative or zero	Confidence intervals	
percent65	LEBdiff	dydx	se(dydx)	t-stat	H0:dydx>=0	H0:dydx=0	H0:dydx<=0	LBdydx	UBdydx
X	Z				HA: dydx<0	HA: dydx!=0	HA: dydx>0	95% CI	95% CI
					p-value	p-value	p-value		
18	5	-0.033699	0.014382	-2.34	0.010	0.020	0.990	-0.06189	-0.00551
18	5.4	-0.026658	0.013766	-1.94	0.027	0.053	0.974	-0.05364	0.00032
18	6	-0.016096	0.013611	-1.18	0.120	0.239	0.881	-0.04277	0.01058
18	7	0.001507	0.015366	0.10	0.540	0.920	0.460	-0.02861	0.03162
18	8	0.019110	0.018959	1.01	0.844	0.313	0.157	-0.01805	0.05627
19	5	-0.039381	0.015987	-2.46	0.007	0.014	0.993	-0.07072	-0.00805
19	5.4	-0.032340	0.015796	-2.05	0.021	0.041	0.980	-0.06330	-0.00138
19	6	-0.021778	0.016189	-1.35	0.089	0.178	0.911	-0.05351	0.00995
19	7	-0.004175	0.018467	-0.23	0.409	0.818	0.591	-0.04037	0.03202
19	8	0.013428	0.022191	0.61	0.729	0.542	0.271	-0.03007	0.05692

The table offers more detailed evidence on the range of values within which the marginal effect of age is significant than is conveyed by the graphical evidence alone. Thus the model finds that when population age is 17% and the difference in life expectancies is 5 years, the marginal effect of age is negative and significant; and when population age is 16% and LEBdiff is 8 years, the marginal effect of age is positive and significant. Neither point appears in Figure 5.3 because there are no observations in the sample which corresponds to these points. Since these graphs illustrate the effects for the sample values of the variables, it is clear that very few observations fall in the significant and negative range.

To summarise, this quadratic interactive model (M5) finds age to be significant and positive in its effect on acute bed utilisation only when age of population is at or below 16% and LEBdiff is above approximately 7.5 years; and age to be negative and significant in its effects on acute bed utilisation only in the age range at or above 17% and the range for the difference in life expectancies at or under approximately 5.5 years. Table 5.11 illustrates the number of observations within the sample falling in each of these categories and the range of years in which such observations occur within the sample. The findings for the quadratic interactive model suggest that when age is moderated by converging life expectancies, the effect of age per se on acute bed utilisation becomes insignificant as life expectancies converge and population age share increases.

Table 5.11 Range of within sample observations in which age is significant (Total obs=355)

	dydx>0		dydx<o	
Model	Obs	Years	Obs	Years
M4 Quadratic interactive	57	1985-2006	4	2003-2006

Turning to the evidence for the moderating effect of age on the converging life expectancy variable, the quadratic interaction model (M5) finds that the variable for the difference between male and female life expectancy has a positive and significant marginal effect on acute bed utilisation, which increases with greater population age (Figure 5.5 and Table 5.12). The preferred model finds this effect to be significant at and above the point where the proportion of population aged 65 and over is 12.3%. The conditioning effect of age is: that as population age share increases; the marginal effect of convergent life expectancies

in reducing acute bed utilisation becomes greater. When population age share is below 12.3%, the effect of convergent life expectancies on acute bed utilisation is insignificant.

Figure 5.5

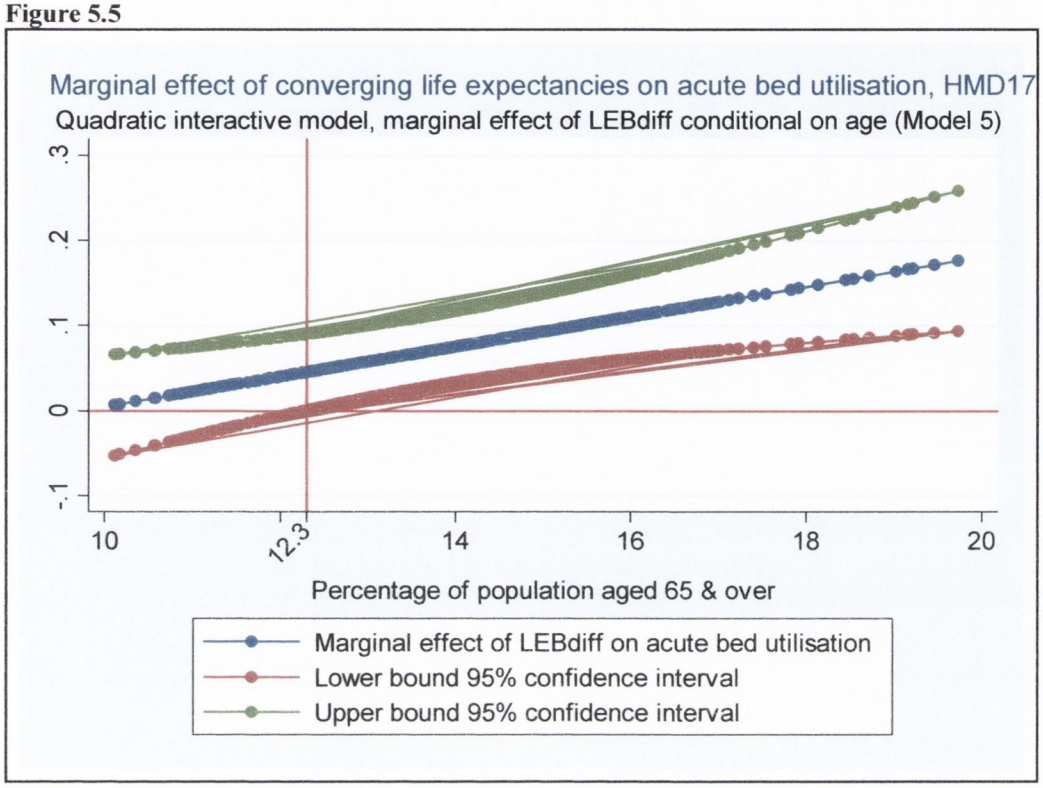


Table 5.12 Tests of hypothesis of whether converging life expectancies affect acute bed utilisation, Model 5

	Marginal effect of LEBdiff on acute utilisation	Standard error of marginal effect of LEBdiff	Test statistic	Test of null hypothesis that marginal effect is positive or zero	Test of null hypothesis that marginal effect is zero	Test of null hypothesis that marginal effect is negative or zero	Confidence intervals	
percent65	dydz	sedydz	t-stat	H0:dydz>=0	H0:dydz=0	H0:dydz<=0	LB dydz	UB dydz
				HA: dydz<0	HA: dydz!=0	HA: dydz>0	95% CI	95% CI
				p-value	p-value	p-value		
10.1	0.006799	0.030339	0.22	0.587	0.826	0.413	-0.052664	0.066263
11.0	0.022542	0.026763	0.84	0.799	0.402	0.201	-0.029913	0.074997
11.5	0.031788	0.024967	1.27	0.898	0.205	0.103	-0.017148	0.080723
12.0	0.040040	0.023608	1.70	0.955	0.090	0.045	-0.006231	0.086310
12.3	0.045855	0.022811	2.01	0.978	0.045	0.023	0.001145	0.090565
13.0	0.057752	0.021665	2.67	0.996	0.008	0.004	0.015289	0.100214
14.0	0.075672	0.021331	3.55	1.000	0.000	0.000	0.033863	0.117481
15.0	0.092749	0.022611	4.10	1.000	0.000	0.000	0.048433	0.137066
16.0	0.110434	0.025325	4.36	1.000	0.000	0.000	0.060798	0.160071
17.0	0.128070	0.029050	4.41	1.000	0.000	0.000	0.071132	0.185008
19.0	0.163571	0.038370	4.26	1.000	0.000	0.000	0.088366	0.238776

It was observed in examination of the effect of age in the model without interaction effects that the quadratic specification for age was no longer significant when the 1980s are excluded from the panel. When interactive models are estimated for the HMD17 panel without the years from 1985 to 1989, these models again show significant interactive effects in the linear (M3) and quadratic (M4) interactive specifications (Table 5.13). Dropping 1985-1989 has the effect that, when significant, the marginal effect of age on acute bed utilisation is more frequently negative than positive. Even in the simplest linear model (M1) the marginal effect of age is negative and significant at the 91% level. The effect of converging life expectancies is again to reduce acute bed utilisation.

The significant interaction effects make the M5 and M6 models, which drop the insignificant FLFP variable, the preferred specifications. However, the coefficient of the quadratic term is so small in the M6 interactive model that on further testing it is not surprising to discover that there are very few points within the sample where the effect of age is positive and significantly different from zero (Figures 5.6, 5.7 and 5.8). The linear interactive model, which specifies that the marginal effect of age on acute bed utilisation is moderated by converging life expectancies but not by the level of the age variable, appears the preferred model over this time period. Insofar as the effect of age is significant in this model, it is more often negative than not with the significant and positive effect of age restricted to the limited range at which difference in life expectancies is over 8.8 years (Figure 5.9). Other coefficients apart from the coefficients for age are almost identical in the M5 and M6 models.

The marginal effect of the convergent life expectancy variable is again positive in all specifications. In the preferred linear interactive (M5) model and in the quadratic interactive model (M6), in both of which it is moderated by the conditioning effect of population age, it is positive and significant at age shares at and above 13.4% of population (Figures 5.10 and 5.11). The effect of converging life expectancies is again to reduce acute bed utilisation at most values for population age.

Table 5.13 Estimation of four alternative acute utilisation models, HMD17 panel Dependent variable: acute bed days per capita, 1990-2006

	M1	M2	M3	M4	M5	M6
X: percent65	-0.024	0.125	-0.140***	-0.137	-0.146***	-0.141
	[0.086]	[0.100]	[0.000]	[0.243]	[0.000]	[0.222]
Z: LEBdiff	0.087**	0.085**	-0.214**	-0.212*	-0.231**	-0.228*
	[0.001]	[0.002]	[0.008]	[0.028]	[0.006]	[0.015]
X^2: age-squared		-0.004		-0.0001		-0.0001
		[0.051]		[0.976]		[0.957]
XZ: age*LEBdiff			0.020***	0.020**	0.021***	0.021**
			[0.000]	[0.003]	[0.000]	[0.001]
GDPpc	0.024***	0.025***	0.021***	0.021***	0.019***	0.019***
	[0.000]	[0.000]	[0.000]	[0.001]	[0.000]	[0.000]
PercentDecedents	0.565**	0.487*	0.514**	0.516**	0.495**	0.497**
	[0.002]	[0.011]	[0.004]	[0.005]	[0.005]	[0.007]
FLFP	-0.005	-0.004	-0.002	-0.002		
	[0.119]	[0.211]	[0.596]	[0.596]		
2006	-0.341***	-0.387***	-0.384***	-0.384***	-0.389**	-0.388**
	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]
Observations	285	285	285	285	285	285
R^2	0.96	0.96	0.96	0.96	0.96	0.96
Sum of country coefficients	10.30	9.99	10.21	10.20	10.30	10.29
Wald test of joint significance of age, LEBdiff and interaction variables	0.004	0.003	0.000	0.000	0.000	0.000
Wald test of significance marginal effect of age	0.086	0.048	0.001	0.003	0.001	0.002
Wald test of significance marginal effect of LEBdiff	0.001	0.002	0.000	0.000	0.000	0.000

p-values in brackets * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$ Source: HMD17 panel. Estimation by PCSE. Country and year dummy variable coefficients not shown.

Figure 5.6

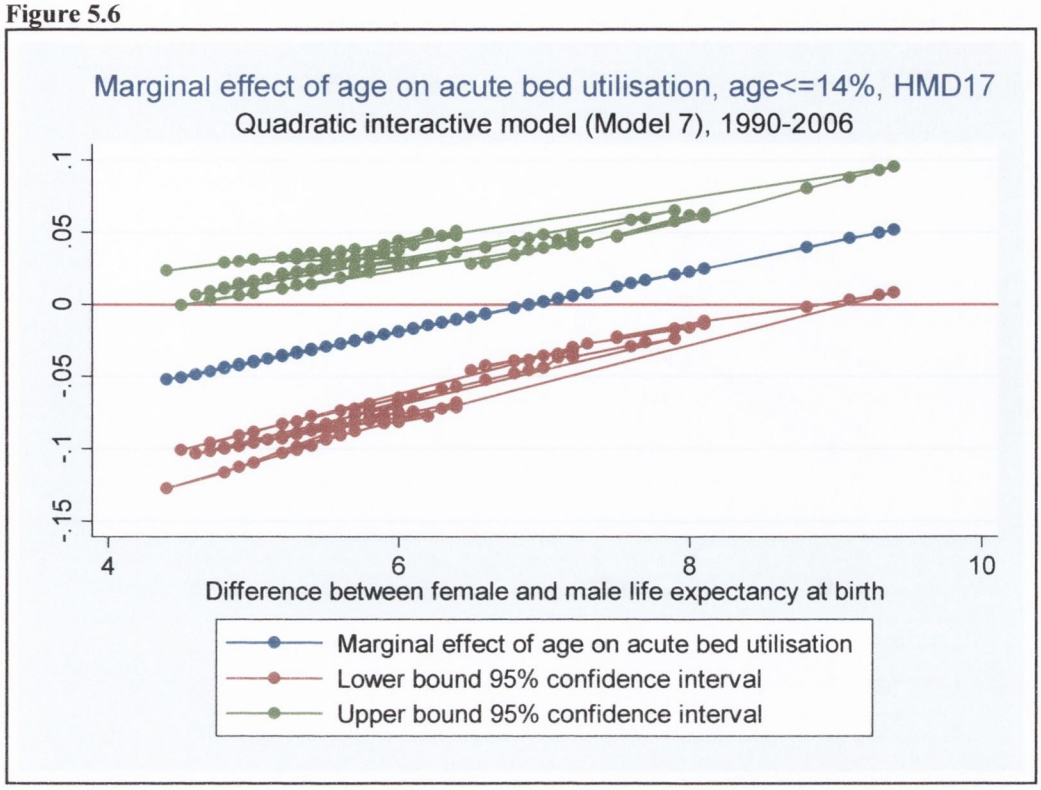


Figure 5.7

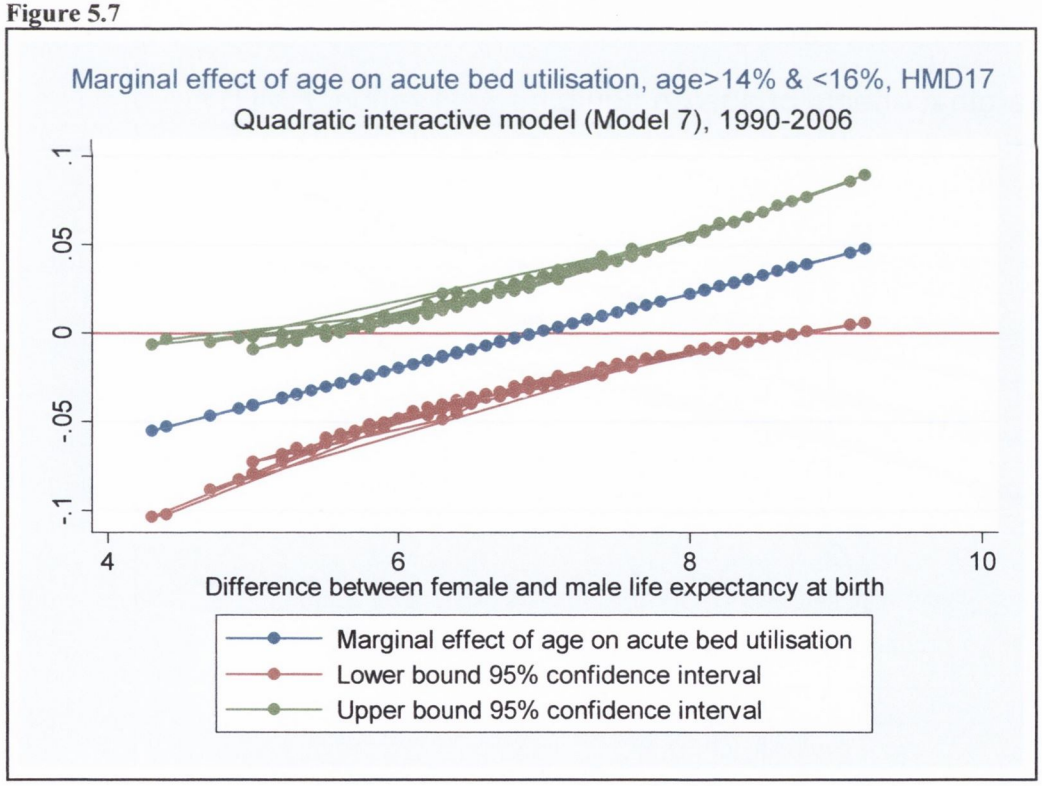


Figure 5.8

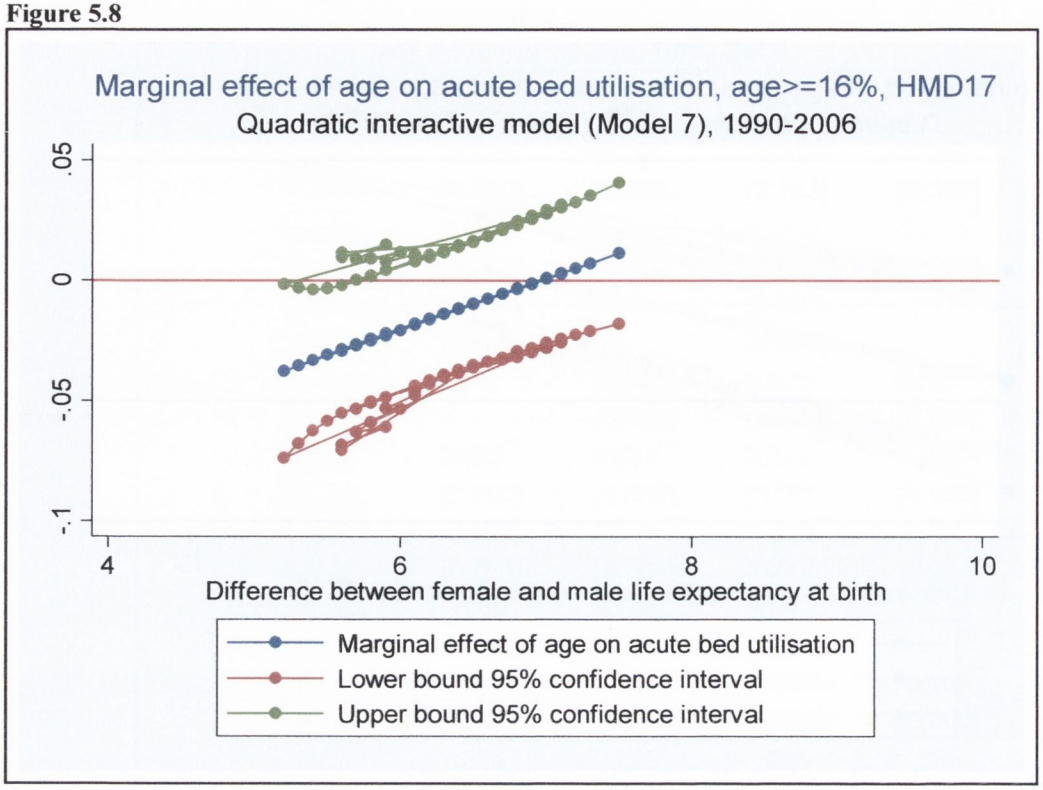


Figure 5.9

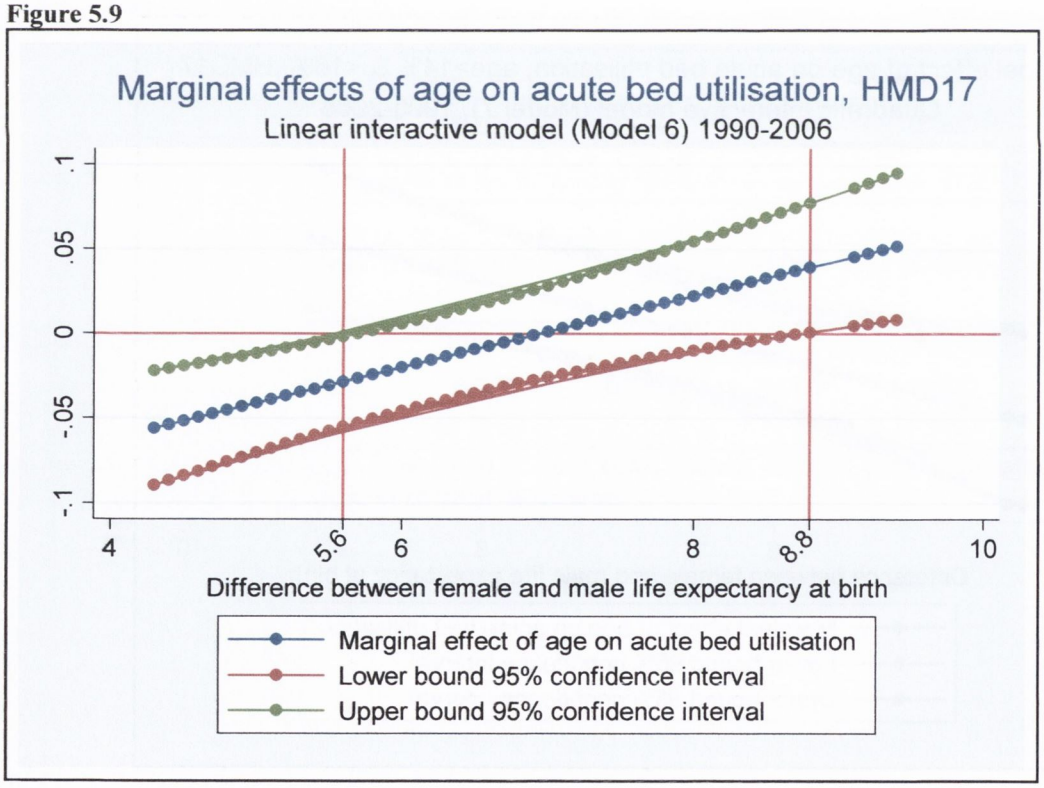


Figure 5.10

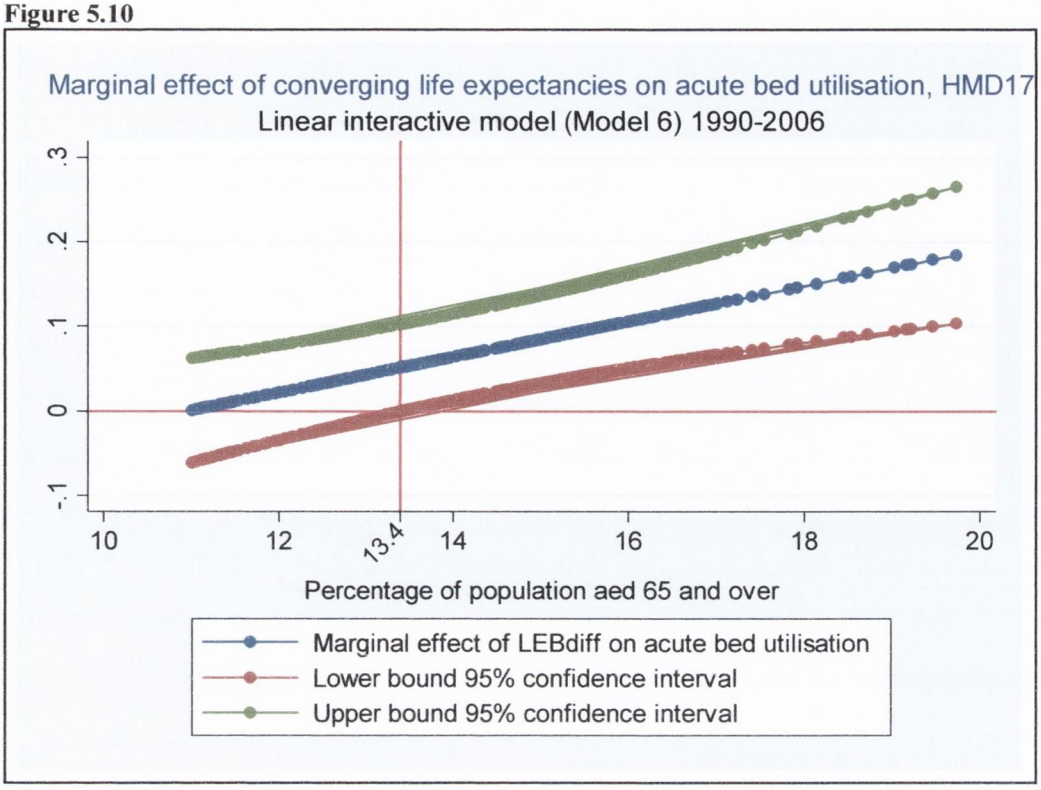
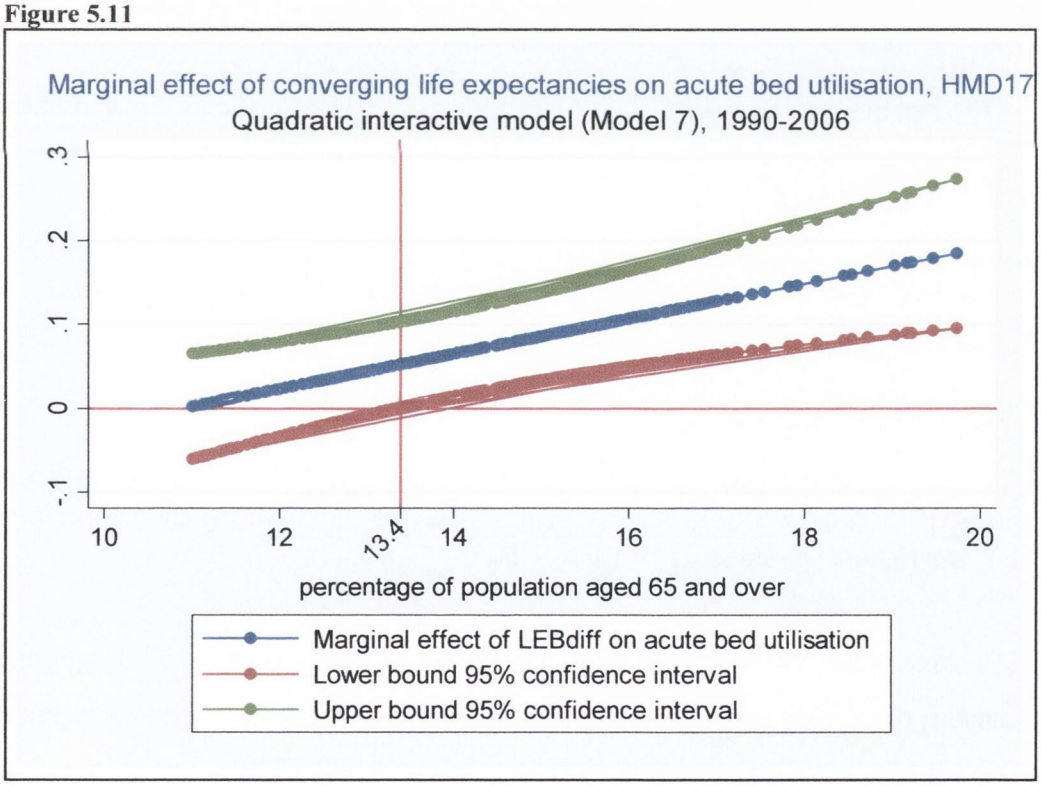


Figure 5.11



In summary, this analysis of the interaction effects of age and converging life expectancies in the acute utilisation model for this panel of 17 OECD countries, confirms the

conditional hypotheses that each variable moderates the effect of the other over both time periods. Over the 1985-2006 period the effect of age on acute bed utilisation changes from positive to insignificant to negative and the point at which these changes occur is conditional on the levels of both the convergent life expectancy and age variables, with age causing reduced acute bed utilisation only in the very limited range of sample values at which age is greater than 17% and the difference in life expectancies under 5.5 years. When the analysis of this panel is restricted to the 1990-2006 period, the effect of age is more often negative than positive when it is significant. The effect of the variable for the difference in years between the life expectancy at birth of men and women is consistently positive and is significant at population age shares above approximately 12% for the full time period and 13.4% in the later period. This implies that at most population age shares, as life expectancies of men and women converge, acute bed utilisation reduces; and this effect is greater as population age share increases.

5.5 (iv) Predicted effects

For the HMD17 panel over the years 1985-2006, the acute utilisation model is estimated as:

$$\text{Acute bed days p.c.} = -0.67 + 0.026\,\text{GDP p.c.}^{***} - 0.019\,\text{percent65} + 0.003\,\text{percent65}^2 + 0.5\,\text{percentDecedents}^{***} - 0.162\,\text{LEBdiff} + 0.017\,(\text{percent65*LEBdiff})^{**} + \beta_i \text{state}_i + \beta_j \text{year}_j$$

$^{*}p < 0.05$, $^{**}p < 0.01$, $^{***}p < 0.001$

Note: In this model, the significance of the effects of age and converging life expectancies is given by the Wald tests for these effects (Table 5.7) not the t-test of the significance of any of the constituent coefficients of these effects.

The finding across these 17 countries over this 22-year period is that, holding other variables constant, per capita acute bed utilisation increases by 0.26 days with an increase of $10,000 in GDPpc; and that it reduces by 0.5 days with a reduction of one percentage point in the death rate. The effects of age and converging life expectancies are each moderated by the other and in the case of age by the level of the age variable itself. As demonstrated in the discussion of marginal effects, there is a very limited range of values of age and convergent life expectancies at which the marginal effect of age is significant in this model (Table 5.11).

The predicted effect on acute bed utilisation of a discrete change in the population age share in this quadratic, interactive model is given by the formula:

$$\frac{\Delta y}{\Delta x} = \beta_x(\Delta x) + \beta_{xx}(\Delta x)^2 + \beta_{xz}(\Delta x)z$$

The predicted effect depends on the level of the age variable at which the change occurs, as well as the magnitude of the change and the level of the converging life expectancy variable. The significance of this predicted effect also varies. Table 5.14 demonstrates that the effect on acute bed days per capita of a one percentage point increase in the population aged 65 and over is significant and positive when the percentage increase occurs at a population age share of 14% and the difference between life expectancies of men and women is 7.5 years; whereas when the population age share is 15%, this effect only becomes significant when the difference in life expectancies is 8 years. The effect is greater at the lower population age share (0.04 additional acute bed days compared to 0.03). The predicted effect on acute bed days per capita of a one percentage point increase in the population aged 65 and over becomes significant and negative when the percentage increase occurs at an age share of 17% and the difference in life expectancies is at 5 years. Since this is a two-way fixed effects model, these are within sample predictions.

Table 5.14 Predicted increase in acute bed utilisation per capita, with confidence intervals, resulting from one percentage point increase in population age share, at varying levels age and converging life expectancies

Percentage of population aged 65 and over	Difference in life expectancies, years	Increase in acute bed days per capita	Standard error of predicted increase in acute bed days	95% Confidence Interval	
14	6	0.00	0.017	-0.0295	0.0370
14	7	0.02	0.015	-0.0081	0.0509
14	7.5	0.03	0.015	0.0009	0.0594
14	8	0.04	0.0150	0.0088	0.0692
15	6	0.00	0.014	-0.0298	0.0260
15	7.5	0.02	0.013	-0.0018	0.0508
15	8	0.03	0.014	0.0050	0.0616
16	6	-0.01	0.013	-0.0322	0.0171
16	7	0.01	0.012	-0.0142	0.0342
16	8	0.03	0.015	-0.0014	0.0567
17	5	-0.03	0.014	-0.0588	-0.0029
17	6	-0.01	0.012	-0.0376	0.0111
17	7.5	0.01	0.015	-0.0156	0.0419

Table 5.15 Predicted decrease acute bed utilisation per capita, with confidence intervals, resulting from convergence in life expectancies

Percentage of population aged 65 & over	Reduction in difference in life expectancies, years	Decrease in LTC recipients as percentage of population	Standard error of predicted decrease in LTC recipients	95% Confidence Interval	
11	-1	-0.02	0.027	-0.0749	0.0302
11	-2	-0.04	0.054	-0.1497	0.0604
11	-3	-0.07	0.080	-0.2246	0.0906
12.3	-1	-0.05	0.023	-0.0901	-0.0004
12.3	-2	-0.09	0.046	-0.1801	-0.0007
12.3	-3	-0.14	0.069	-0.2702	-0.0011
14	-1	-0.08	0.021	-0.1169	-0.0334
14	-2	-0.15	0.043	-0.2338	-0.0667
14	-3	-0.23	0.064	-0.3507	-0.1001

The predicted effect of a discrete change in convergence in life expectancies also varies with population age. Table 5.15 demonstrates that a decrease in the difference in life expectancies of one year is insignificant when the population age share is 11% but is significant at 12.3% and over, and increases with population age. Thus at a 12.3% age share, the effect of a one year convergence in life expectancies is to reduce acute bed days per capita by 0.05 whereas at a 14% age share, this reduction is 0.08 acute bed days per capita.

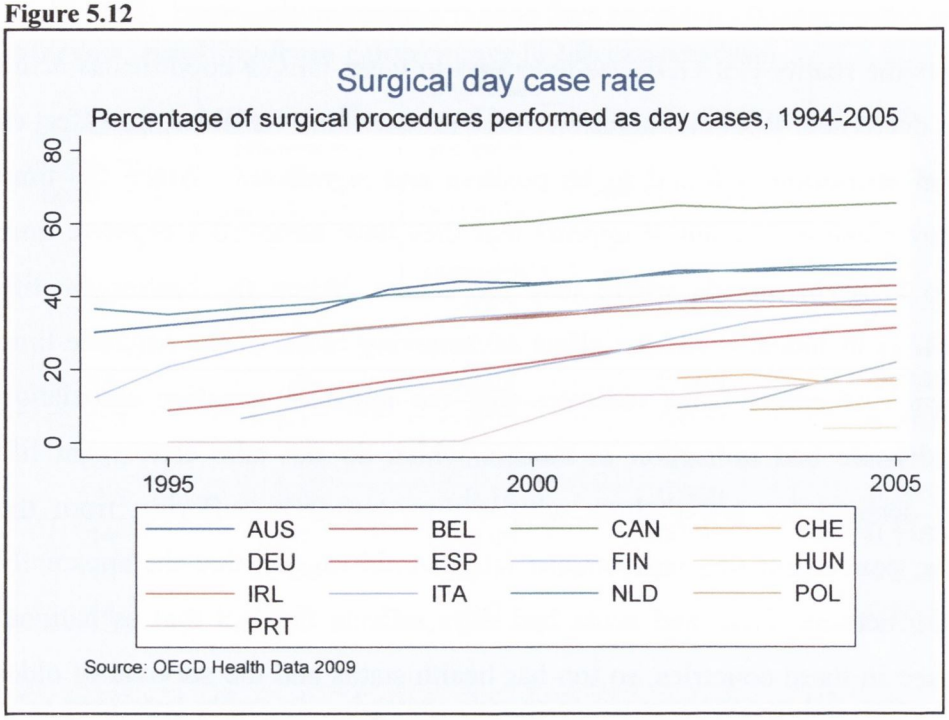
5.5 (v) Discussion of unobserved time effects in acute utilisation model

The fixed effects model specification identifies a time trend attributable to unobserved factors that are not independent of the regressors and are experienced across the countries. This trend is estimated in the coefficients for the year dummy variables with the coefficients for a given year measuring the difference between the time effect in that year and the year represented by the constant, which is the first year in the panel in all estimations in this thesis. In the models in this chapter these coefficients are invariably negative and increase with time, indicating a common cross-country trend of reduced acute bed utilisation. These unexplained time effects notably reduce in magnitude when the model includes a variable for converging life expectancies (Table 5.3). In comparison of estimation of the acute utilisation model by alternative methodologies in Appendix A, it is observed that when time is not explicitly modeled by the inclusion of dummy variables for the years, GDP has a negative sign and varying significance which corresponds with an

inverse correlation between GDP and acute bed days per capita in this panel. The inverse relationship reflects the reality that GDP has increased in these OECD countries as acute bed utilisation has decreased. With the inclusion of the time dummy variables, the effect of GDP on acute bed utilisation is found to be positive and significant. Since the time dummies are negative and significant, it appears that they have removed a negative time trend attributed to GDP in models where they are absent. When the convergent life expectancy variable is included, it has the effect of removing much of the negative time trend. This sequence of comparisons indicates that the apparent negative association between GDP and acute bed utilisation in models which do not take convergent life expectancies into account (or proxy them with a time trend) is suffering from the confounding factor, convergent life expectancies. This would suggest that the apparently inverse relationship between GDP and acute bed days reflects the fact that as national wealth has increased in these countries, so too has health status and the survival of older couples longer together, both factors which reduce age-specific acute bed utilisation.

There remains a negative time trend which is not explained in the preferred model. While greater use of day procedures is likely to have contributed to this reduction in many countries, it is arguable whether this is a factor which is related to the included regressors rather than an omitted variable which is independent of the regressors and would be manifest in the disturbance term. OECD data on day procedures are inadequate to include this factor in the model. The limited time series data available for 13 of the countries included in this analysis confirm a shared upward trend in the surgical day case rate (Figure 5.12). Given the understanding within this thesis that acute utilisation is determined within a balance of care setting, a further probable explanation for this unexplained negative time trend is the omission of measures for formal long-term care utilisation. Evidence within and across countries supports a hypothesis that acute and long-term care substitute for one another (European Commission 2001; Forder 2009). Although data inadequacy prevents testing this hypothesis across countries within this dataset, it is probable that in this model for the determinants of acute bed utilisation, the unexplained effects that the time dummy coefficients are capturing include some part of the effect of increase over time in the supply of long-term care. To the degree that this effect is not shared across countries, it will not however be captured by the time dummy coefficients and may cause omitted variable bias in the estimated coefficients.

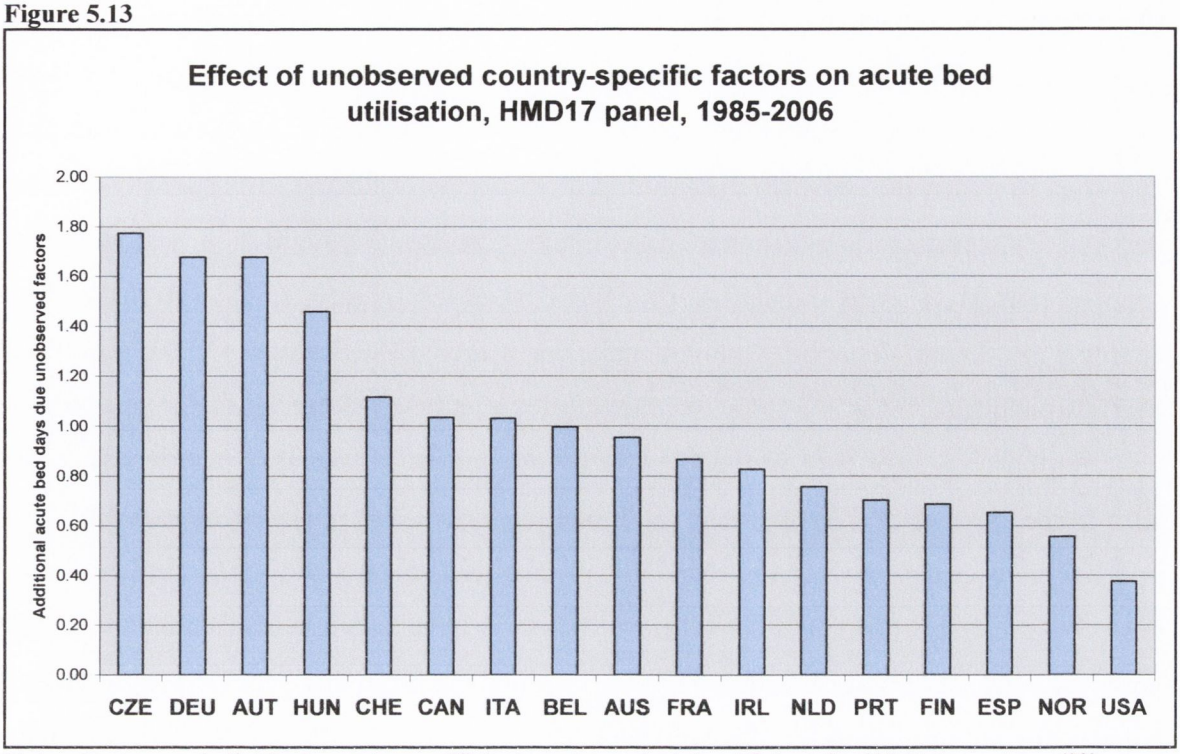
Figure 5.12



5.5 (vi) Discussion of the effect of death, location of death and unobserved country effects in acute utilisation model

The fixed effects model also identifies the effect of unobserved country-specific factors that are time invariant, related to the included regressors and which cause acute bed utilisation to differ between countries. The country coefficients demonstrate differences between countries in acute bed utilisation, having controlled for national income, age, deaths, converging life expectancies and a shared time trend. Each country's coefficient is a measure of the difference between the effect of such unobserved country-specific factors on that country's acute bed utilisation and on utilisation in the state represented by the constant (USA). For countries other than the country represented by the constant, the full effect of such unobserved factors in the first year of the panel is measured by adding the constant and that country's coefficient and represents the intercept for that country in that year. When these country-specific effects for the final quadratic interactive model in Table 5.2 are compared by means of a bar chart, these effects demonstrate the varying degrees, to which countries' acute bed utilisation remains unexplained by this model due to unobserved, time invariant factors which are related to the included regressors (Figure 5.13).

Figure 5.13



Note: chart sums individual country coefficients and constant (coefficient for USA) to capture differences between country-specific intercepts.

The literature on location at death offers a possible explanation for some of this remaining divergence between countries in acute bed utilisation. The decedent effect captured by the variable measuring all deaths will have a correspondingly greater or lesser effect on utilisation depending on the proportion of deaths that occur in hospital. Location at death could be one of the unobserved factors captured in the country coefficient. While the literature offers snapshot data on location at death and some individual country time trends, no international time series database is available. Considerable cross-country differences in location at death have been identified among decedents in Europe (Cohen et al. 2008; Jürges 2008). The SHARE (Survey of Health, Ageing and Retirement in Europe) project found from interviews about the circumstances of deaths of a small sample of people aged 50 and over between 2004 and 2007 across 11 countries that dying in hospital was most common in the countries of Western Europe, whereas dying outside hospital was more common in Northern and Southern countries. In Northern countries 58 per cent died outside hospitals, divided almost equally between deaths outside institutions (typically at home) and in nursing homes. In Southern countries, 50 per cent died outside institutions/at home and 3% in nursing homes (Jürges 2008). Thus the Northern countries had fewest hospital deaths at 42% and in Southern countries 47% of deaths were in hospitals.

The ranking of country-specific effects in this analysis conforms sufficiently with this evidence from SHARE to suggest that location at death is an important contributory factor explaining divergences between countries in acute bed utilisation. The Western European countries in which the SHARE study found more deaths occurring in hospital (Germany, Austria, Switzerland, Belgium and France) come 2nd to 10th highest in the ranking of country effects on acute utilisation for the 17 countries (Figure 5.13). The 1st ranking country, the Czech Republic, was not included in the SHARE study. Of the six lowest ranking countries, three are from Northern Europe and two from Southern Europe. The only Northern country both in the SHARE study and in this panel (Netherlands) comes 12th in the ranking of 17 countries. Additional countries that might be expected to fit in this Northern grouping (Norway and Finland) are ranked 14th and 16th. Further studies have confirmed low hospital death rates in Norway and the Netherlands (Klinkenberg et al. 2005; Van der Velden et al. 2009). The USA is ranked 17th in this panel, a position that is compatible with the evidence of hospital deaths declining to 41 per cent of all deaths in the US in 1998 (Flory et al. 2004), just below the proportion for the Northern European countries in the SHARE study.

The SHARE study's geographical groupings are mostly but not entirely supported by a study of all deaths in 6 European countries in 2002-2003 employing death certificates: whereas this study recorded hospital death rates for Belgium and the UK (England, Scotland and Wales) that would place them in the SHARE Western grouping, Sweden's 62.5% hospital death rate was notably higher than even the SHARE Western European average (Cohen et al. 2008). The SHARE sample was small and limited to people aged 50 and over who had lived at home when surveyed in 2004 and died in the subsequent few years, excluding people already in long-term residential care in 2004. The relatively high hospital death rate recorded for Sweden by Cohen et al (2008) is accompanied by relatively low acute bed utilisation, suggesting that a high proportion of care close to the end of life is provided either in long-term care settings or the community. This interpretation is supported by evidence reviewed in Chapter 2 that in Sweden, a high proportion of older people are admitted to residential care in their last few years of life and this is where they are likely to die, whereas for older people living at home, rates of admission to hospital increase steeply with proximity to death (Jakobsson et al. 2006; Larsson et al. 2008).

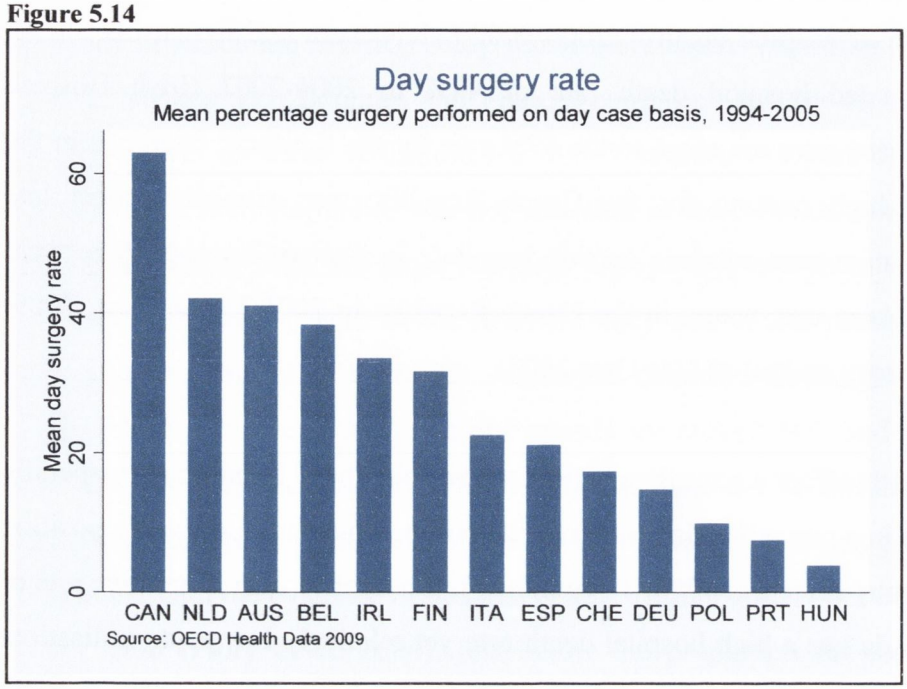
Southern countries with a hospital death rate in the middle range in the SHARE study (Italy and Spain) rank 7th and 15th in this panel. Australia and Ireland have country effect rankings at 9th and 11th, below Italy and above Spain. Evidence from Western Australia suggests a 48.6% rate of hospital death in 2000-2002 (McNamara and Rosenwax 2007); Ireland has an estimated hospital death rate of 48% in 2004-2007 (Irish Hospice Foundation 2010). These rates are close to the 47% rate for the Southern countries in the SHARE study. The high ranking for the Czech Republic may partially reflect late development of palliative care services outside hospitals in Eastern Europe: there were only four palliative home care teams in the Czech Republic in 2005(Lynch et al. 2009; International Observatory on End of Life Care 2003).

While location at death offers a contributory explanation for these fixed country-specific differences observed in acute utilisation, it is not the entire explanation. Canada's position in the ranking of country effects at 6th of 17 countries is at variance with its relative rate of hospital deaths. Canada has a high hospital death rate yet relatively low acute utilisation. In Canada in 2004 61% of deaths occurred in hospital, a decline from 78% in 1994 (Wilson et al. 2009). The case of Canada and the mixed evidence on Sweden suggests that a further factor warranting consideration in interpreting decedent effects on utilisation is the duration of hospital stays for people who are terminally ill. This in turn is likely to be influenced by the relative availability of hospital beds and care in other locations for people in their last year of life, reflecting the financial and administrative approach taken to the resourcing of hospital and alternative care. Canada has a relatively high rate of provision of formal home care and a relatively high day surgery rate (Huber et al. 2009; OECD 2009; Figure 5.14).

In Alberta in the 1990s most people who died in hospital received relatively short, low intensity hospital care: over one quarter died within two days of admission (Wilson and Truman 2002). In Canada, regional studies have shown hospital deaths to be both positively and inversely related to hospital bed numbers. When hospital bed numbers were reduced by 50% in the province of Alberta during the 1990s, inpatient deaths were reduced by 18.5% and length of final stay by 83%. Numbers of inpatient deaths and length of final stay rose again when inpatient beds were re-opened (Wilson and Truman 2001). In the more rural province of Manitoba rural residents had higher odds of dying in hospital than urban dwellers, despite greater acute bed availability in urban areas, reflecting the

availability of palliative care centres and generally better endowed health services in urban areas (Menec et al. 2010).

Figure 5.14



Note: Graph limited to countries in this study for which day case rate data are available.

While the literature on location at death offers a possible explanation for some of the divergence between countries in acute bed utilisation, it would be surprising were it to explain all the divergence. Since the decedent variable in this model is all deaths as a percentage of population in a year, more important than location at death is all acute bed utilisation in the final year of life. The evidence from Germany is that acute utilisation peaks in the last year of life but that this peak is at its greatest for people aged 55-64 (Busse et al. 2002). Patterns of treatment and utilisation by age may in turn be influenced by the availability of alternative locations of care.

Differences in how countries finance their health care systems may offer further explanation for divergences in acute utilisation. The five countries with the highest rankings for unexplained country-specific influences on acute utilisation are also countries with more accommodating social insurance-funded health care systems (Figure 5.13), which arguably strengthens the national income effect on acute care utilisation and/or resourcing. Countries with tax-funded and more centrally rationed health care are ranked lower (Saltman et al. 2004; Thomson et al. 2009).

5.6 Estimation of split-sample panels to compare age at death effects.

5.6 (i) Evidence from the literature on location of death at varying ages

In this further analysis, the evidence from the literature on location of death is employed to test the hypothesis that cross-country variation in acute bed utilisation reflects the within-country evidence on alternative locations of all deaths and of deaths at older ages. There is evidence for some countries of particular variation in deaths at older ages, reflecting differing traditions in care of older people. The literature on location of death by age is therefore reviewed here to support split-sample estimation as a means to test the effect of location of death on the effect of age at death on acute bed utilisation.

The SHARE project's interviews about the circumstances of death found a clear age gradient with 58% of all decedents aged 50-74 dying in a hospital compared to only 39% of those aged 85 and over (Jürges 2008). Considerable cross-country differences in location at death by age have been identified among decedents in Europe (Table 5.14;Cohen et al. 2008).

Table 5.14 Percentage of deaths occurring in hospital at varying ages, 2002/2003

Age at death	England	Scotland	Wales	Sweden	Netherlands	Belgium/ Flanders
0-39	58.9	49.2	51.8	43.3	50	46.5
40-69	56.2	57	62	67.4	40.1	56.2
70-79	61.7	62.3	66.6	70.9	40.3	60.2
80-89	60.4	61.7	65.4	63.6	30.5	50.9
90+	49.8	48.1	53	47	16.3	33.5
All deaths	58.1	58.5	62.8	62.5	33.9	51.6

Source: Table 2 in Cohen et al, 2008: page 705. Data for 2003 except in the case of Sweden

Cohen et al (2008) show that despite great differences between countries in the proportion of deaths at all ages occurring in hospital, the 6 countries in Table 5.14 share a common decreasing age gradient for hospital deaths from the age of 80, with peak hospital deaths in the 70-79 age cohort. Gruneir (2007) also found evidence of a reducing hospital death rate with age for the USA in 1997 but with a higher proportion of deaths occurring in hospital for people aged under 65 than for people aged 65 and over. Hospital death rates in the USA in 1997 were well above rates in the Netherlands in 2003, where Cohen recorded by far the lowest rate of hospital deaths (Figure 5.15; Gruneir et al. 2007; Cohen et al. 2008).

Figure 5.15 Percentage in age cohort dying in hospital, USA and the Netherlands

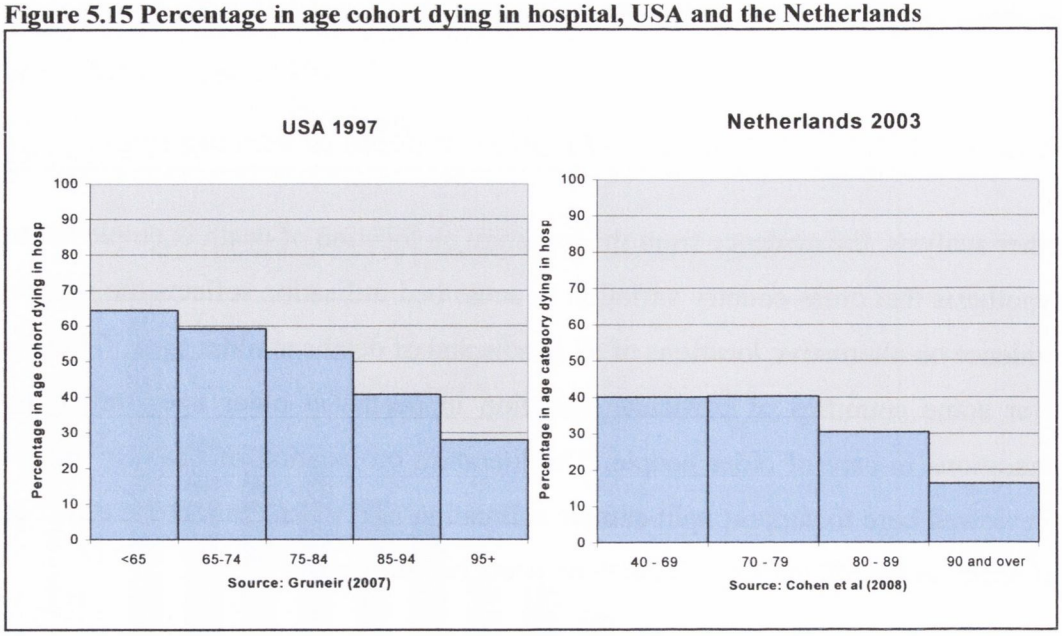
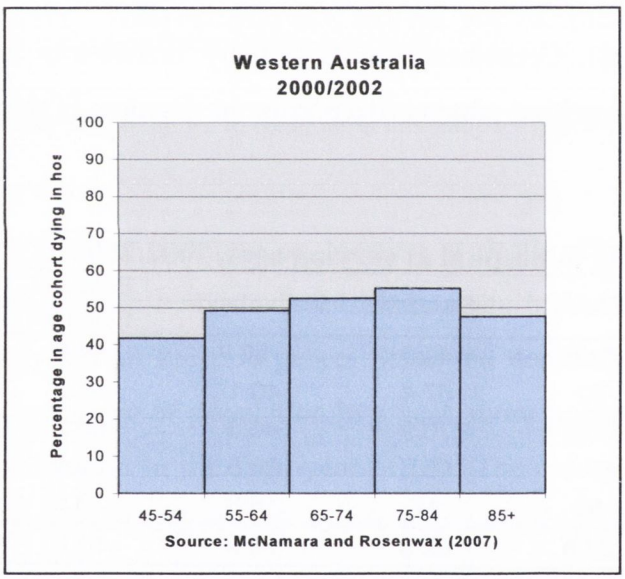


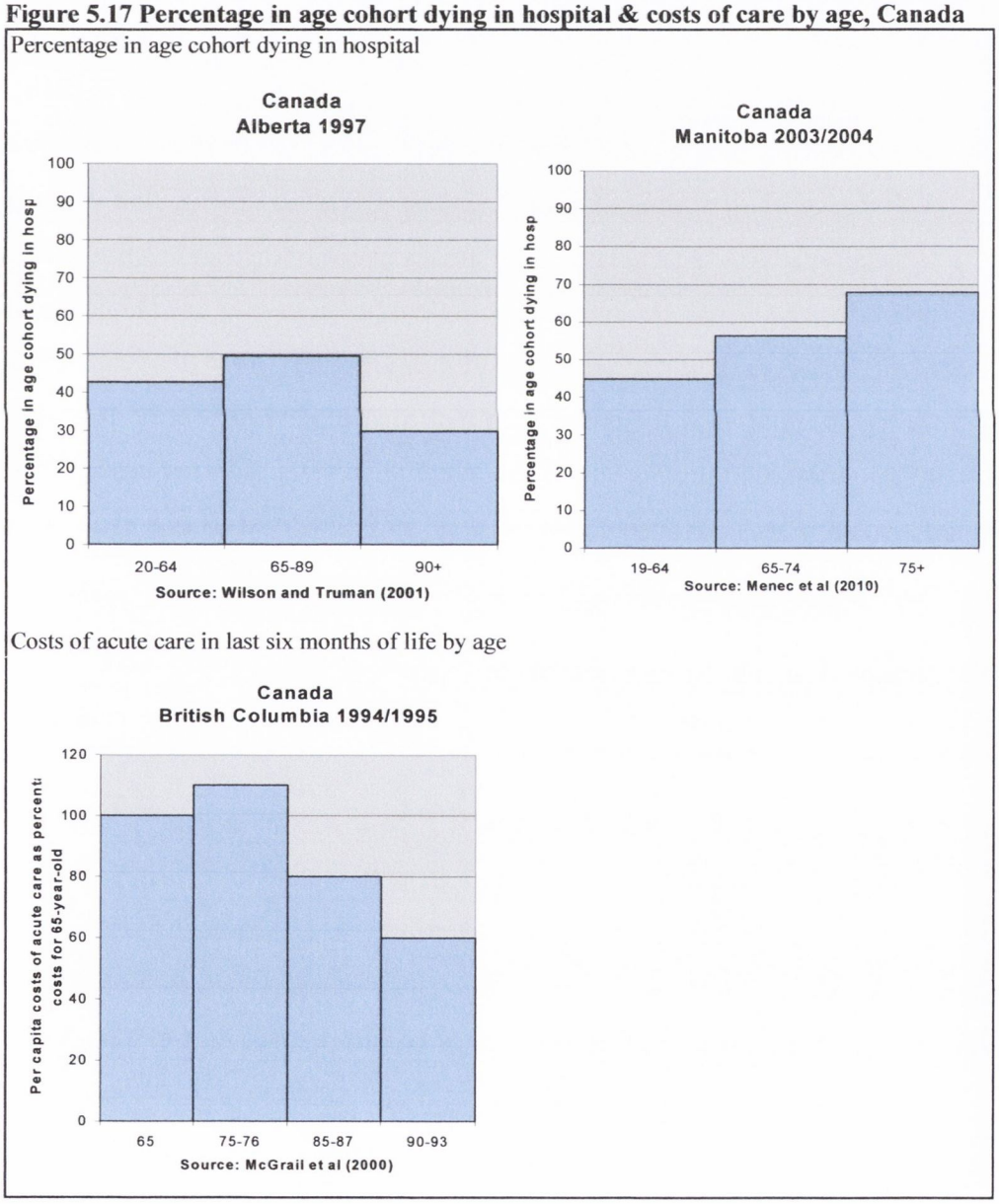
Figure 5.16 Percentage in age cohort dying in hospital, Australia



A study of hospital death rates in Western Australia shows an increasing age gradient between the 65-74 and 75-84 age cohorts with a marginal reduction at ages 85 and over (Figure 5.16; McNamara and Rosenwax 2007). There is mixed evidence on the age gradient of hospital deaths in Canada. In the province of Alberta, the hospital death rate is very much lower at ages 90 and over than at ages 65-89, while in the province of Manitoba, the hospital death rate at ages 75 and over is higher than at ages 65-74 (Wilson and Truman 2001; Menec et al. 2010; Figure 5.17). These contrasting age gradients may be an artefact of the differing age cohorts in these two studies, with peak hospital deaths conceivably occurring in the 70-79 age cohort in either location. The age gradient at ages

above 75 is not evident from the Manitoba study. If the age gradients do differ at higher ages between these two provinces, this may reflect differences between health system resourcing in rural and urban regions. It is likely that the more populous parts of Canada at least have a declining age gradient at older ages, as in Alberta. This assumption is supported by the evidence of a sharply reducing age gradient for the costs of acute care in the last 6 months of life in the province of British Columbia (McGrail et al. 2000; Figure 5.17). Since the decedent variables capture deaths in a year at varying ages, their coefficients should reflect not only location at death but acute bed utilisation in the last year of life.

Figure 5.17 Percentage in age cohort dying in hospital & costs of care by age, Canada



Deaths that do not occur in hospital generally occur at home or in a long-stay facility, with a minority in hospices (Table 2.1 Chapter 2). Gomes and Higginson (2008) found evidence of substantial reductions in rates of home deaths for older people in the UK over the 30 years from 1974 to 2004 with a much steeper declining age gradient for home deaths at older ages in the later year (Gomes and Higginson 2008; Table 5.15).

Table 5.15 Percentage of deaths occurring at home at varying ages, England & Wales, 1974-2004

Age	65-74	75-84	85 & over
1974	33.8	31	29
2004	24.3	17.7	10.7

Source: Table A in Gomes and Higginson (2008:38)

Gruneir et al (2007) found for the USA in 1997 that with increasing age, a higher proportion of deaths occurred in long-stay facilities than either at home or in hospital (Gruneir et al. 2007; Table 5.16). Mystakidou et al (2009) found for Greece that while in 1995 a majority of cancer patients died at home, by 2005 a majority died in hospital and in both periods the proportion of deaths occurring at home was greater with age (Mystakidou et al. 2009; Table 5.17). Busse et al (2002) found that in Germany over the years 1991-1995, whereas average hospital days increased with age for people who were not in their last three years of life, in the final three years of life average hospital days increased for all age groupings but peaked for people aged 45-64 in their last year of life (Busse et al. 2002; Table 5.18).

Table 5.16 Percentage of deaths by age in differing locations, USA, 1997

Age	Home	Acute hospital/ Hospital	Long-stay facilities
<65	29.2	64.4	6.4
65–74	28.1	59.3	12.6
75–84	22.7	52.7	24.6
85–94	16.9	40.8	42.3
95+	14.5	28	57.6

Source: Table 1 in Gruneir (2007: 362)

Table 5.17 Percentage of deaths by age at home & in hospital, Greece, 1995/2005

Age		<20	20-29	30-39	40-49	50-59	60-69	70-79	80+	Total
Home	1995	20	12	34	32	38	41	48	57	51
	2005	31.9	20.4	11.5	23.6	26.1	32.6	41.3	53.4	44.7
Hospital	1995	79.7	87.7	65.9	68.4	61.6	58.5	51.5	42.6	49.2
	2005	68.1	79.6	88.5	76.4	73.9	67.4	58.7	46.6	55.3

Source: Calculated from information in Table 1 in Mystakidou et al (2009: 349) Data for 3 areas of Greece.

Table 5.18 Average hospital days per year, Germany, 1991-1995

Age	Survivors	3rd last year of life	2nd last year of life	Last year of life
<24	0.8	9.3	11.2	24.2
25–34	0.9	13.4	12	28.6
35–44	1.1	13.7	22.5	34.7
45–54	1.9	11	15.5	39.2
55–64	2.3	6.9	12.4	40.6
65–74	3	9	12.4	36.4
75–84	4.8	8.5	11.4	31.8
85+	5.4	5.1	6.3	23.2

Source: Table 2 in Busse et al (2002: 291)

5.6 (i) Estimation of effect of deaths at differing ages

The purpose of this further analysis is to test the hypothesis that cross-country variation in acute bed utilisation reflects the within-country evidence on alternative locations of all deaths and of deaths at older ages. This section reviews the estimation results when the single decedent variable for deaths at all ages is replaced by a number of decedent variables for deaths at alternative ages which are then employed in estimating models of acute bed utilisation for the original HMD17 panel and for two further panels, created by splitting the HMD17 panel according to the evidence from the literature on location of death. These are the HMD9 and HMD8 panels described in Section 5.3.

A methodological issue limits the analysis in some respects. Depending on the panel employed, variables for age at death can be near-collinear with one another or with the population age variable. This restricts which variables may be modelled as covariates. (Near-collinearity between covariates can cause incorrect signs for coefficients and misleading tests of significance.) The chief restriction in this analysis is that a variable for deaths of the oldest old at ages 85 and over cannot be included in a model with a variable for population aged 65 and over. Since this analysis cannot therefore combine decedent variables capturing all deaths and age variables capturing all ages over 65, this comparative split-sample analysis is necessarily less comprehensive and employs versions of the acute bed utilisation model without interaction terms for age and converging life expectancies.

Table 5.19 compares estimations for the full HMD17 panel and the two split-sample panels of models with linear (M1) and quadratic (M2) age specifications, without

interaction effects and with the single aggregate decedent variable employed hitherto. In all 3 panels, the effect of the all deaths decedent variable is positive and significant although coefficients for some of the other variables differ in sign and significance between the panels.

Table 5.19 Acute utilisation, age and death models, HMD17 panel and alternative panels defined by location at death, 1985-2006; Dependent variable: acute bed days per capita

	HMD17		HMD9		HMD8	
	M1	M2	M1	M2	M1	M2
GDPpc	0.027***	0.028***	0.043***	0.043***	-0.015	-0.015
	[0.000]	[0.000]	[0.000]	[0.000]	[0.113]	[0.104]
Percent65	-0.008	0.207***	-0.007	0.282*	-0.075***	0.071
	[0.524]	[0.001]	[0.779]	[0.013]	[0.000]	[0.381]
Age-squared		-0.007***		-0.009**		-0.005
		[0.000]		[0.005]		[0.061]
%Decedents	0.624***	0.498**	0.813***	0.609*	0.752**	0.684*
	[0.000]	[0.001]	[0.001]	[0.022]	[0.009]	[0.018]
FLFP	-0.003	-0.003	-0.011**	-0.007*	-0.001	-0.002
	[0.136]	[0.232]	[0.001]	[0.046]	[0.604]	[0.459]
LEBdiff	0.095***	0.094***	-0.025	-0.021	0.238***	0.235***
	[0.000]	[0.000]	[0.472]	[0.553]	[0.000]	[0.000]
Observations	355	355	179	179	176	176
R^2	0.95	0.96	0.97	0.97		

p-values in brackets * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$. Estimation is by PCSE with 2-way fixed effects for HMD17 and HMD9 and by FGLS with 2-way fixed effects for HMD8. Constants and country and year dummy variable coefficients not shown.

Table 5.20 compares estimations for the same three panels employing two further models with disaggregated age at death variables. In a model (M3) with a single age variable and three decedent variables for deaths at ages 15-34, 35-74 and 75-84, all three decedent variables are significant in their effect on acute bed utilisation in the HMD17 panel estimation but with a negative coefficient for the youngest deaths. Deaths of the oldest cohort aged 75 to 84, have the largest coefficient and show the greatest significance.

There are contrasting results in the split sample estimations. In the HMD8 panel comprising countries where there is evidence that most deaths at older ages or most deaths occur outside hospital, the oldest deaths are insignificant in their effect while the signs and significance for the coefficients for younger deaths are similar to those for the full panel.

In the HMD9 panel, comprising countries where the evidence suggests that most deaths occur within hospital, only the older deaths are positive and significant in their effect.

In a model with a quadratic specification for age (M4) and with the same three decedent variables, the HMD17 panel estimation finds that the youngest deaths are significant and negative in their effect and only the oldest deaths have a significant and positive effect on acute bed utilisation; in the HMD 8 panel estimation the youngest deaths are significant and negative in their effect but only the deaths in the middle cohort aged 35-74 are significant and positive in effect; while in the HMD9 panel estimation only the oldest deaths are significant and positive in effect if the significance level is lowered to 90%.

Table 5.20 Acute utilisation, ageing and age at death; Panels split by location of death; Dependent variable is acute bed days per capita

Panel Model	HMD17 M3	HMD17 M4	HMD9 M3	HMD9 M4	HMD8 M3	HMD8 M4
GDPpc	0.032***	0.034***	0.040***	0.039***	0.008	0.009
	[0.000]	[0.000]	[0.000]	[0.000]	[0.338]	[0.325]
Percent65	-0.009	0.279***	-0.021	0.347***	-0.079***	0.015
	[0.424]	[0.000]	[0.322]	[0.000]	[0.000]	[0.837]
Age-squared		-0.009***		-0.011***		-0.003
		[0.000]		[0.000]		[0.189]
FLFP	-0.005*	-0.003	-0.011**	-0.006	-0.002	-0.002
	[0.036]	[0.144]	[0.002]	[0.108]	[0.340]	[0.282]
LEBdiff	0.102***	0.096***	-0.042	-0.034	0.302***	0.297***
	[0.000]	[0.000]	[0.145]	[0.229]	[0.000]	[0.000]
Dec1534pc	-6.167**	-6.513**	-2.196	1.385	-14.117***	-14.242***
	[0.009]	[0.005]	[0.548]	[0.697]	[0.000]	[0.000]
Dec3574pc	0.665*	0.448	0.545	0.542	1.961***	1.686***
	[0.045]	[0.174]	[0.275]	[0.264]	[0.000]	[0.000]
Dec7584pc	0.921***	0.703**	1.104***	0.481	-0.414	-0.337
	[0.000]	[0.001]	[0.000]	[0.105]	[0.413]	[0.504]
Observations	355	355	179	179	176	176

p-values in brackets * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$ Estimation is by FGLS with two-way fixed effects Constants and country and year dummy variable coefficients not shown.

These observations of the levels of significance of the age at death variables while suggestive that there are significantly differing patterns in the effects of deaths at differing ages across these split-sample panels do not establish whether the differences in the estimated coefficients are significant. This hypothesis is tested by the t-test proposed by Kam and Franzese (2007). Table 5.21 shows the outcome from t-tests for the split-sample estimations in Tables 5.19 and 5.20. The findings for the t-tests for significant coefficient differences support the hypothesis that location of death affects the significance for acute

utilisation of death at varying ages. It is striking that when death is represented by a single decedent variable for all deaths at all ages in models with a single age variable or a quadratic specification for age (Table 5.19, Models 1 and 2) death is not only significant and positive in its effect on acute bed utilisation but there is no significant difference in the estimated coefficients for the decedent variable in the split-sample panels (Table 5.21).

In contrast, in Model 3 where there is a single age variable and three decedent variables, there are significant differences in the coefficients for all three age at death variables. In Model 4 when these three decedent variables are included with a quadratic specification for age, there are significant differences for the younger age variables while the significance of the difference in the older age variable is reduced to 84%. The quadratic term for age is not, however, significant for the HMD8 panel in this model, which suggests that Model 3 is the better specification in which to compare the significance of the age at death variable coefficients.

Table 5.21 Test for significant differences between coefficients in Tables 5.19 and 5.20

Variable	Sub-sample	Coefficient	Standard Error	Test that coefficients in sub-samples significantly different	
				t-stat	p-value
M1					
%Decedents	HMD9	0.8133	0.24162		
	HMD8	0.7516	0.28565	-0.17	0.850
M2					
%Decedents	HMD9	0.6092	0.26509		
	HMD8	0.6841	0.28813	0.19	0.840
M3					
dec1534pc	HMD9	-2.1955	3.65528		
	HMD8	-14.1172	2.47413	-2.70	0.010
dec3574pc	HMD9	0.5450	0.49907		
	HMD8	1.9606	0.41533	2.18	0.030
dec7584pc	HMD9	1.1039	0.27665		
	HMD8	-0.4135	0.50470	-2.64	0.010
M4					
dec1534pc	HMD9	1.3849	3.56296		
	HMD8	-14.2417	2.47153	-3.60	0.001
dec3574pc	HMD9	0.5418	0.48488		
	HMD8	1.6858	0.46517	1.70	0.090
dec7584pc	HMD9	0.4806	0.29656		
	HMD8	-0.3373	0.50454	-1.40	0.160

This analysis employing differing panels supports the hypothesis that cross-country variation in acute bed utilisation reflects the within-country evidence on alternative

locations of death and of death at older ages. The effect of age at death on acute bed utilisation is found to differ depending on whether the older old more commonly die in or outside hospital. Although all deaths are found to be significant upward drivers of acute bed utilisation in all three panels, the effect of death at differing ages is found to differ between panels of countries, chosen according to within-country evidence on location of death. Older deaths in the 75 to 84 year age group are found not to be significant determinants of acute bed utilisation in a panel comprising Southern and Northern European countries, the USA and Canada; whereas such older deaths are found to be positive and significant upward drivers of acute bed utilisation in a panel comprising Western and Eastern European countries and Australia.

It is acknowledged in the methodological discussion in Section 5.4 that in place of split-sample estimation, it would be preferable to test the effect of location of death on the effects of age at death in a pooled sample with a categorical variable for location of death interacted with the age at death variables. For the reasons discussed the data do not allow combining such a variable with a two-way fixed effects model specification. Dropping country-specific fixed effects to permit estimation by alternative methodologies leads to biased estimation. A further method which allows estimation of time-invariant variables in the presence of country-specific fixed effects is the Hausman-Taylor estimator, which requires overcoming the challenge of identifying instrumental variables for the regressors which are uncorrelated with the errors or the unobserved country-specific effects. Substituting country-specific age at death variables for a single age at death variable is another possible route to examine further the evidence for the hypothesis that in countries where the majority of deaths or of older deaths occur outside hospital, the effect on acute bed utilisation of older deaths is of lesser magnitude and significance than in countries where the majority of deaths occur within hospital.

5.7 Summary and conclusions

This chapter has investigated a series of hypotheses about the determinants of acute bed utilisation across countries. Death has been found to be a significant upward driver of acute bed utilisation across 17 OECD countries over the years 1985 to 2006. However, the effect on acute bed utilisation of deaths at older ages has been found to vary: in analysis employing a panel of countries where there is evidence that most deaths or most deaths at older ages occur outside hospitals, deaths at ages 75-84 are insignificant to acute bed

utilisation; whereas in a panel of countries where most deaths occur within hospitals, such older deaths are significant upward drivers of utilisation.

This analysis has found that the effect on acute bed utilisation of population age represented by the percentage of population aged 65 and over, has changed as population age share has increased and life expectancies of men and women have converged. Analysis of the interaction effects of age and converging life expectancies confirms that each variable moderates the effect of the other. Over the 1985-2006 period the effect of age on acute bed utilisation has changed from positive to insignificant to negative but is more generally insignificant than not. The effect of the variable for the difference in years between the life expectancy at birth of men and women is consistently positive and is significant at most population age shares. This implies that at most population age shares, the effect of convergence in life expectancies of men and women is to reduce acute bed utilisation, an effect which is greater as population age share increases.

The finding that across countries and over time the percentage of deaths in a population is a significant upward driver of acute bed utilisation, whereas age of the population has become insignificant to acute bed utilisation, supports within country studies employing micro-data that have found health care costs or utilisation to be more closely related to proximity to death than calendar age. The effect of the variable for converging life expectancy offers an insight into the influence of changing household composition and health status on the effect of ageing on health care utilisation in cross-country settings. While convergence in life expectancies is expected to reduce the incidence of living alone and increase the availability of co-resident caring by spouses and may also capture some of the effect of improved health status, interpretation of this variable requires some caveats: it is an imprecise measure of household composition which is also affected by trends in rates of marriage, divorce and cohabitation; and its degree of correlation with improved health status across countries requires testing. To the degree that it mis-measures the effects it is conceived to capture, the inclusion of this variable may bias coefficient estimates.

The hypothesis that increased female labour force participation has the effect of increasing acute bed utilisation is not supported by this analysis, which assigns a negative but insignificant coefficient to the female labour force participation variable. Given the evidence from other studies suggesting heterogeneity in the relationship of female labour

force participation, informal care supply and formal care need, this finding across this heterogeneous group of countries suggests that understanding the relationship of female labour force participation to utilisation requires closer examination of effects within groups of countries, which is undertaken in the next chapter. The effect of GDP on acute bed utilisation is found to be positive and significant. Although acute bed utilisation has fallen across these countries while GDP per capita has increased, this analysis suggests that as national wealth has increased, so too has health status and the survival of older couples longer together, both factors which reduce age-specific acute bed utilisation.

It is the understanding in this thesis that acute bed utilisation is determined within a balance of care setting, in which acute hospital care utilisation and supply and long-term care utilisation and supply are simultaneously determined. A significant remaining negative time trend is captured in the time dummy coefficients in this analysis, which may in part be explained by the omission of measures for formal long-term care utilisation, which cannot be represented in this model because of data inadequacy. To the degree that this effect is not shared across countries, it will not however be captured by the time dummy coefficients and may cause omitted variable bias in the estimated coefficients, a form of endogeneity.

The inclusion of country-specific fixed effects may reduce some element of this omitted variable bias. Unexplained country-specific effects are found to be largely consistent with within-country evidence on location of death. Location of death appears to be relatively time-invariant suggesting that the aspect of long-term care supply and utilisation captured in location of death may be represented in the fixed effects in the model. Further factors that are not represented in this model and that might be expected to influence cross-country differences in acute bed utilisation are: duration of hospital stays for people who are terminally ill and in the last year of life; day surgery rates; and differences in how countries finance their health care systems. To the degree that they are relatively time invariant, as in the case of systems of financing, they will be captured by the country fixed effects.

The next chapter develops a model of the determinants of long-term care utilisation and re-visits this analysis of the determinants of acute bed utilisation to investigate whether these

separate models of utilisation cast light on the relationships between utilisation in alternative settings.

Chapter 6 Female labour force participation, converging life expectancies and the balance of care

6.1 Introduction

This chapter examines the determinants of long-term care utilisation and further analyses acute bed utilisation to investigate the balance of care between the acute and long-term care settings. Although data limitations prevent the direct estimation of the effect of utilisation or supply of care in either setting on the other, these separate models suggest a potential mechanism to explain the balance of care between them.

The panel employed to test the determinants of long-term care utilisation comprises 7 OECD countries over the 10 years 1997-2006. In this long-term care utilisation model, the dependent variable is formal long-term care recipients as a percentage of population and the drivers of utilisation examined are population age, deaths, convergence between male and female life expectancies and female labour force participation. The hypotheses tested for long-term care utilisation and the findings in relation to these hypotheses are:

1) Whether population ageing is an upward driver of long-term care utilisation;

Age represented by share of population aged 65 and over is a significant upward driver of LTC utilisation;

2) Whether convergence in life expectancies moderates the effect of population ageing on long-term care utilisation;

The effect of age is moderated and reduced by converging life expectancies and is insignificant when the difference between male and female life expectancy is below 5 years;

3) Whether convergence in male and female life expectancy which could be expected to reduce numbers of older people living alone and increase care of older people for one another reduces long-term care utilisation;

Convergence between female and male life expectancies has a significant reducing effect on LTC utilisation. This effect is moderated by population age and is only significant when the percentage of population aged 65 and over exceeds 17%.

4) Whether increased female labour force participation which proxies for reduced supply of informal carers has the effect of increasing long-term care utilisation;

Female labour force participation is a significant upward driver of LTC utilisation;

5) Whether proximity to death is an upward driver for long-term care utilisation as it is for acute care utilisation;

Proximity to death, measured as all deaths in a year, is found to be insignificant for long-term care utilisation. However this finding is qualified because this measure of deaths - all deaths as a percentage of population - is not the best measure to test this hypothesis in this long-term care utilisation model. It would be preferable to examine the effect of deaths among older people only but it is not possible to include such a variable with the age variable due to near-collinearity. This is not therefore a satisfactory test of this hypothesis in this model.

In this chapter the determinants of acute bed utilisation are re-examined for a panel of 14 OECD countries over the years 1985-2006. This panel differs from the panel in Chapter 5 solely by the exclusion of 3 Southern European countries. This re-examination is informed by other studies which found a North-South gradient within Europe in which Northern countries supply more long-term care formally and Southern countries supply more long-term care informally.

This chapter re-examines the hypotheses for acute care utilisation that were tested in Chapter 5. The central differences in the findings, when the panel excludes the Southern European countries, are:

1) Female labour force participation is found to have a significant, inverse relationship to acute bed utilisation;

2) The quadratic specification for age no longer holds; the effect of age is insignificant over the 1985-2006 period; and the percentage of population aged 65 and over has a significant, inverse relationship to acute bed utilisation from 1990-2006.

Due to limited availability of LTC data (discussed in Chapter 3), my investigation of LTC utilisation is restricted to a relatively small panel of countries and years. While an inverse relationship is observable between acute and long-term care utilisation, the available data are inadequate to support including long-term and acute care variables in the same model. Near-collinearity between female labour force participation and GDP per capita further restricts the analysis in the small dataset for long-term care utilisation, a restriction which qualifies the findings since the model does not include a control for GDP per capita. Although it does not prove feasible to incorporate both acute and long-term care utilisation measures in the same model, the opposing role played by female labour force participation in separate models of acute and long-term care utilisation suggests an insight into how utilisation is balanced across the sectors.

The findings of a significant, inverse relationship between female labour force participation rates and acute bed utilisation and a significant, positive relationship between female labour force participation rates (FLFP) and utilisation of long-term care suggest that reduced availability of informal LTC has the effect of reducing acute bed utilisation and increasing utilisation of formal LTC. I hypothesize from these findings that a balance of care mechanism may exist whereby reduced availability of informal care for older and frailer people drives the development of formal care alternatives; and when a formal care infrastructure develops in response to reduced supply of informal care, this in turn has the effect of reducing acute care utilisation and supply. Given the data limitations that prevent estimating these models simultaneously, it must be acknowledged that there remains the possibility that due to omitted variable bias, FLFP is proxying the effect of the missing variable for long-term care utilisation in the acute utilisation model, so that its coefficient is biased and this apparent inverse effect of FLFP on acute utilisation essentially captures

the inverse relationship of LTC utilisation to acute utilisation, observed in within-country studies.

In this analysis female labour force participation is by design an inverse, proxy measure for the availability of women to provide informal care. A further proxy measure for the availability of informal care by older people of one another is supplied by the variable for converging life expectancies of men and women. Convergence between male and female life expectancies is shown to have a significant reducing effect on both acute and LTC utilisation. These findings suggest that greater availability of care by older people for their partners/spouses has the effect of reducing both acute and LTC utilisation. In addition to capturing improvements in male life expectancy, this converging life expectancy variable may capture overall improvements in health status, which would be expected to cause reduced need for and utilisation of all forms of care. Although both are proxy measures for the availability of informal care, female labour force participation and convergent life expectancies appear to have differing effects on acute utilisation, which reduces both in response to *lesser* availability of care by younger women and *greater* availability of care by older people. The chapter discusses a number of possible explanations for this apparent contradiction.

The chapter is structured as follows. The next section briefly reviews the strands of the literature pertaining to the analysis which were reviewed at greater length in Chapter 2 and further reviews the evidence for a North-South gradient in long-term care in Europe. Section 6.3 outlines the data employed in this analysis. Section 6.4 explains the methodological approach. Section 6.5 reports and discusses the findings when analysis of determinants of acute bed utilisation excludes the Southern European countries, under the sub-headings: (i) central estimation results; (ii) alternative specifications for age and interaction effects; (iii) estimation results for the yeas 1990-2006. Section 6.6 reports and discusses the findings in the analysis of the determinants of long-term care utilisation, reviewing preliminary estimations and tests of alternative specifications and the predicted effects of the final model. Section 6.7 summarises and concludes the chapter.

6.2 Literature

Discussion of the literature in Chapter 2 reviewed evidence that the supply of long-term care alternatives may reduce acute care utilisation, especially for older people (Carr-Hill et al. 1994; Martin and Smith 1996; European Commission 2001; Forder 2009). Studies of location at death have shown that there is a much greater likelihood for an older person, who is resident in a long-term care facility, of eventually dying there, whereas older people who are resident and receive care at home, are more likely to be admitted to hospital close to death (Jakobsson et al. 2006; Van Rensbergen et al. 2006; Larsson et al. 2008). While increased formal long-term care supply may reduce pressures on acute care, reductions in informal care supply could affect both acute and formal long-term care demand. Informal care and formal home care have been found to be substitutes in some studies (Bolin et al. 2008; Bonsang 2009).

There is evidence that the effects of proximity to death differ for long-term care utilisation and acute care utilisation. McGrail et al (2000) found in Canada that the costs of acute care rose with age but proximity to death was more important in determining costs and the additional costs of dying fell with age; whereas costs of nursing and social care rose with age and additional costs for the dying increased with age. This study argued that in planning services it was important to take into account the relatively larger impact of ageing on social and nursing care than on acute care. Spillman and Lubitz (2000) found in the US that acute care costs increased at a reduced rate as age at death increased, whereas long-term care costs increased at an accelerated rate. Weaver et al (2009) in an analysis of US data found that proximity to death, measured by being within two years of death, significantly increased the probability of nursing home use and formal home care use but availability of informal support significantly reduced the effect of proximity to death. Among married older people, proximity to death had no effect on institutionalisation.

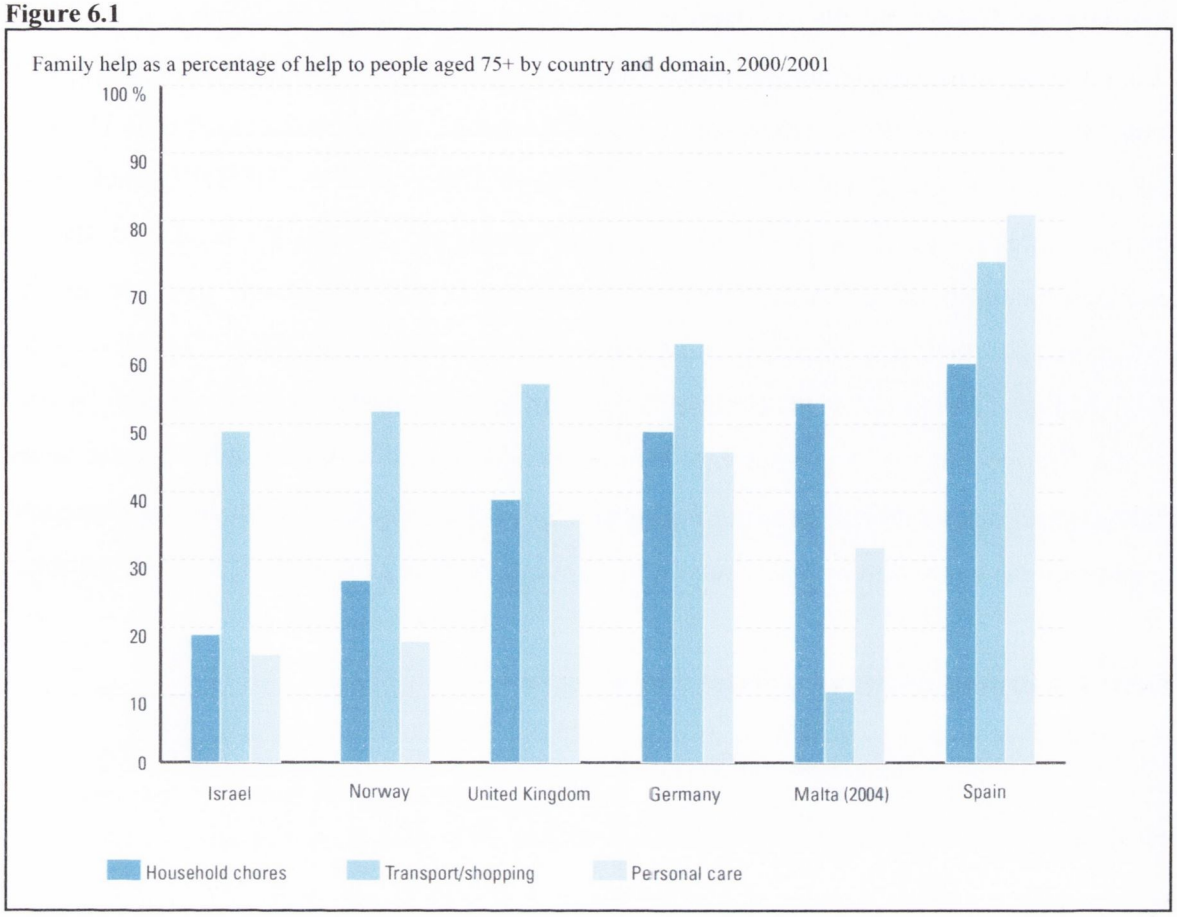
Opposing trends have been identified in the provision of informal care supply: increasing female labour force participation decreases numbers of potential care-givers in younger and middle-aged groups whereas reduced disparity in male and female life expectancy increases potential provision of care by spouses (Pickard 2002; Schulz 2004). Living alone has been widely found to be a predictor of formal LTC need because intense care needs can generally only be met informally by co-resident carers while availability of care by a spouse has been found to be associated with substantially reduced long-term care

expenditure (Klein 1996; Wittenberg et al. 1998; Portrait et al. 2000; Yoo et al. 2004; Connolly and O'Reilly 2009). Although rising female labour force participation rates are expected to reduce informal care availability and increase formal long-term care utilisation, there is mixed evidence on the effects of female labour force participation on long-term care expenditure with a rise in numbers of part-time working women negatively associated with formal LTC (Mortensen et al. 2004; Schulz 2004; Yoo et al. 2004; OECD 2006).

Within Europe there is evidence of a North-South gradient in the response of women to their parents' care needs following an adverse health shock, with a lesser likelihood of women in such circumstances being in paid employment in Southern Europe than in Northern Europe (Crespo and Mira 2008). The countries of Southern Europe (Italy, Spain, Portugal and Greece) have been found to have notably higher rates of informal caring for co-resident older relatives than other countries of the pre-enlargement EU15 with rates in Spain and Portugal exceeding Italy (Huber et al. 2009). In the countries of Western and Northern Europe, older, dependent relatives are less likely to be co-resident. Families in Spain provide a high proportion of the care that older people receive (Figure 6.1 from Huber et al. 2009).

The SHARE project found for the years 2004-2007 that dying at home was most common in the countries of Southern Europe (Spain, Greece and Italy), where 50 per cent died at home, 3% in nursing homes and 47% in hospital (Jürges 2008). This compared with a home death rate of 29% in Northern Europe. An earlier study of location of death for patients with gastric cancer in the 1980s in the Zaragoza province of Spain found that 46% overall died at home, with 66% dying at home in rural areas (Jimeno et al. 1993). Pressure on informal caring arrangements is evident in the high ranking of Spain and Portugal in the response to a 2008 Eurobarometer question: "do dependent older people rely too much on their relatives?" In Spain and Portugal over 80% of respondents agreed while across Western and Northern Europe, agreement rates ranged between 45% and 70% (Huber et al. 2009). Such studies suggest a heterogeneity in the relationship of female labour force participation, informal care supply and care need, which may reflect the development of formal long-term care services; cross-country variability of rates of part-time employment; and North-South cultural differences in the strength of family ties (Bolin et al. 2008; Reher 1998).

Figure 6.1



Source: Huber at al, 2009, Figure 4.12.

6.3 Data

The analysis in this chapter employs two cross-country panels, which have differing constituent countries and/or years to the HMD17 panel employed in Chapter 5 (Table 6.1). As in Chapter 5, all panels source population and decedent data from the Human Mortality Database (HMD). The OECD Health Data 2009 database supplies health and long-term care and macroeconomic variables. These are: acute bed days per capita; life expectancy at birth of men and women; recipients of formal long-term care in institutions and at home; GDP per capita, in national currency units at 2000 GDP prices; and 2000 conversion rates, employed to convert GDP per capita in national currency units into constant US dollars at purchasing power parity. The OECD per capita variables (acute bed days and GDP) are re-calculated to conform to the HMD population data. The World Bank's World Development Indicators database supplies labour force participation rates for all women aged 15 and over.

The data are limited by the availability of country observations for acute bed days per capita and in particular by the scarcity of long-term care data. The panel in the analysis of acute bed utilisation in this chapter is the HMD14 panel, which includes 14 OECD states for the years 1985-2006 and has 289 observations. It differs from the HMD17 panel solely by the exclusion of three Southern European countries - Spain, Portugal and Italy - excluded because of evidence from the literature of a North-South gradient in the provision of formal and informal long-term care. A smaller panel (HMD7) with only 60 observations is employed to analyse long-term care utilisation. It is limited by the availability of data for long-term care recipients and covers 7 OECD states for the years 1997-2006. I discussed in Chapter 3 my rationale for choosing LTC recipients at home and in institutions, expressed as a percentage of population, as my measure of LTC utilisation.

Table 6.1 Panels' constituent states and observations

	HMD17 1985-2006		HMD14 1985-2006		HMD7 1997-2006	
	State	Frequency	State	Frequency	State	Frequency
Australia	AUS	22	AUS	22		
Austria	AUT	21	AUT	21		
Belgium	BEL	21	BEL	21		
Canada	CAN	22	CAN	22		
Switzerland	CHE	22	CHE	22	CHE	7
Czech Rep.	CZE	17	CZE	17		
Germany	DEU	16	DEU	16	DEU	10
Spain	ESP	22				
Finland	FIN	22	FIN	22	FIN	10
France	FRA	22	FRA	22		
Hungary	HUN	16	HUN	16	HUN	10
Ireland	IRL	22	IRL	22		
Italy	ITA	22			ITA	7
Netherlands	NLD	22	NLD	22		
Norway	NOR	22	NOR	22	NOR	6
Portugal	PRT	22				
Sweden					SWE	10
USA	USA	22	USA	22		
	Total	355	Total	289	Total	60

The panels are not entirely balanced (i.e. not every state has observations for each year). However they have been balanced sufficiently to enable estimation methods taking into account possible cross-sectional correlation. It has been a matter of judgment to determine to what degree observations and heterogeneity should be sacrificed to achieve greater

balance and better estimation. Unsurprisingly, LTC data availability is best in those states with developed formal LTC systems, and worst where informal home care predominates. Thus, the panel employed to model LTC utilisation (HMD7) includes only one Southern state, Italy, and has the highest proportion of Northern states and observations. This needs to be taken into account in analysis employing this panel.

This analysis models drivers of LTC utilisation separately from acute utilisation. Although an inverse relationship is apparent between acute and LTC utilisation in the limited panel for which both acute bed and LTC recipient data are available, covering 6 states and with 50 observations (Figure 6.2), this panel is too small and too many variables exhibit near-collinearity to support estimation of the balance of care. A similar inverse correlation is evident between acute bed days and the ratio of LTC beds to population (Figure 6.3) but, as discussed in Chapter 3, although data availability is greater for LTC beds, they would make a poor proxy for formal LTC utilisation.

Excluding the acute utilisation variable increases the panel available for a model of LTC utilisation to the slightly larger HMD7 panel with 60 observations for the years 1997-2006. The near-collinearity of female labour force participation, LTC utilisation and GDP is suggestive of the importance of the linkages between these variables (Figure 6.4). In states with highly developed formal long-term care and high female labour force participation rates, hitherto unwaged informal caring has been replaced by waged work in two spheres: the work of the formal carer of dependent older people; and the reimbursed work of the female relatives of these older people, who in another era would have cared for them informally. These formal reimbursed employments add to GDP, whereas the traditional informal caring did not. Long-term care utilisation measures and GDP are likely to exhibit near-collinearity as formal care replaces informal caring. I explore these relationships further in Chapter 7.

Figure 6.2

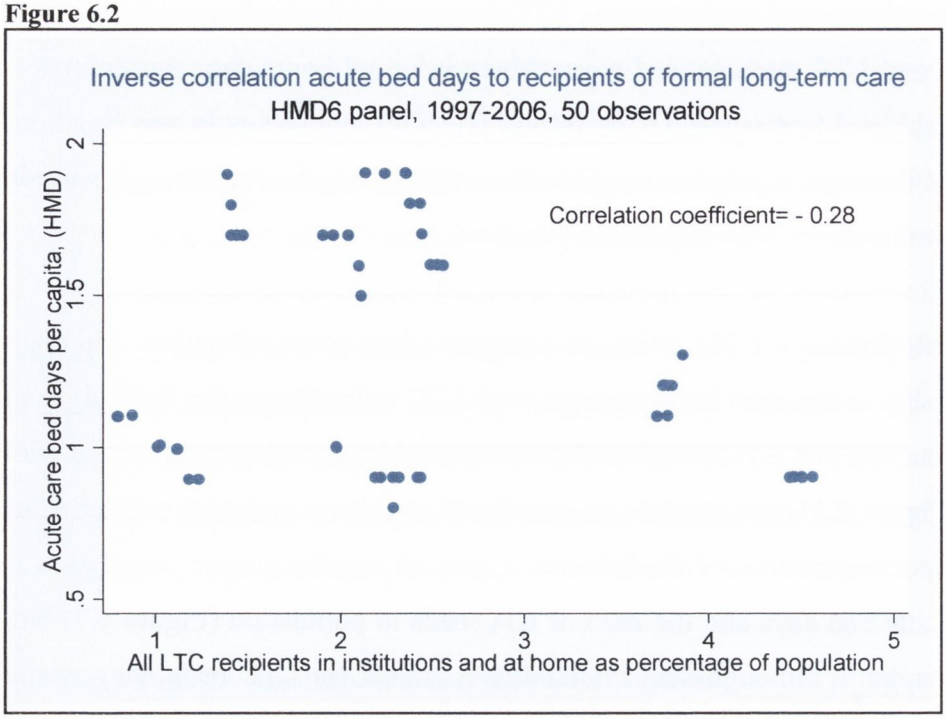


Figure 6.3

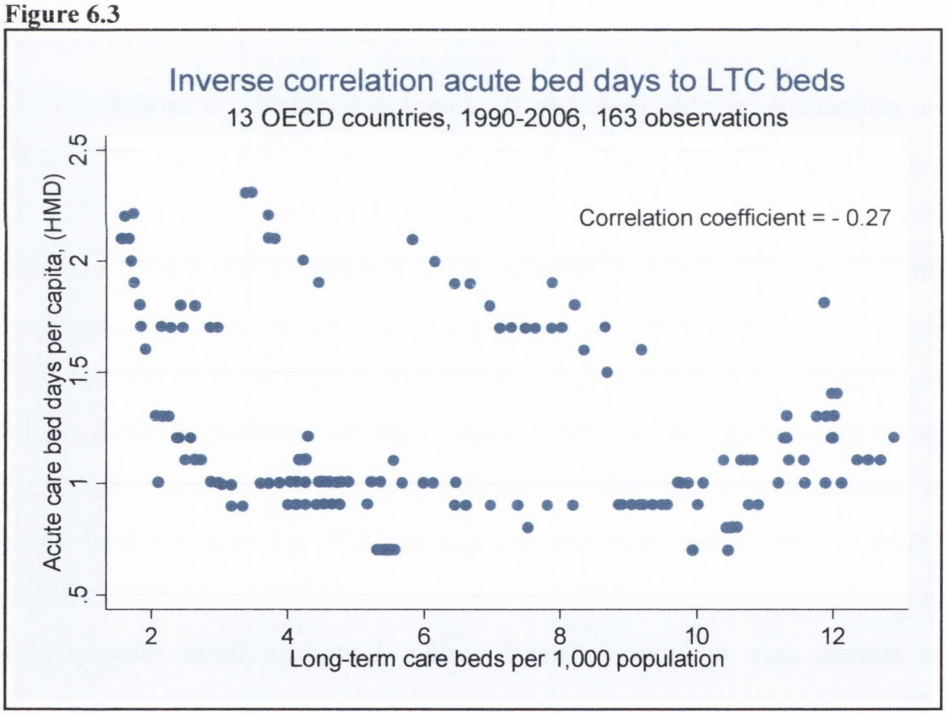
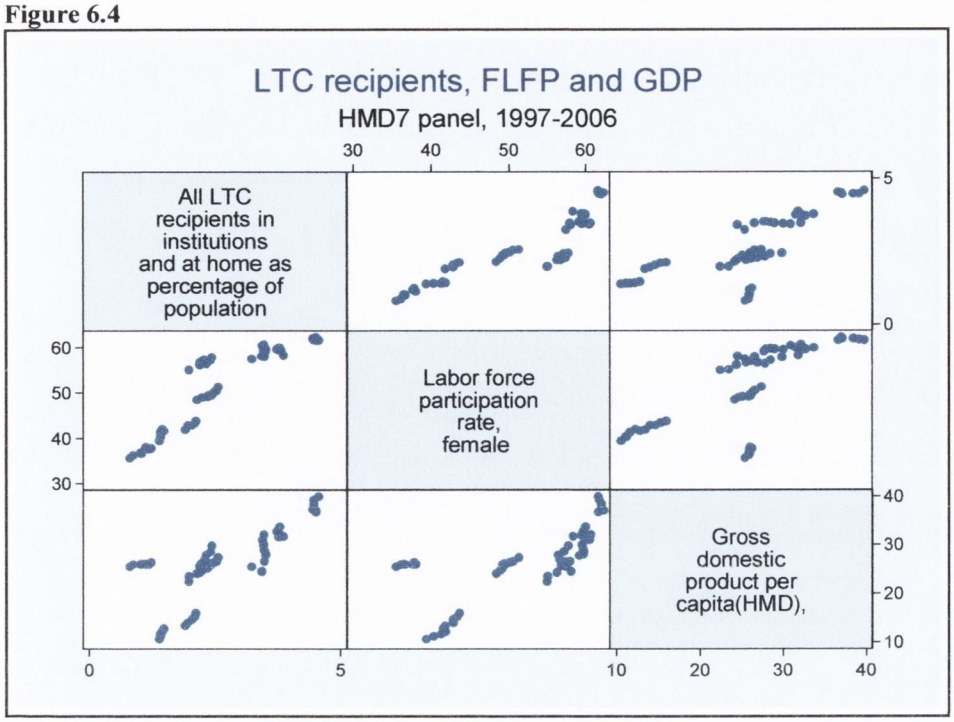


Figure 6.4



6.4 Methodology

The evidence from within-country studies suggests that the balance between acute hospital care and long-term care is in effect a set of simultaneous equations with acute care supply affecting long-term care demand; long-term care supply affecting acute care demand; informal care supply affecting formal care demand; and community care supply affecting residential care demand. In this analysis employing measures of utilisation, it can be represented by the following simultaneous equations (omitting interaction terms):

$$\text{Acute bed days p.c.} = \beta_1 + \beta_2\text{GDP p.c.} + \beta_3\text{percent65} + \beta_4\text{percentDecedents} + \beta_5\text{FLFP} + \beta_6\text{LEBdiff} + \beta_7\text{LTC recipients} + \beta_i\text{state}_i + \beta_j\text{year}_j \quad (9)$$

$$\text{LTC recipients} = \beta_1 + \beta_2\text{GDP p.c.} + \beta_3\text{percent65} + \beta_4\text{percentDecedents} + \beta_5\text{FLFP} + \beta_6\text{LEBdiff} + \beta_7\text{Acute bed days p.c.} + \beta_i\text{state}_i + \beta_j\text{year}_j \quad (10)$$

Where:

GDP p.c. = Gross domestic product per capita, constant US dollars(thousands);

percent65 = percentage of population aged 65 and over;

percentDecedents = all deaths in a year as a percentage of population;

FLFP = female labour force participation rate (a proxy for informal care supply);

LTC recipients = formal long-term care recipients in institutions and the community as percentage of population;

LEBdiff = LEBF − LEBM = Difference between male and female life expectancy

LEBF = Female life expectancy at birth

LEBM = Male life expectancy at birth

In this chapter the model of acute bed utilisation estimated for the HMD14 panel of 14 countries over 22 years with 289 observations is the more limited equation:

$$\text{Acute bed days p.c.} = \beta_1 + \beta_2\text{GDP p.c.} + \beta_3\text{percent65} + \beta_4\text{percentDecedents} + \beta_5\text{FLFP} + \beta_6\text{LEBdiff} + \beta_7\text{percent65*LEBdiff} + \beta_i\text{state}_i + \beta_j\text{year}_j \quad (11)$$

The model of LTC utilisation estimated for the HMD7 panel of 7 countries over 10 years with only 60 observations is:

$$\text{LTC recipients} = \beta_1 + \beta_2\text{percent65} + \beta_3\text{percentDecedents} + \beta_4\log(\text{FLFP}) + \beta_5\text{LEBdiff} + \beta_6\text{percent65*LEBdiff} + \beta_i\text{state}_i + \beta_j\text{year}_j \quad (12)$$

This chapter reviews alternative specifications for both models. The central methodological challenge in estimating the full balance of care as represented by equations (9) and (10) is the endogeneity of LTC utilisation in an acute utilisation model. Endogeneity arises in an economic relationship when the dependent variable causes one of the co-variates, or there is simultaneous determination of the response variable and regressors. The endogenous regressor is correlated with the error term so that conventional estimation methods will produce inconsistent estimates. In the balance of care equations (9) and (10) a variable on either side of the equation drives a variable on the other (acute bed days and LTC recipients). Furthermore, both sides share at least one known driver, the female labour force participation rate variable, and may share others. Chapter 4 discusses endogeneity as it arises in these models and the potential methodological approaches to addressing it. However, the issue of addressing this endogeneity due to simultaneous equations bias does not arise in this instance because limited availability of LTC data and the problem of near-collinearity in the panel for which such data are available make it infeasible to estimate a single balance of care model.

Endogeneity nonetheless remains an issue in both the acute and long-term care utilisation models precisely because of the omission of a variable in each to represent the other form of utilisation. If the hypothesis of a balance of care in which acute and long-term care utilisation substitute for one another is correct, these omissions are likely to cause omitted variable bias, a further instance of endogeneity. To the degree that the omitted variable, for acute or LTC utilisation, is time-invariant, it may be captured by the country-specific fixed effects. But to the degree that it varies across countries and over time, it is present in the idiosyncratic error term in these models. The analysis in this chapter demonstrates that LTC utilisation is correlated with the included regressors in the acute utilisation model for female labour force participation, age and converging life expectancies. It may also be correlated with GDP. This establishes a correlation between these covariates and the error term in the acute utilisation equation, making them endogenous. In Chapter 4, I discussed my inability to circumvent this endogeneity by employing 2SLS or dynamic panel data methods of estimation. Due to my inability to apply such methods, I again in this chapter as in Chapter 5 estimate by either FGLS or PCSE with fixed effects. Interpretation of my results must be qualified by recognition of potential omitted variable bias.

Each model in this chapter has a two-way fixed effects model specification, with intercepts that vary over countries and over time. In each specification, a modified Wald test confirms groupwise heteroscedasticity and a Wooldridge test confirms first-order autocorrelation. I again employ Pesaran's test for cross-sectional dependence. Following the methodology in the preceding chapters, if cross-sectional correlation is not present, FGLS (feasible generalized least squares) estimation with fixed effects is appropriate: if it is present, the appropriate methodology is PCSE (panel-corrected standard errors) estimation with fixed effects. The tables in this chapter show results employing the preferred method. In the case of the acute utilisation models, this is PCSE with assumed autocorrelation, while it is more often FGLS with assumed autocorrelation for the LTC utilisation models. Due to the small size of the HMD7 panel that I employ for the LTC utilisation models, which affects the reliability of the Pesaran test, I show results for both PCSE and FGLS estimations where results of the test are marginal.

The analysis in this chapter of the relationship of age, converging life expectancies and their interaction to acute bed utilisation follows the approach to testing conditional hypotheses in interaction models in Chapter 5, employing Wald tests: initially of the joint

hypothesis that age, converging life expectancies and their interaction have significant effects on acute bed utilisation; and then of the separate hypotheses that age or converging life expectancies affect acute bed utilisation. The test of the fundamental conditional hypothesis that a conditioning relationship exists in which the moderating variable affects the effect of the moderated variable on the dependent variable is the t-test of the coefficient on the interaction term. Where there is confirmation of this fundamental conditional hypothesis, further graphical and t-tests are conducted to establish the significance or direction of the marginal effect of either variable on acute bed utilisation across a range of values of the moderating variable.

This chapter tests hypotheses about the determinants of acute bed utilisation when the panel excludes Southern European countries. An alternative approach to identifying differences in the determinants of utilisation for these countries would be to include a categorical regional variable and to interact this variable with other regressors where regional effects are hypothesised. As in the case of the categorical variable for location of death, discussed in Chapter 5, inclusion of such a time invariant categorical variable would require dropping country-specific fixed effects. This approach is not adopted in this analysis but represents a further avenue to test regional effects.

6.5 Analysis and discussion - acute bed utilisation model in a panel excluding the Southern European countries

6.5 (i) Central estimation results

The preferred acute utilisation model specification for the HMD14 panel, that excludes the Southern European countries, is a simple linear model with age represented by a single age cohort and with an interaction term for age and converging life expectancies (Table 6.2, Model 1). The effects of female labour force participation and age on acute bed utilisation in this HMD14 panel differ from their effects in the HMD17 panel employed in the analysis in Chapter 5. Female labour force participation shows a significant inverse effect on acute bed utilisation, whereas it was insignificant in the larger panel. The marginal effect of age on acute bed utilisation is insignificant over the 1985-2006 period and, when the 1980s are excluded, its effect is found to be negative and significant, whereas in a quadratic specification, it was positive and significant in the earlier years of the analysis for the HMD17 panel (Tables 6.2 and 6.3). The effect of convergence in life expectancies

is to reduce acute bed utilisation in this panel over both time periods. When the 1980s are excluded, the interaction term between age and converging life expectancies ceases to be significant.

6.5 (ii) Examination of alternative specifications for age and interaction effects

Table 6.2 also shows the results from preliminary analysis testing alternative age specifications in models with interaction terms for age and converging life expectancies for this panel over the full 1985-2006 period. The age specifications examined are: a single age cohort for the percentage of population aged 65 and over (Model 1); a quadratic specification for this single age cohort (Model 2); two age cohorts for the percentage of population aged 65 to 79 and 80 and over (Model 3); and quadratic specifications for these two age cohorts (Model 4). These four models have interaction terms for all age cohorts and converging life expectancies. The final model (Model 5) drops the insignificant interaction term for the oldest age cohort.

Wald tests indicate that only in the two-cohort models are the marginal effects of age and converging life expectancies significant (Table 6.2). Since the interaction effect is significant only for the younger age cohort, Model 5 is preferred to Model 4. Although the Wald tests find significant marginal effects, the question remains as to whether these effects are generally significant. Following the methodologies in Chapter 5, tests of the significance of the marginal effects of the age variables establish that in the preferred Model 5, the effect of either age cohort on acute bed utilisation is more generally insignificant than not. Despite the Wald tests, these further tests indicate that there is no reason to prefer this model to Model 1.

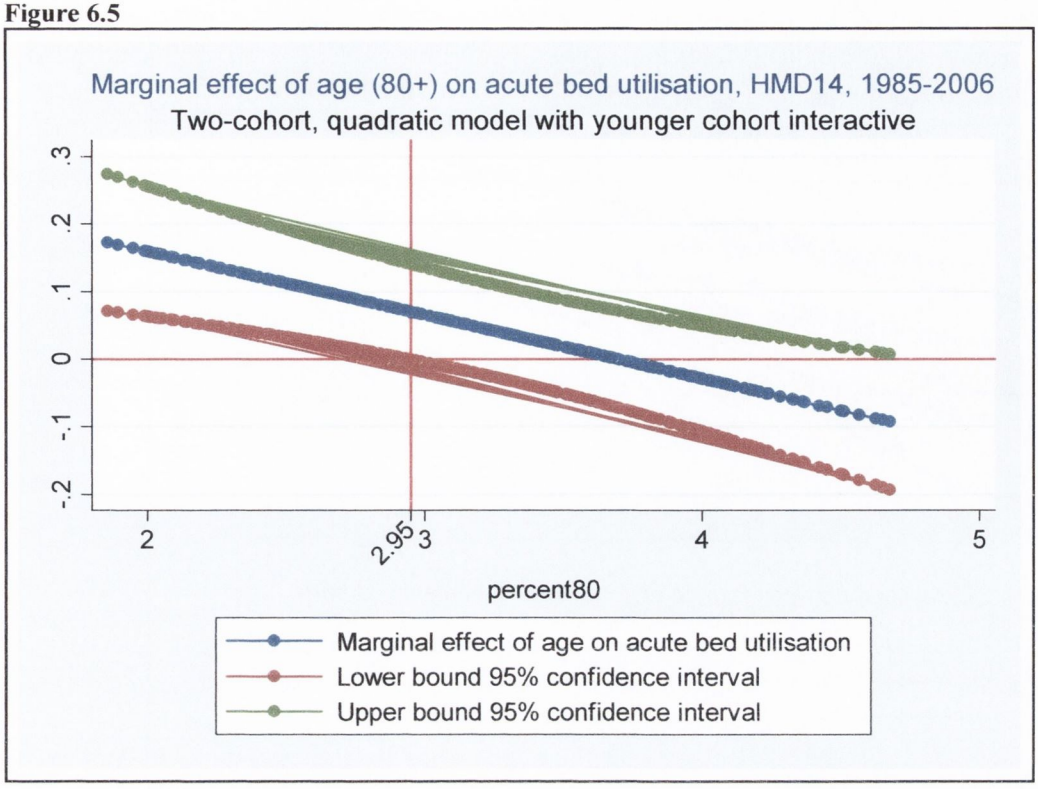
In Model 5 with a significant quadratic term for the percentage of population aged 80 and over, the marginal effect of this age cohort and its significance varies with its level. Figure 6.5 demonstrates that the range of values at which the older age variable is significant is relatively small and is limited to lower population age shares, where its effect is positive but diminishing with greater age share.

Table 6.2 Acute utilisation models, alternative age and converging life expectancies interaction terms, HMD14, 1985-2006; Dependent variable: acute bed days per capita

	Aggregate Age, interaction term	Aggregate Age as Quadratic, interaction term		Two Age Cohorts, 2 interaction terms	Two Age Cohorts as Quadratics, 2 interaction terms	Two Age Cohorts as Quadratics, 1 interaction term
	M1	M2		M3	M4	M5
percent65	-0.084*	-0.070				
	[0.029]	[0.458]				
percent65-squ		-0.0004				
		[0.869]				
pc65*LEBdiff	0.011*	0.011				
	[0.025]	[0.061]				
percent6579				-0.128**	-0.527***	-0.511***
				[0.005]	[0.000]	[0.000]
pc6579*LEBdiff				0.020**	0.026***	0.022**
				[0.008]	[0.001]	[0.001]
Percent80				0.075	0.523***	0.347***
				[0.579]	[0.001]	[0.000]
pc80*LEBdiff				-0.008	-0.019	
				[0.646]	[0.241]	
percent6579squ					0.015***	0.015***
					[0.001]	[0.001]
percent80squ					-0.053***	-0.047***
					[0.000]	[0.000]
LEBdiff	-0.124	-0.117		-0.146*	-0.159*	-0.185*
	[0.085]	[0.150]		[0.041]	[0.031]	[0.011]
PercentDecedents	0.325*	0.319		0.275	0.178	0.208
	[0.041]	[0.056]		[0.101]	[0.280]	[0.209]
GDPpc	0.030***	0.031***		0.031***	0.022***	0.021***
	[0.000]	[0.000]		[0.000]	[0.000]	[0.000]
FLFP	-0.006*	-0.006*		-0.006*	-0.005	-0.004
	[0.036]	[0.037]		[0.034]	[0.067]	[0.100]
2006	-0.744***	-0.747***		-0.815***	-0.735***	-0.702***
	[0.000]	[0.000]		[0.000]	[0.000]	[0.000]
Constant	1.237*	1.113		1.251*	2.993***	3.275***
	[0.036]	[0.208]		[0.034]	[0.000]	[0.000]
R^2	0.96	0.96		0.96	0.97	0.97
Wald test of age, LEBdiff & interaction vars	0.088	0.151		0.074	0.000	0.000
Wald tests of significance marginal effect of age cohorts	0.080	0.166	Effect of 65-79 cohort	0.020	0.000	0.000
			Effect of 80+ cohort	0.821	0.000	0.001
Wald test of significance marginal effect of LEBdiff	0.038	0.077		0.020	0.001	0.001

p-values in brackets * $p =< 0.05$, ** $p < 0.01$, *** $p < 0.001$ Source: HMD14 panel Estimation by PCSE

Figure 6.5



The marginal effect of the younger age cohort variable on acute bed utilisation is effectively only significant when it is negative. As a quadratic interaction, this effect is a function of the levels of both the age and converging life expectancy variables. In Figure 6.6, the marginal effect of age is depicted at values of the age cohort below 10% of population, when the effect is significant, negative and of greater magnitude as life expectancies converge. (As in Chapter 5, neither the marginal effect function nor the confidence intervals are clean curves because the marginal effect varies with levels of age as well as converging life expectancies.) In Figure 6.7, the marginal effect is depicted at a population age share for this cohort ranging between 10% and 12% when it is at no point significantly different from zero. In Figure 6.8, when this cohort's share of population exceeds 12%, there are only a few within sample observations where its effect is positive and significant.

Figure 6.6

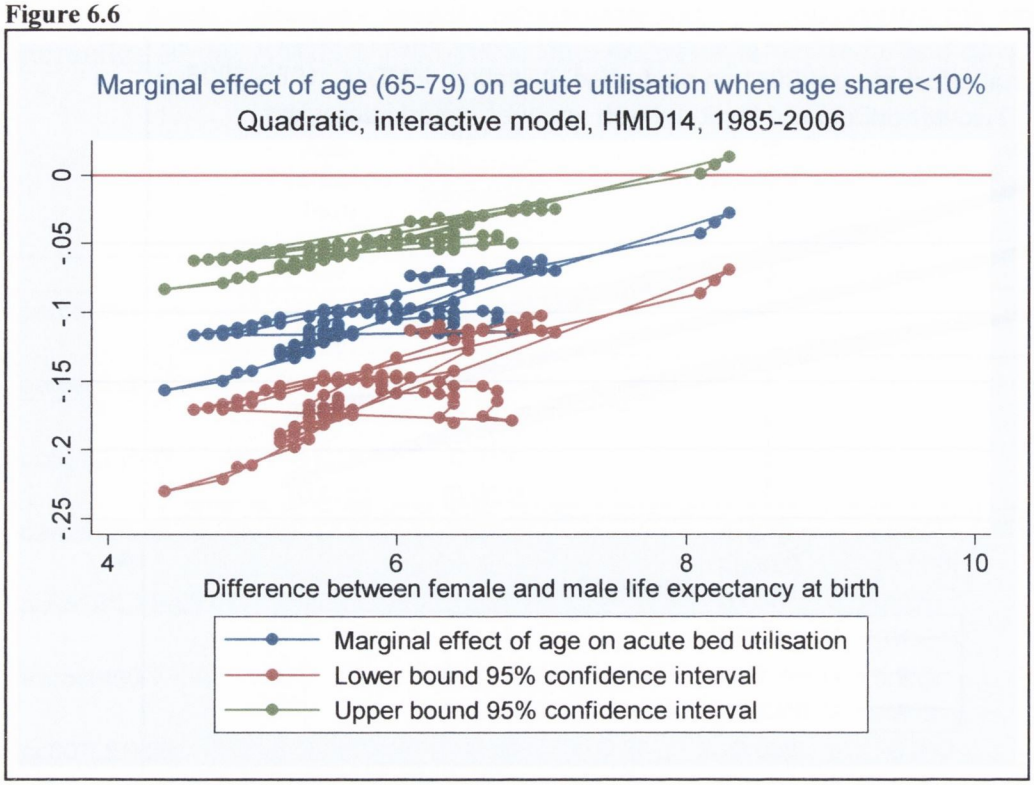


Figure 6.7

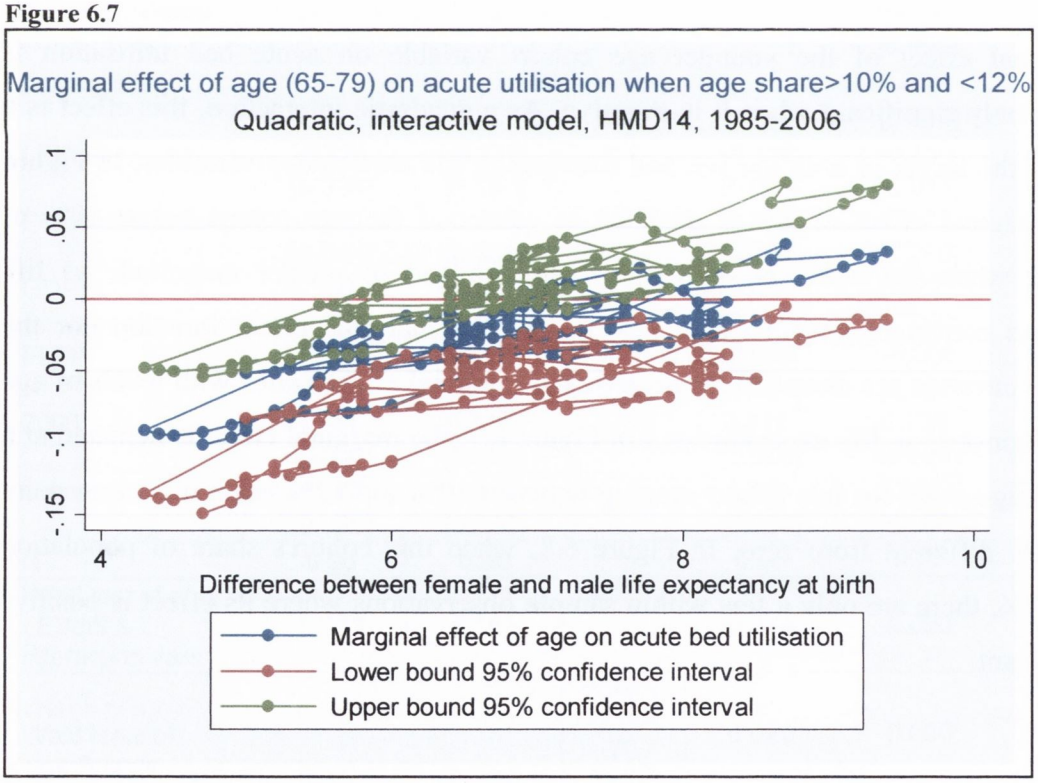
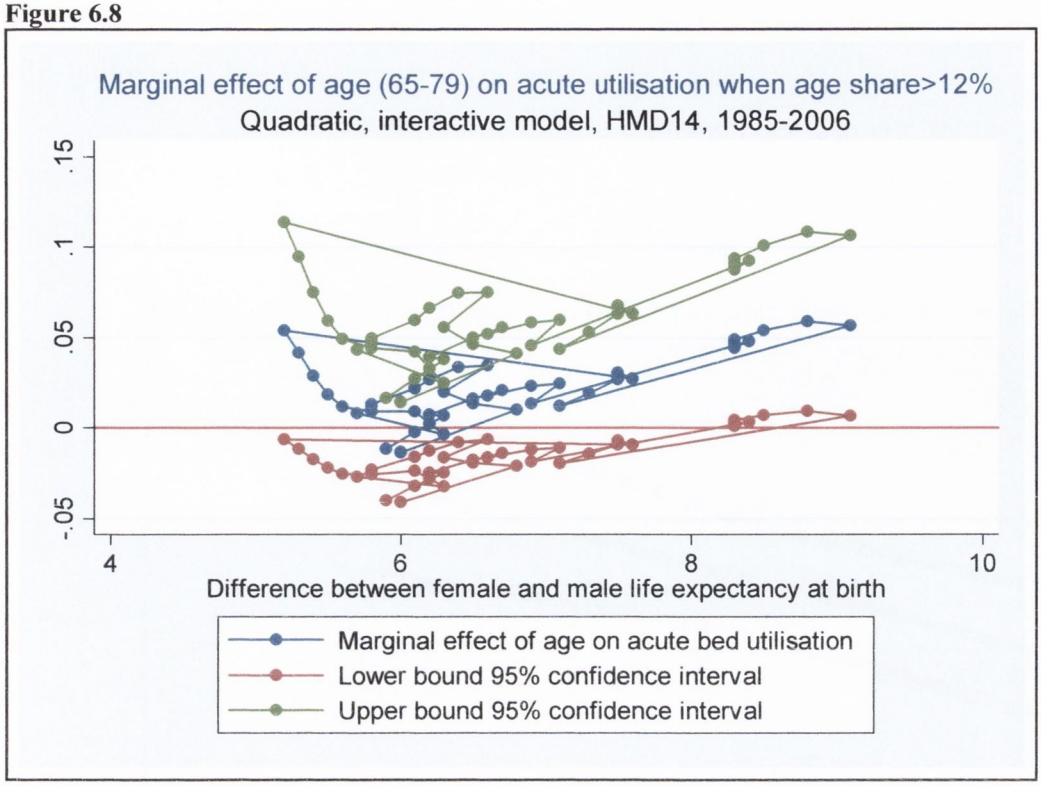


Figure 6.8



In summary, the marginal effect of the younger age cohort variable is negative at the lower age shares where it is significant; and the effect of the older age cohort variable is significant and positive also only at lower population age shares. There is a sizeable range of values for both age cohorts at which their effect on acute utilisation is insignificant. While this analysis is of interest in differentiating between the effects of the two age cohorts, which when significant are of differing sign, in combination the two-cohort analysis for this model conforms to the Wald test for the interactive model employing a single age variable (M1), which finds the overall effect of the population share aged 65 and over to be insignificant in this panel over these years (Table 6.2).

Over the 1985-2006 period, Wald tests find the marginal effect of the converging life expectancy variable to be significant in the single-age cohort interactive model and the two-cohort models (Table 6.2). The marginal effect of the convergent life expectancy variable is positive when it is significant, i.e. acute bed utilisation reduces as life expectancies converge and this effect is moderated by age. Model 5 finds that it is significant at population shares above 10.5% for the cohort aged 65 to 79 (Figure 6.9); while Model 1 finds that it is significant at population shares above 15.2% for the cohort aged 65 and over (Figure 6.10). The significance of the decedent effect at 96% in Model 1 is only 79% in Model 5 (Table 6.2). This may be a consequence of its near-collinearity

with the interaction term. The correlation coefficient between the decedent variable and the interaction term for the percentage of population aged 65 to 79 and converging life expectancies is 0.78. On balance, therefore, Model 1 is the preferred model.

Figure 6.9

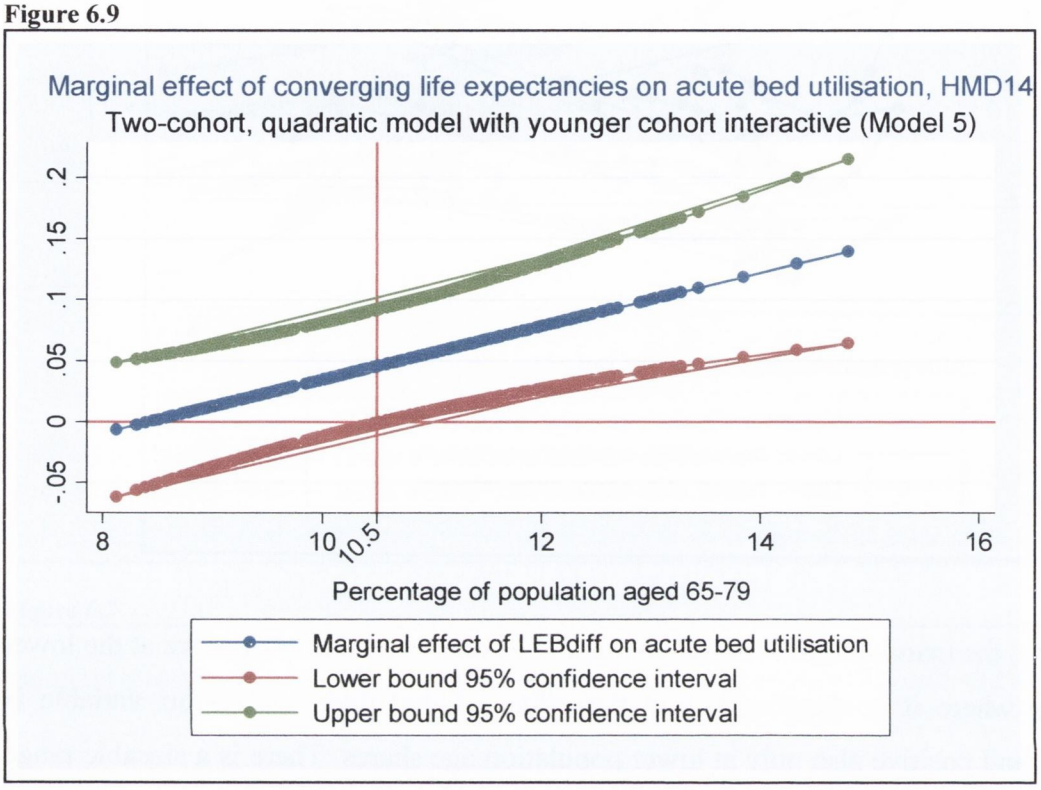
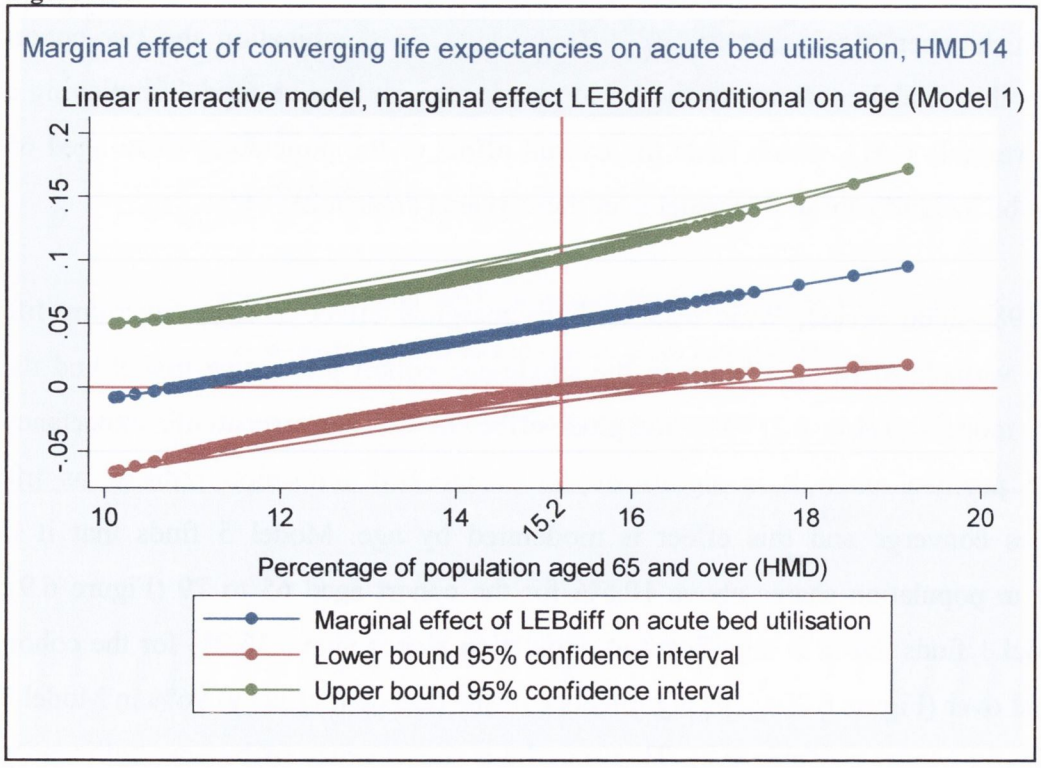


Figure 6.10



6.5 (iii) Estimation results for the HMD14 panel in the years 1990-2006

When the HMD14 panel is restricted to the years from 1990-2006, the effect of the single aggregate age variable on acute bed utilisation becomes unambiguously negative and significant in the simplest linear model, which is the preferred model (Table 6.3, Model 1). The quadratic age specification is insignificant (Model 2). The coefficient for the interactive term is insignificant, which rejects the conditional hypothesis in Model 3 and Model 4. The analysis of the marginal effects of age is therefore straightforward in this panel over this period. Increased population age, without any moderating effect of converging life expectancies, has the effect of reducing acute bed utilisation. Converging life expectancies without any moderating effect of age have the effect of reducing acute bed utilisation, at a 94% significance level.

Table 6.3 Estimation of alternative acute utilisation models, HMD14 panel, Dependent variable: acute bed days per capita, 1990-2006

	Model 1	Model 2	Model 3	Model 4
percent65	-0.035**	-0.055	-0.061	-0.142
	[0.010]	[0.505]	[0.166]	[0.177]
percent65-squ		0.001		0.002
		[0.819]		[0.437]
Percent65*LEBdiff			0.004	0.007
			[0.493]	[0.321]
LEBdiff	0.051	0.052	-0.012	-0.041
	[0.058]	[0.055]	[0.895]	[0.657]
PercentDecedents	0.491**	0.508**	0.481**	0.532**
	[0.004]	[0.007]	[0.006]	[0.004]
GDPpc	0.032***	0.032***	0.031***	0.030***
	[0.000]	[0.000]	[0.000]	[0.000]
FLFP	-0.011***	-0.011***	-0.010**	-0.010**
	[0.000]	[0.000]	[0.003]	[0.002]
2006	-0.438***	-0.431***	-0.440***	-0.421***
	[0.000]	[0.000]	[0.000]	[0.000]
Constant	0.313	0.453	0.689	1.354
	[0.324]	[0.456]	[0.328]	[0.177]
Observations	234	234	234	234
R^2	0.97	0.97	0.97	0.97
Sum of country coefficients	9.77	9.78	9.75	9.77
Wald test of joint significance of age, LEBdiff and interaction variables	0.013	0.014	0.026	0.021
Wald test of significance marginal effect of age	0.010	0.015	0.030	0.022
Wald test of significance marginal effect of LEBdiff	0.059	0.055	0.156	0.121

p-values in brackets * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$ Source: HMD14 panel

In the HMD14 panel for the years 1990-2006, the acute utilisation model is estimated as:

$$\text{Acute bed days p.c.} = 0.3 + 0.03\,\text{GDP p.c.}^{***} - 0.04\,\text{percent65}^{**} + 0.49\,\text{percentDecedents}^{**} - 0.01\,\text{FLFP}^{***} + 0.05\,\text{LEBdiff}^{*1} + \beta_i \text{state}_i + \beta_j \text{year}_j$$

$^{*1}p < 0.06$, $^{*}p < 0.05$, $^{**}p < 0.01$, $^{***}p < 0.001$

The coefficients for each covariate are significant to the 94% level or higher. The finding across these 14 countries over this 17-year period is that, holding other variables constant, per capita acute bed utilisation increases by 0.3 days with an increase of $10,000 in GDPpc; and that it reduces by 0.5 days with a reduction of one percentage point in the death rate; by 0.1 days with a 10 percentage point increase in female labour force participation; by 0.4 days with a 10 percentage point increase in the proportion of population aged 65 and over; and by 0.05 days with a reduction of one year in the difference between male and female life expectancy at birth.

6.6 Analysis and discussion of model of long-term care utilisation

Table 6.4 shows estimations for progressively more complex long-term care utilisation models estimated for the HMD7 panel of 7 OECD countries over the years 1997-2006. The preferred model is the final model, which the measures of fit concur has superior explanatory power (Table 6.5). Population aged 65 and over and female labour force participation are found to be positive and significant drivers of LTC utilisation. Convergence in life expectancies reduces LTC utilisation. A variable for all deaths as a percentage of population is insignificant and is dropped in the final model, which includes a variable interacting convergent life expectancies and population age.

In earlier analysis, I employed a variable for population aged 80 and over to represent age, since utilisation of long-term care is associated with more advanced age. However, since this variable is collinear with the converging life expectancy variable in this panel, I reverted to the broader age measure to enable the development of a more complex model. Although the decedent variable is insignificant in its effect, it is a poor measure of proximity to death effects in long-term care setting. A better measure would be a variable for deaths at older ages. Such a variable would be near-collinear with the age variable

which makes it impossible to separate age and death effects satisfactorily with the data available for this panel.

Table 6.4 Long-term care utilisation model development, HMD7, 1997-2006
Dependent variable: Formal LTC recipients as percentage of population

	Age & FLFP	Age, FLFP & LEBdiff	Age, FLFP, LEBdiff & deaths	Interactive model	Interactive Model without deaths
Percent65	0.052*	0.060**	0.060*	-0.309**	-0.268**
	[0.033]	[0.005]	[0.010]	[0.002]	[0.003]
lnFLFP	2.486***	2.678***	2.690***	2.710**	2.756**
	[0.001]	[0.001]	[0.001]	[0.002]	[0.002]
LEBdiff		0.151***	0.150**	-1.065***	-0.944**
		[0.001]	[0.001]	[0.001]	[0.001]
PercentDecedents			-0.014	0.768	
			[0.984]	[0.242]	
Age*LEBdiff				0.067***	0.061***
				[0.000]	[0.000]
2006	0.199**	0.254***	0.253**	0.135	0.095
	[0.001]	[0.000]	[0.001]	[0.114	[0.209]
Observations	60	60	60	60	60

p-values in brackets * $p = < 0.05$, ** $p < 0.01$, *** $p < 0.001$ Source: HMD7 panel Estimation by FGLS. Constant, country and year dummy coefficients not shown.

Table 6.5 Measures of fit, LTC utilisation models, HMD7, 1997-2006

	Age & FLFP	Age, FLFP & LEBdiff	Age, FLFP, LEBdiff & deaths	Interactive model	Interactive Model without deaths
R^2 *(PCSE)*	0.99	0.99	0.99	0.99	0.99
R^2 *(FEC)*	0.67	0.67	0.67	0.77	0.77
AIC (FEC)	-111.6	-110.3	-108.4	-128.5	-128.9
2006 (FGLS)	0.199	0.254	0.253	0.135	0.095
Sum of state coefficients	5.13	6.02	6.00	5.14	4.98

The final model specification is justified by preliminary estimations, in which I employed three alternative specifications of the interactive model: with log transformation for the dependent variable and FLFP; with log transformation only of FLFP; and a purely linear model (Table 6.6). Although FGLS is the preferred methodology, estimation results by PCSE are also presented. In all three specifications the interaction effect is significant by either estimation method. The log-log transformation was designed to represent an apparently exponential relationship of LTC utilisation to FLFP, suggested by the graphical appearance of the data (Figure 6.11). However, the lin-log specification performs best when judging by the significance of the coefficients, which suggests a diminishing returns

specification for FLFP. To determine the preferred specification, the R-square is not an appropriate measure in this instance because the dependent variables are not comparable. Although the log-log specification had appeared supported by the Box-Cox testing procedure, as noted in Chapter 4, this can be misleading in the presence of heteroscedasticity. An alternative is the MacKinnon, White and Davidson (MWD) test recommended by Gujarati for choosing between linear and log-linear regression models (Gujarati, 2003).

The MWD test essentially generates a variable for the difference in predicted values in the two alternative methods which are being compared and includes this variable in repeated regression by the method to be tested. If the t-test finds the new variable's coefficient to be significant, this implies a rejection of the null hypothesis that the specification being tested is correct. Application of the MWD test to the models in Table 6.6 prefers the linear specification to the log-log specification; and the lin-log specification to either the linear or the log-log. The test was employed using predicted values after estimation by fixed effects with a cluster option since the two-way fixed effects estimations by FGLS or PCSE as in Table 6.6 engender predicted values which take into account the full explanatory power of the dummy coefficients thereby masking the effect of the alternative specifications. The MWD test favours the lin-log specification for the relationship of LTC utilisation to FLFP in univariate and multivariate models. This outcome prompts a re-examination of the graphical evidence on the relationship of LTC utilisation to FLFP which suggests that whereas the full panel data appears to support an exponential function (Figure 6.11), on closer examination of the country-specific data, a diminishing returns function appears a better fit and the graph for the full panel data can be re-interpreted as a series of diminishing returns functions (Figures 6.12-6.14).

Table 6.6 Alternative specifications of LTC utilisation model, HMD7, 1997-2006

Dependent variable	Log(LTC recipients)		LTC recipients			
Specification	Log-log(FLFP)		Lin-log(FLFP)		Linear	
Method	FGLS	PCSE	FGLS	PCSE	FGLS	PCSE
Percent65	-0.155**	-0.113	-0.268**	-0.302**	-0.265**	-0.303*
	[0.008]	[0.139]	[0.003]	[0.009]	[0.007]	[0.019]
LEBdiff	-0.528**	-0.380	-0.944**	-0.995**	-0.957**	-1.022*
	[0.004]	[0.121]	[0.001]	[0.010]	[0.003]	[0.017]
percent65*LEBdiff	0.034**	0.027*	0.061***	0.068**	0.062***	0.070**
	[0.001]	[0.050]	[0.000]	[0.001]	[0.001]	[0.004]
lnFLFP	1.781**	2.290**	2.756**	2.904*		
	[0.004]	[0.006]	[0.002]	[0.015]		
FLFP					0.040*	0.041
					[0.044]	[0.129]
Observations	60	60	60	60	60	60
R^2		0.98		0.99		0.99

p-values in brackets * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$ FGLS preferred estimation method. Source: HMD7 panel. Constant, country and year dummy coefficients not shown.

Figure 6.11

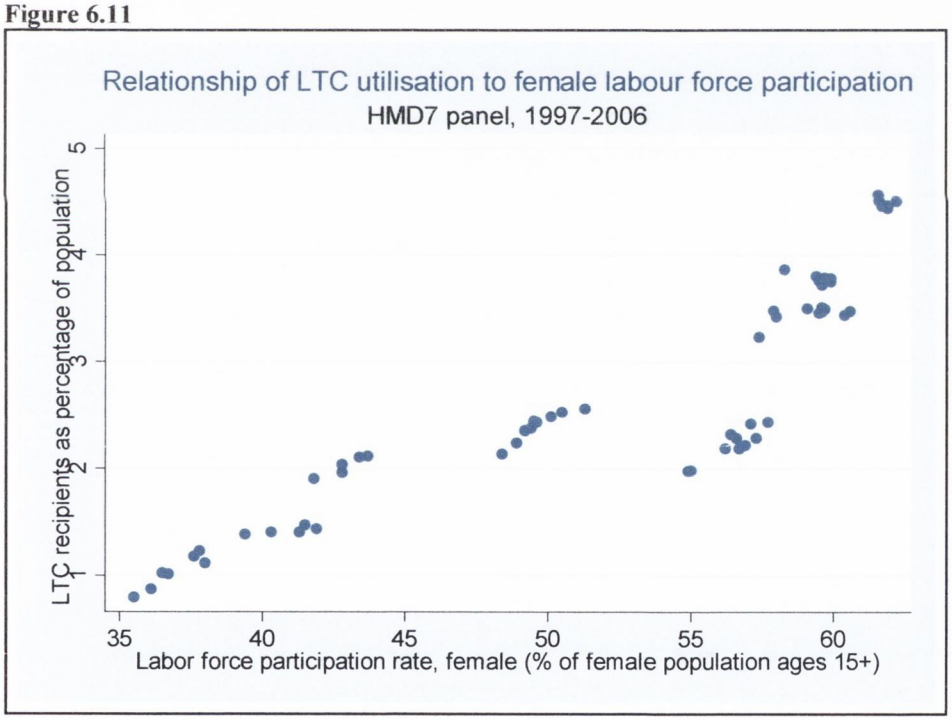


Figure 6.12

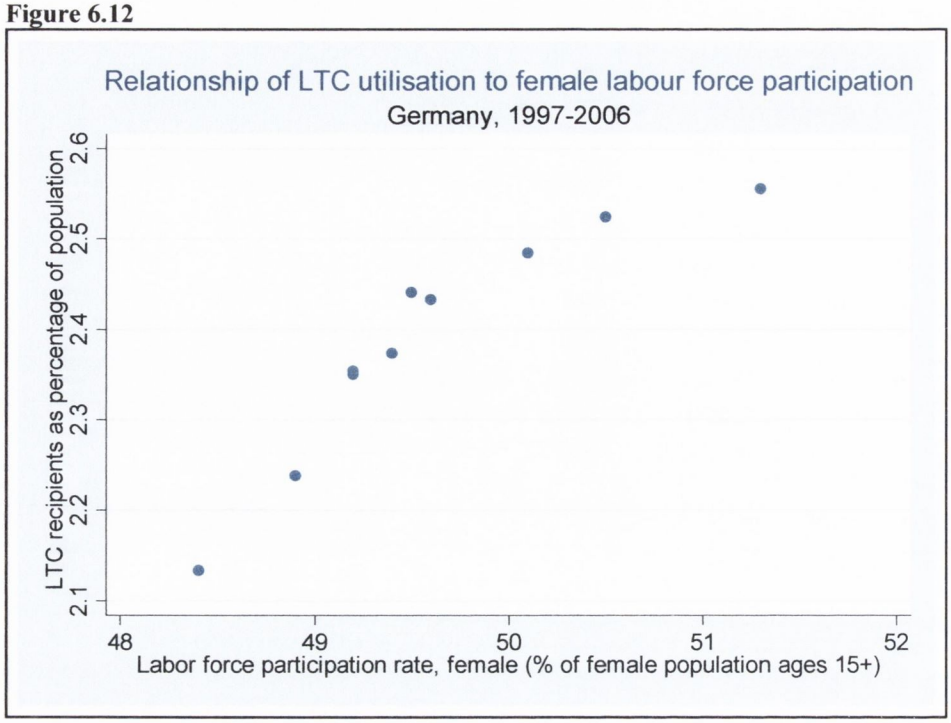
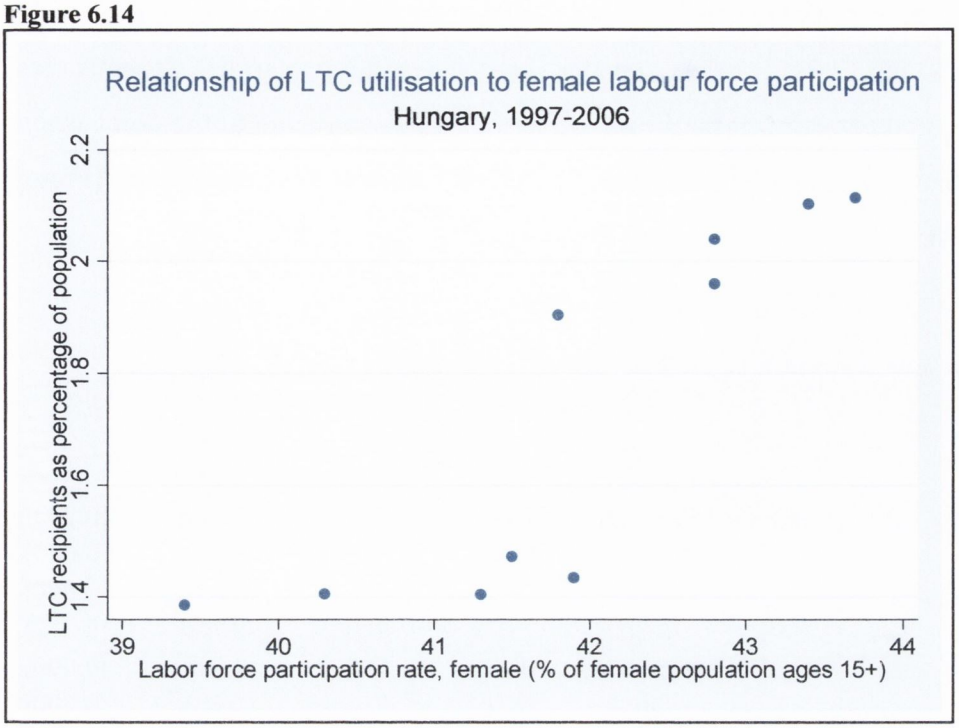


Figure 6.13

Figure 6.14



The lin-log specification appears sufficiently supported to prefer it in this analysis of the effects of age and converging life expectancies in the LTC utilisation model. The significant p-value for the interaction variable coefficient supports the conditional hypotheses that converging life expectancies moderate the effect of age on LTC utilisation and age moderates the effect on utilisation of converging life expectancies. In estimations of LTC utilisation with three alternative age and converging life expectancy models (Table 6.7) the interactive model is preferred to models without the LEBdiff variable (M1) and without an interaction term (M2) since to exclude the significant interaction effect represents a mis-specification. The Wald tests further confirm this, with significant effects of age and converging life expectancies in all three models but with the third model representing the most successful specification. The third model very much reduces the unexplained time effects captured in the year dummy coefficients, which a Wald test shows to be jointly significant at the 96% level in that model, with only one of 9 year dummy coefficients showing a significant difference from the excluded year, 1997.

While the significance of the marginal effects of age and converging life expectancies are confirmed by the Wald tests, further tests are necessary to examine the range of values of the moderating variable for which the moderated variable's marginal effects are significant. The graphical evidence, supported by t-tests, establishes that the marginal effect of age on long-term care utilisation is significant and positive when the difference in life

expectancies between men and women exceeds 5 years; but above this point the greater the convergence in life expectancies or the smaller the difference between life expectancies, the lesser the marginal effect of age. When life expectancies converge to the point where the difference is under 5 years, the effect of age on LTC utilisation is insignificant (Figure 6.15 and Table 6.8).

Table 6.7 LTC utilisation models, HMD7 panel, 1997-2006
Dependent variable: LTC recipients as a percentage of population

Model	M1		M2		M3	
Method	FGLS		FGLS		FGLS	
Percent65	0.052*	[0.033]	0.060**	[0.005]	-0.268**	[0.003]
LEBdiff			0.151***	[0.001]	-0.944**	[0.001]
percent65*LEBdiff					0.061***	[0.000]
lnFLFP	2.486***	[0.001]	2.678***	[0.001]	2.756**	[0.002]
CHE	0.384***	[0.000]	0.252***	[0.000]	0.328***	[0.000]
DEU	-0.612***	[0.000]	-0.747***	[0.000]	-0.645***	[0.000]
FIN	-0.992***	[0.000]	-1.341***	[0.000]	-1.006***	[0.000]
HUN	-0.745**	[0.005]	-1.261***	[0.000]	-0.656	[0.092]
ITA	-1.358***	[0.000]	-1.480***	[0.000]	-1.388**	[0.002]
NOR	1.034***	[0.000]	0.945***	[0.000]	0.959***	[0.000]
1998	-0.008	[0.782]	-0.021	[0.529]	-0.003	[0.908]
1999	0.129***	[0.000]	0.120**	[0.001]	0.119***	[0.001]
2000	0.101**	[0.006]	0.144***	[0.000]	0.079	[0.062]
2001	0.109**	[0.008]	0.145***	[0.000]	0.072	[0.137]
2002	0.157***	[0.001]	0.229***	[0.000]	0.097	[0.108]
2003	0.142**	[0.002]	0.221***	[0.000]	0.080	[0.188]
2004	0.157**	[0.003]	0.215***	[0.000]	0.083	[0.186]
2005	0.185***	[0.001]	0.262***	[0.000]	0.090	[0.200]
2006	0.199**	[0.001]	0.254***	[0.000]	0.095	[0.209]
Constant	-7.717**	[0.010]	-9.365**	[0.003]	-3.738	[0.300]
Observations	60		60		60	
Sum of country coefficients	5.13		6.04		4.98	
Wald test year coefficients	0.001		0.000		0.040	
Wald test age & LEBdiff coefficients			0.001		0.000	
Wald test marginal effect of age	0.033		0.005		0.000	
Wald test marginal effect of LEBdiff			0.001		0.000	

p-values in brackets * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$ Wald tests report P>chi2 Source: HMD7 panel. The excluded state is Sweden and the excluded year is 1997.

Figure 6.15

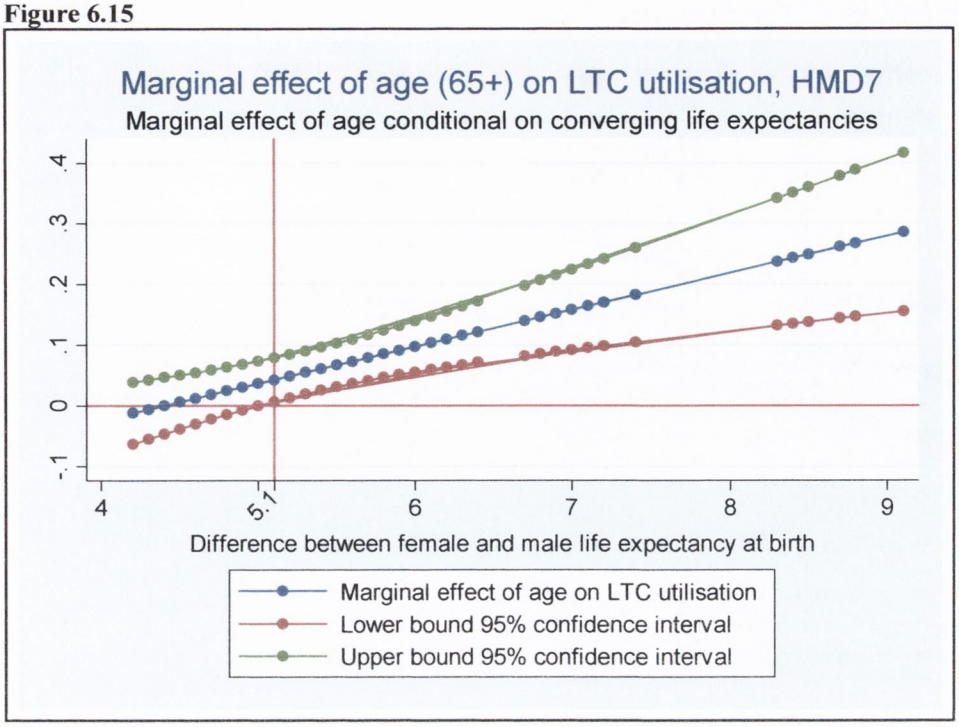


Table 6.8 Tests of hypothesis of whether age affects LTC utilisation, HMD7, Model 3

LEBdiff	t-statistic	H0:dydx>=0	H0:dydx=0	H0:dydx<=0	Confidence intervals	
		HA: dydx<0	HA: dydx!=0	HA: dydx>0	LBdydx	UBdydx
		p-value	p-value	p-value	95% CI	95% CI
4.5	0.27	0.400	0.800	0.600	-0.03841	0.05035
5.1	2.38	0.010	0.020	0.990	0.00648	0.07842
6.0	4.68	0.000	0.000	1.000	0.05522	0.13913
7.0	4.83	0.000	0.000	1.000	0.09194	0.22404
9.1	4.43	0.000	0.000	1.000	0.15543	0.41594

In the case of the marginal effect of the converging life expectancy variable, the graphical evidence supported by t tests indicates that when the population age share is greater than 17%, the marginal effect of the converging life expectancy variable on LTC utilisation is positive and significant. This means that reduction in the difference in life expectancies between men and women reduces LTC utilisation, when the population age share is above 17% (Figure 6.16 and Table 6.9). Below that point the effect of converging life expectancies is insignificant. Above that point as age share increases, the effect of converging life expectancies in reducing LTC utilisation becomes greater.

Figure 6.16

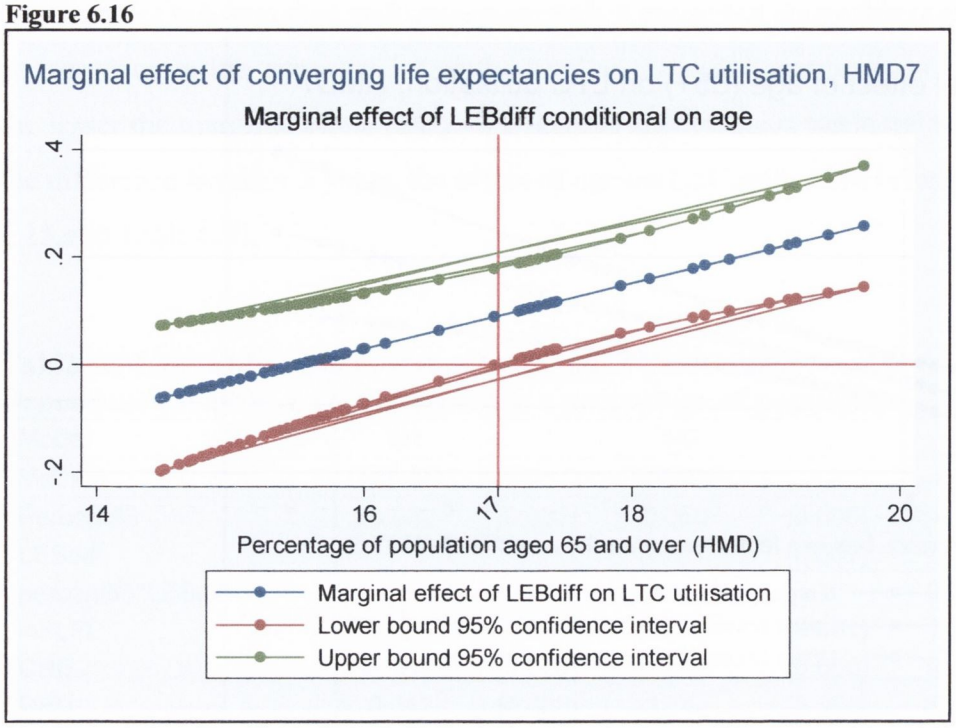


Table 6.9 Tests of hypothesis of whether LEBdiff affects LTC utilisation, HMD7, Model 3

Percentage of population aged 65 & over	t-statistic	H0:dydz>=0	H0:dydz=0	H0:dydz<=0	Confidence intervals	
		HA: dydz<0	HA: dydz!=0	HA: dydz>0	LBdydz	UBdydz
		p-value	p-value	p-value	95% CI	95% CI
15.0	-0.52	0.500	1.000	0.500	-0.15418	0.09141
16.0	0.59	0.275	0.550	0.725	-0.07264	0.13196
17.2	2.26	0.015	0.030	0.985	0.01054	0.18832
18.5	3.91	0.000	0.001	1.000	0.08634	0.27056
19.5	4.52	0.000	0.000	1.000	0.13277	0.34732

It is instructive to relate the population age share at 65 years and over to the age share of the older old, who would be expected to have higher rates of LTC utilisation than the younger old. If this sample is restricted to the observations at which the minimum value for the percentage of population aged 65 and over is above 17%, the minimum value for the population age share at 80 and over is approximately 4% (Table 6.10). This suggests that when the population age share of the older old passes this threshold, the effect of convergent life expectancies is to reduce LTC utilisation.

Table 6.10 Summary statistics for age variables when panel restricted to observations at which percentage of population aged 65 & over is >17%
HMD7 panel, 1997-2006

Variable	Obs	Mean	Std. Dev.	Min	Max
percent65	21	18.0	0.89	17.2	19.7
percent80	21	4.75	0.47	3.97	5.4

In the HMD7 panel for the years 1997-2006, the preferred long-term care utilisation model is estimated as:

$$\text{LTC recipients} = 0.095 - 0.27\,\text{percent65}^{**} + 2.76\log(\text{FLFP})^{**} - 0.94\,\text{LEBdiff}^{**} + 0.06\,\text{percent65*LEBdiff}^{***} + \beta_i \text{state}_i + \beta_j \text{year}_j$$

$^{*}p < 0.05$, $^{**}p < 0.01$, $^{***}p < 0.001$

The predicted effect of female labour force participation which follows from the lin-log specification is that LTC utilisation increases at a diminishing rate with increased female labour force participation. The estimated coefficient translates into an average increase in LTC recipients as a percentage of population of 0.28 percentage points with a 10% increase in female labour force participation.

The significant interaction effect in this model makes prediction of the effect on LTC utilisation of changes in population age share or difference in life expectancies conditional on the value of the conditioning variable as well as the change in the predictor variable. The magnitude and the significance of the predicted effect of a discrete change in the moderated variable varies with the level of the moderating variable in the same way as the marginal effect. Increased population age does not significantly change the percentage of LTC recipients in the population when the divergence in life expectancy is less than 5 years (Table 6.11). When the divergence is 5.5 years, an increase of 2.5 percentage points in population age share increases LTC recipients by 0.2% of population; when divergence is 6.5 years, the same increase in population age share increases LTC recipients by 0.3% of population. Similarly, the effect of greater convergence in life expectancies in reducing LTC utilisation is not significant when population age share is at 16% but is significant and increases in magnitude when population age share is greater than 17%. When population age share is 18%, a 3-year convergence in life expectancies is predicted to

reduce LTC recipients as a percentage of population by 0.46% whereas when population age share is 19% the same convergence is predicted to reduce LTC recipients by 0.65% of population (Table 6.12). Since these predictions derive from a two-way fixed effects estimation, they are limited to the countries and years within the sample. Their value is in understanding the determinants of LTC utilisation in these countries and years rather than in making predictions beyond the sample.

Table 6.11 Predicted increase in LTC recipients as a percentage of population, with confidence intervals, resulting from increases in population age

Difference in life expectancies, years	Percentage point increase in percentage aged 65+	Increase in LTC recipients as percentage of population	Standard error of predicted increase in LTC recipients	95% Confidence Interval	
4.5	1	0.01	0.022	-0.0379	0.0509
4.5	2.5	0.02	0.055	-0.0947	0.1272
4.5	5	0.03	0.110	-0.1894	0.2544
5.5	1	0.07	0.018	0.0317	0.1033
5.5	2.5	0.17	0.044	0.0793	0.2582
5.5	5	0.34	0.089	0.1585	0.5165
6.5	1	0.13	0.026	0.0757	0.1813
6.5	2.5	0.32	0.065	0.1893	0.4532
6.5	5	0.64	0.131	0.3786	0.9064

Table 6.12 Predicted decrease in LTC recipients as a percentage of population, with confidence intervals, resulting from convergence in life expectancies

Percentage of population aged 65 & over	Reduction in difference in life expectancies, years	Decrease in LTC recipients as percentage of population	Standard error of predicted decrease in LTC recipients	95% Confidence Interval	
16	-1	-0.03	0.051	-0.1344	0.0704
16	-2	-0.06	0.101	-0.2688	0.1408
16	-3	-0.10	0.152	-0.4031	0.2111
16	-5	-0.16	0.253	-0.6719	0.3519
18	-1	-0.15	0.044	-0.2427	-0.0653
18	-2	-0.31	0.088	-0.4853	-0.1307
18	-3	-0.46	0.132	-0.7280	-0.1960
18	-5	-0.77	0.219	-1.2133	-0.3267
19	-1	-0.22	0.049	-0.3142	-0.1158
19	-2	-0.43	0.098	-0.6284	-0.2316
19	-3	-0.65	0.147	-0.9426	-0.3474
19	-5	-1.08	0.246	-1.5709	-0.5791

Methodological note: The predicted effect on the dependent variable y of a discrete change in the predictor variable x conditional on the moderating variable z is: $\frac{\Delta \hat{y}}{\Delta x} = \hat{\beta}_x \Delta x + \hat{\beta}_{xz}(\Delta x)z$.

6.7 Summary and conclusions

The analysis in this chapter of the determinants of LTC utilisation in a small panel of 7 OECD countries over the years 1997-2006 finds increased population age increases LTC utilisation and convergence in life expectancies reduces LTC utilisation. Furthermore, the effect of each variable moderates the effect of the other. The symmetrical conditional hypotheses that converging life expectancies moderate the effect of age on LTC utilisation and age moderates the effect of converging life expectancies are confirmed in this panel of countries for these years.

In both the acute bed utilisation model estimated for a panel of 14 OECD countries over the years 1985-2006 and in the LTC utilisation model, convergence in life expectancies reduces utilisation. This significant reducing effect for LTC utilisation occurs when the percentage of population aged 65 and over exceeds 17% whereas in the acute utilisation model over the 1985-2006 period the reducing effect of convergent life expectancies is significant when this population age share exceeds 15.2%. In the LTC model increased population age share increases LTC utilisation provided convergence in life expectancies does not fall below 5 years. In the acute utilisation model the effect of age is generally insignificant over the years 1985-2006 but negative if the 1980s are excluded.

The inclusion of the converging life expectancy variable and a term for its interaction with the age variable has the effect in the LTC utilisation model of removing much of the unexplained negative time trend as well as reducing the unexplained differences between countries' utilisation, captured in the country coefficients. The postulated capturing by the convergent life expectancy variable of the twin effects on LTC utilisation of the provision of more informal care by partners' surviving longer together and of improved health status among older people provides much greater explanation of the factors driving long-term care utilisation that countries have in common.

A diminishing returns function for the relationship of LTC utilisation to female labour force participation is supported by this analysis. It may be that this reflects a growing proportion of women in part-time work, who retain caring roles, which Yoo et al (2004) suggested might explain a negative association between a rising proportion of women in the labour force and long-term care expenditures. Analysis that differentiates between

labour force participation rates for women in full and part-time employment could shed light on this diminishing returns effect. As discussed in Chapter 3, the International Labour Organization's Key Indicators of the Labour Market (KILM) database supplies adequate data on part-time work by women to support such analysis.

This analysis supports a view of age, female labour force and converging life expectancies as significant drivers of LTC utilisation in these countries over these years. This is, however, a very small panel of states and observations. Due to near-collinearity, a number of key variables for important factors such as national income and deaths at older ages are excluded and it is not possible to model the effect of share of population aged 80 and over with the effect of converging life expectancies. While this analysis is, unavoidably, limited in scope due to data inadequacy, it is nonetheless consistent with evidence from the literature on long-term care that demand for LTC rises with population age and rising female labour force participation and that convergence in male and female life expectancies increases the availability of care by partners of one another and reduces demand for formal care.

Female labour force participation is found to have a significant inverse effect on acute bed utilisation in the HMD14 panel that excludes the Southern European countries, having been insignificant when these countries were included in the HMD17 panel in Chapter 5. This finding is further evidence of a North-South gradient in Europe in patterns of informal caring. Female labour force participation in Italy remained at the lowest rate of the countries in the HMD17 panel in 2006 at 37.8%, whereas Spain and Portugal showed steady increases in participation over the 1985-2006 period to 47% and 56% respectively (Figure 6.17). While all three countries experienced increased female labour force participation, Spain and Portugal have had low and only marginally decreasing acute care utilisation rates over the period 1985-2006 (Figures 6.18 and 6.19). It is probably the case that the level of acute care utilisation in Spain and Portugal was already so low at the beginning of this period that there has been little scope to lower it further - and this is the alternative paradigm for these countries. This very low acute bed utilisation has been accompanied by the survival of traditional family living arrangements, the gradual erosion of which contributed to demand for provision of care in the acute hospital setting in other states (Mpinga et al. 2006).

Although OECD Health Data 2009 does not include time series data on LTC recipients in Spain and Portugal, there is point in time evidence on the evolution of rates of receipt of formal LTC care for people aged 65 and over across Europe (Huber et al. 2009). Italy's low rate of female labour force participation accompanied a low rate of formal care provision with fewer than 5% of people aged 65 and over receiving formal LTC services, either in institutions or at home in 2004. Receipt of formal LTC services was higher in Spain and Portugal at 8% and 7% in 2006/7, with evidence of a steep increase in Spain from under 4% in the mid-1990s. It would appear that increased female labour force participation in these two countries has provoked increases in LTC provision but the effect on acute utilisation has been marginal.

Figure 6.17

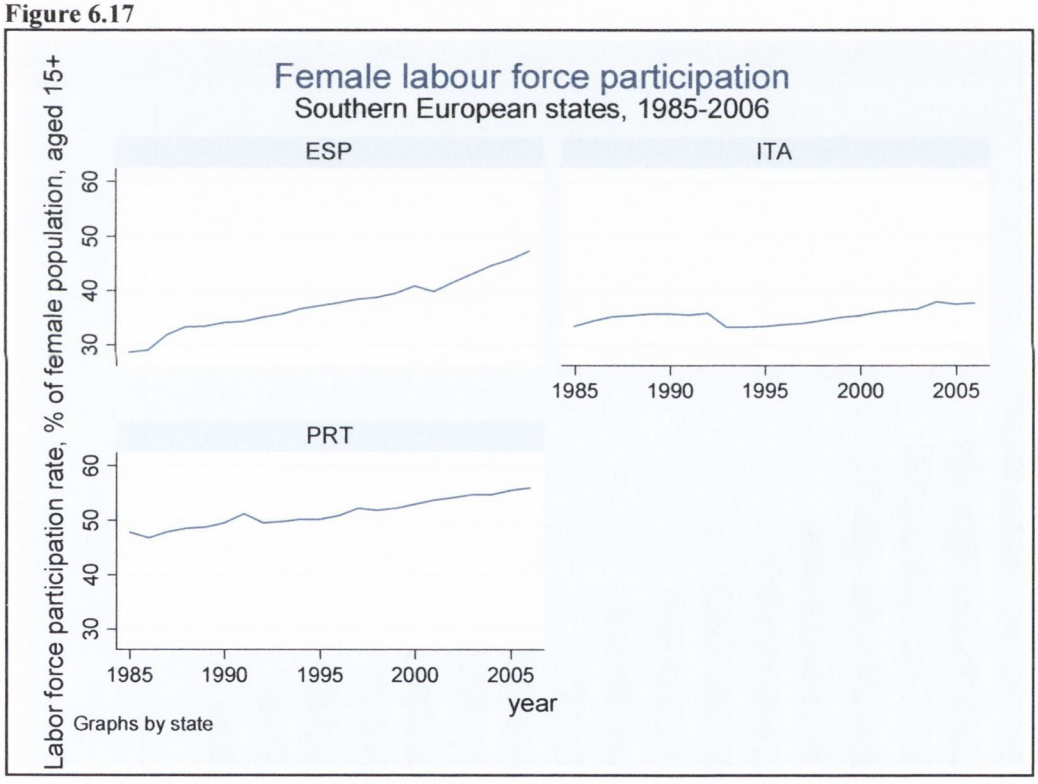


Figure 6.18

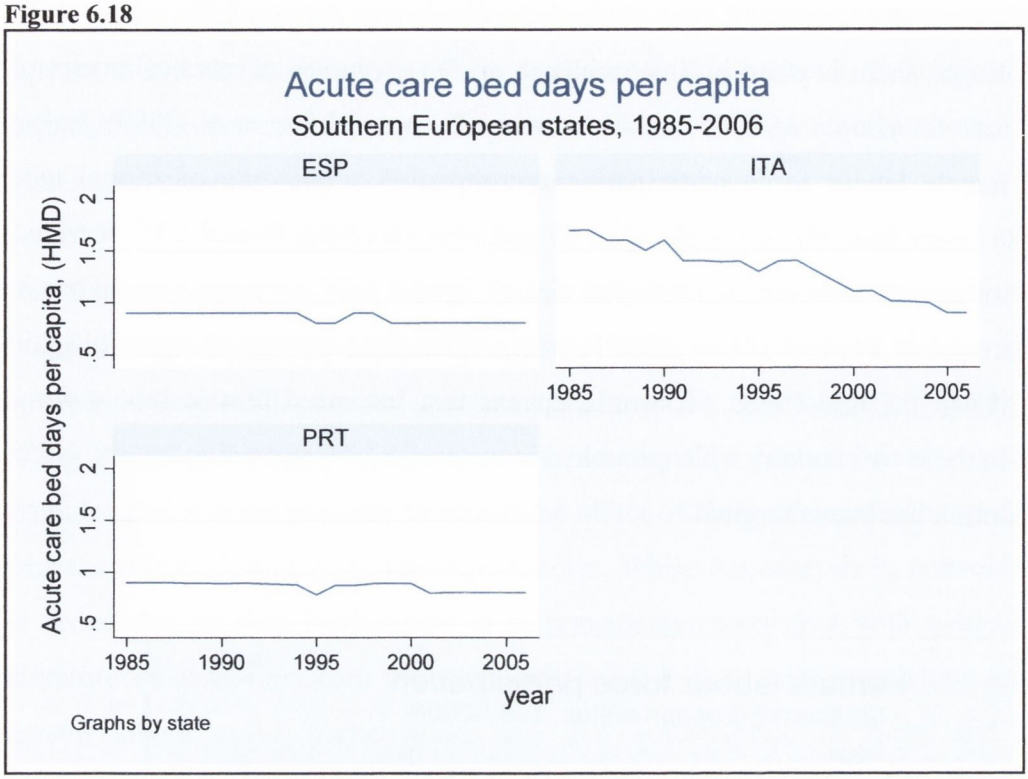
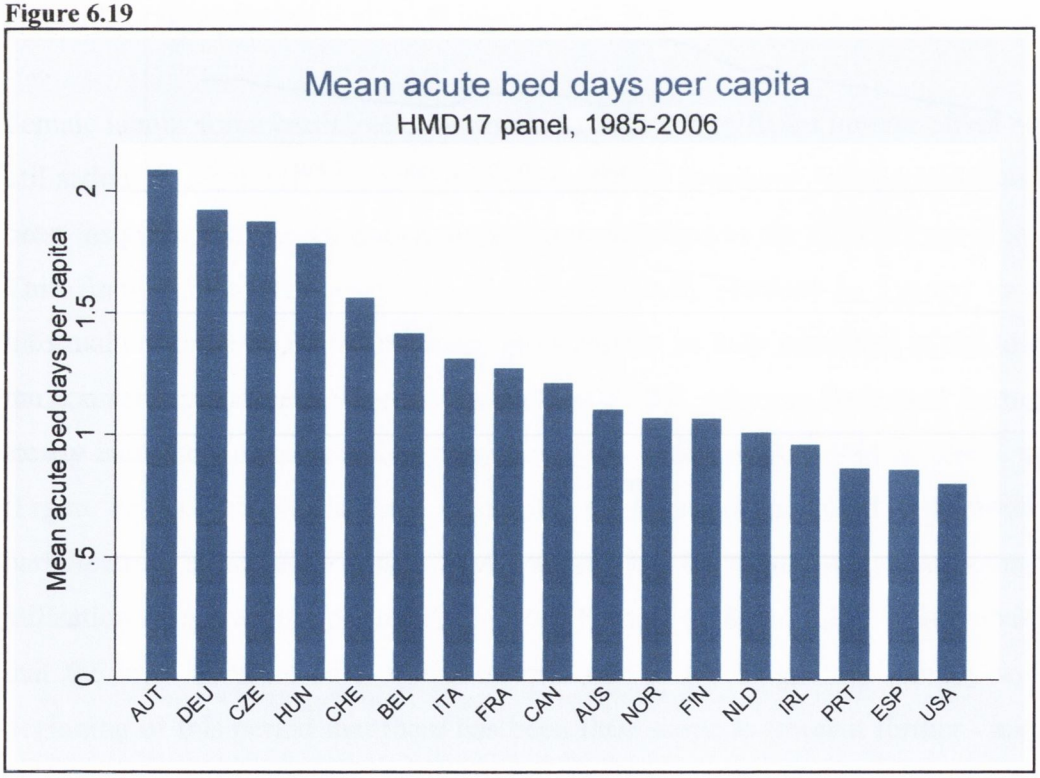


Figure 6.19



The finding of significant, inverse relationships to acute care utilisation of female labour force participation rates and age in the HMD14 panel for the years 1990-2006 and significant, positive relationships to utilisation of long-term care of female labour force

participation rates and age in the HMD7 panel for the years 1997-2007 offers a potential mechanism to explain how a balance of care emerges between the acute and long-term care sectors. In this postulated balance of care mechanism population ageing combined with rising female labour force participation increases long-term care utilisation, which reduces acute bed utilisation. Such a mechanism would be compatible with the findings in Chapter 5 that death is a more significant upward driver of acute bed utilisation than age; that cross-country variations in location at death closely conform to acute bed utilisation rates; and that across countries where most deaths at older ages occur outside hospitals, deaths of people aged 35 to 74 are significant, upward drivers of acute bed utilisation while deaths among people aged 75 to 84 are insignificant. The analysis in this chapter is consistent with the evidence that in countries where there is a more developed LTC infrastructure, much of the care needs of frail, older and dying people are met in a long-term care setting and acute utilisation rates are lower.

Although both are proxy measures for the availability of informal care, female labour force participation and convergent life expectancies have differing effects on acute utilisation, which reduces both in response to *lesser* availability of care by younger women and *greater* availability of care by older people. This apparent contradiction may be explained by a capturing of the effect of improved health status through including the converging life expectancy variable and further by the sequence in which these developments - more women in remunerated work, longer male life expectancy - have occurred. While in many countries, a long-term trend of rising female labour force participation may have played a pivotal role in the relationship of acute to long-term care, with higher participation driving the development of formal LTC, improved male life expectancy and consequent convergent life expectancies are more recent phenomena. It can be observed that across OECD countries, convergence in life expectancies was more pronounced from 1995 to 2006 than in the preceding decade (Figure 6.20) whereas there is not the same marked acceleration in the rate of change of female labour force participation rates over the period (Figure 6.21).

Figure 6.20

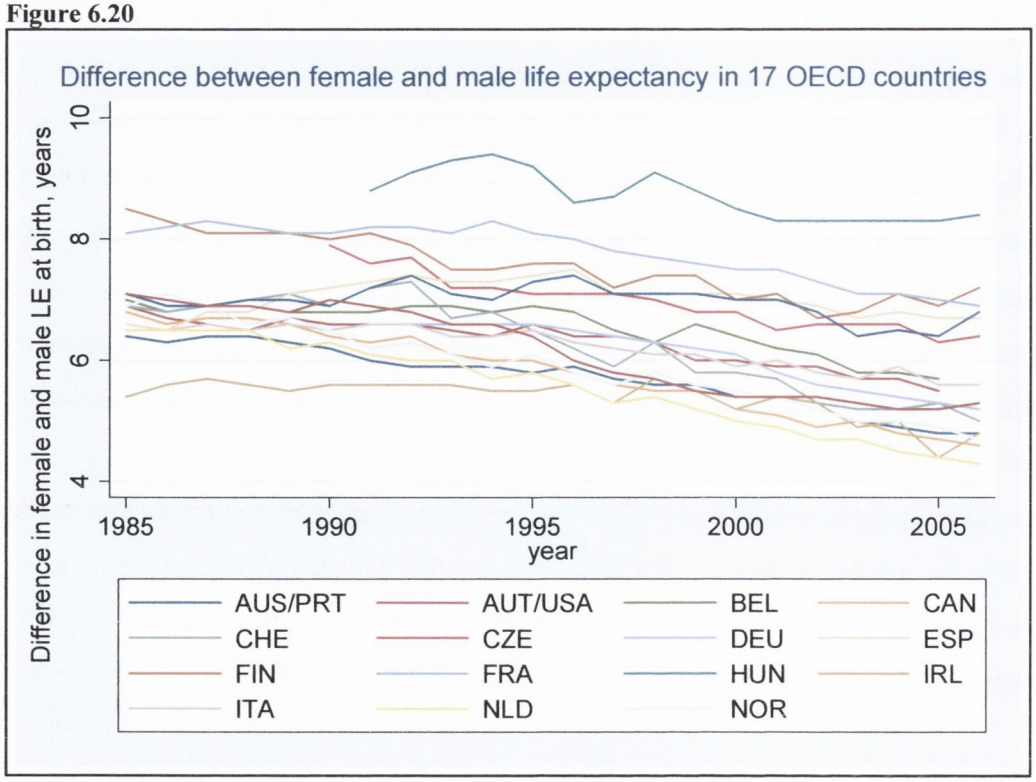
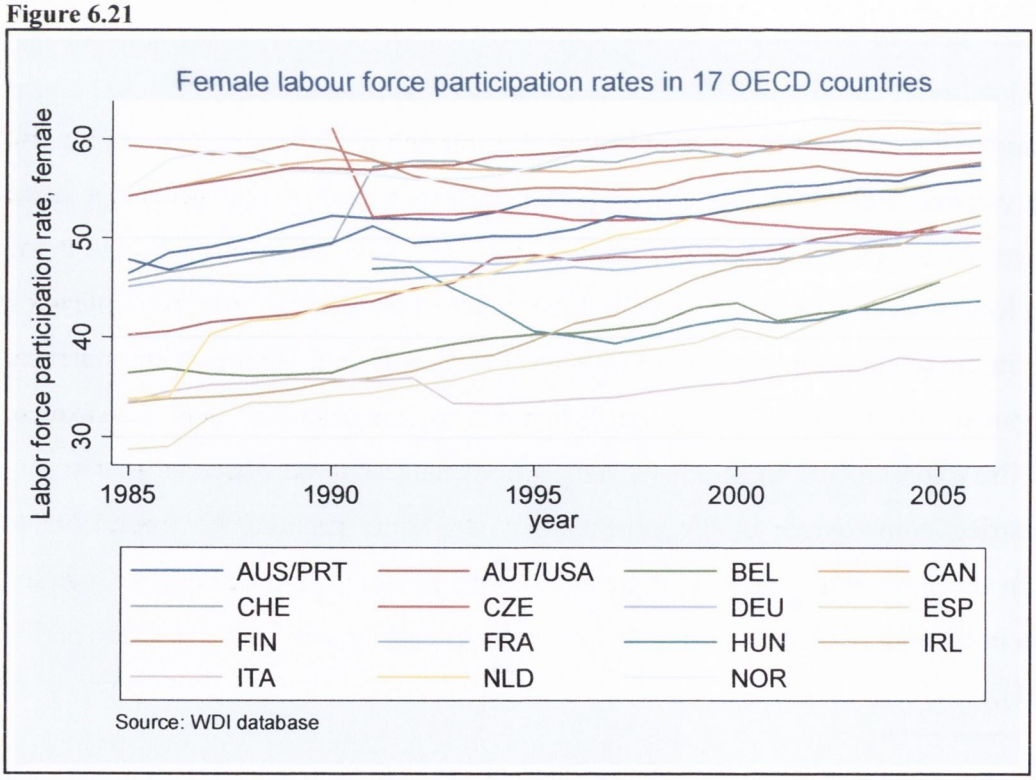


Figure 6.21



The findings in this chapter in separate models of the determinants of long-term and acute care utilisation are qualified by the data limitations which prevent estimation of a composite model addressing the endogeneity of each form of utilisation or supply in estimation of the determinants of the other. The consequent omission of variables for the alternative form of utilisation in each model is a potential source of omitted variable bias, notwithstanding the two-way fixed effects models specifications, which are designed to reduce the effect of omitted unobserved factors. The analysis of long-term care is further limited by the size of the dataset.

Since the estimation methods are by two-way fixed effects, inference is restricted to the countries and years in the analysis. Further caveats which must qualify the application of this analysis to predictive models of demand for either form of care are: the potentially differing effects of female labour force participation on informal care supply depending on trends in full and part-time employment of women; and the potentially differing effects of converging life expectancies on informal care supply depending on trends in marital status, with increasing separation and divorce rates in developed countries (Kinsella and Velkoff 2001).

Although in this chapter I have attributed the counter-intuitive finding of an inverse relationship between female labour force participation and acute bed utilisation to a hypothesis about the balance of care, there remains the possibility that because of the omission due to data deficiencies of a variable for LTC utilisation in this acute utilisation model, the age and FLFP variables which are correlated with LTC utilisation may appear negative and significant because of omitted variable bias, given the evidence of an inverse relationship between LTC utilisation and acute utilisation. Furthermore, interpretation of the role of FLFP in an acute utilisation model that includes GDP is additionally complicated by the relationship of FLFP to GDP, an issue discussed in Chapter 4. The next chapter further explores these questions.

Chapter 7 Female labour force participation, measures of welfare and determinants of acute utilisation

7.1 Introduction

This chapter examines the implications for models of acute bed utilisation of the relationship of female labour force participation (FLFP) to GDP. Rising female labour force participation is a driver of demand for formally-delivered health and social care. Simultaneously, rising FLFP drives GDP growth, since by definition it measures a transition from unpaid caring work to paid, economically enumerated, caring activity. These dual attributes of FLFP invite a reappraisal of the appropriateness of including GDP as a measure of welfare in models of health care utilisation or expenditure. This chapter examines the effects on the acute utilisation model of employing differing measures of national welfare to overcome the challenge of disentangling the effect of FLFP from the effect of growing material welfare.

The causal relationship between female labour force participation and GDP per capita is an obstacle to estimating the effect of either individually in a model of acute bed utilisation. The inclusion of these variables in the model is intended to capture quite different influences on utilisation: including GDP per capita is intended to measure the effect of varying real national income - a measure of material welfare - on utilisation of acute care across countries and over time, a recognition in the model specification that national income emerges in most analyses as the major positive driver of health care spending; on the other hand, including FLFP is intended to capture the effect on acute utilisation of a growing proportion of women in the paid labour force because this is an inverse measure of the effect of a reduction in the proportion of women available to supply informal care at home. In estimating these separate effects of GDP per capita and FLFP on acute bed utilisation, the effect of FLFP on GDP introduces a confounding factor. A reduction in women available to supply informal care is arguably a reduction in net national welfare, certainly a reduction in the supply of care; yet in the model it appears as increased GDP per capita, an increase in material welfare.

The discussion in this chapter arises from the alternative welfare perspectives on the balance of care, introduced in Chapter 2, which centrally differ on whether GDP is regarded as an adequate measure of material welfare or whether non-monetized transactions such as informal care should be included in the measurement of welfare. This chapter tests the feasibility of estimation employing differing measures of national welfare designed to separate the effects of FLFP and GDP per capita on acute bed utilisation from the effect of FLFP on GDP.

The chapter is structured as follows. The next section examines the relationship of female labour force participation to GDP. Section 7.3 extends this examination to the relationship of FLFP to productivity. Section 7.4 discusses how measurement of national welfare might take into account the welfare loss occasioned by increased FLFP. Section 7.5 re-estimates the acute utilisation model developed in Chapters 5 and 6 substituting alternative measures of welfare for GDP. Section 7.6 offers some general reflections on the analysis in the chapter and on its possible implications for other models of health care utilisation and expenditure.

7.2 Relationship of FLFP to GDP

The causal connection between these two variables - FLFP and GDP per capita - is a logical corollorary of models of economic growth and is supported by other studies (Goldin 1986; Klasen and Lamanna 2009). Traditional models of economic growth conceive it as a function of capital and labour, of which female labour is a growing share. More women in paid work contribute to GDP growth, even if they only supply for pay the same care that they previously supplied without pay and informally. There could be the same amount of care and the same amount of activity but in the national accounting sense, there is an increased amount of economic activity.

The relationship between FLFP and GDP per capita has consequences for estimating the model of acute bed utilisation developed in the preceding chapters. This model, when applied to the HMD14 panel employed in Chapter 6 which, over the 17 years from 1990-2006, comprises 234 observations for 14 OECD countries, is estimated by two-way fixed effects as:

$$\text{Acute bed days p.c.} = 0.3 + 0.03\,\text{GDP p.c.}^{***} - 0.04\,\text{percent65}^{**} + 0.49\,\text{percentDecedents}^{**} - 0.01\,\text{FLFP}^{***} + 0.05\,\text{LEBdiff}^{*1} + \beta_i \text{state}_i + \beta_j \text{year}_j$$

$^{*1}p < 0.06$, $^{*}p < 0.05$, $^{**}p < 0.01$, $^{***}p < 0.001$

$R^2 = 0.97$

GDP p.c. = Gross domestic product per capita, constant US dollars(thousands);

percent65 = percentage of population aged 65 and over;

percentDecedents = all deaths in a year as a percentage of population;

FLFP = female labour force participation rate (a proxy for informal care supply);

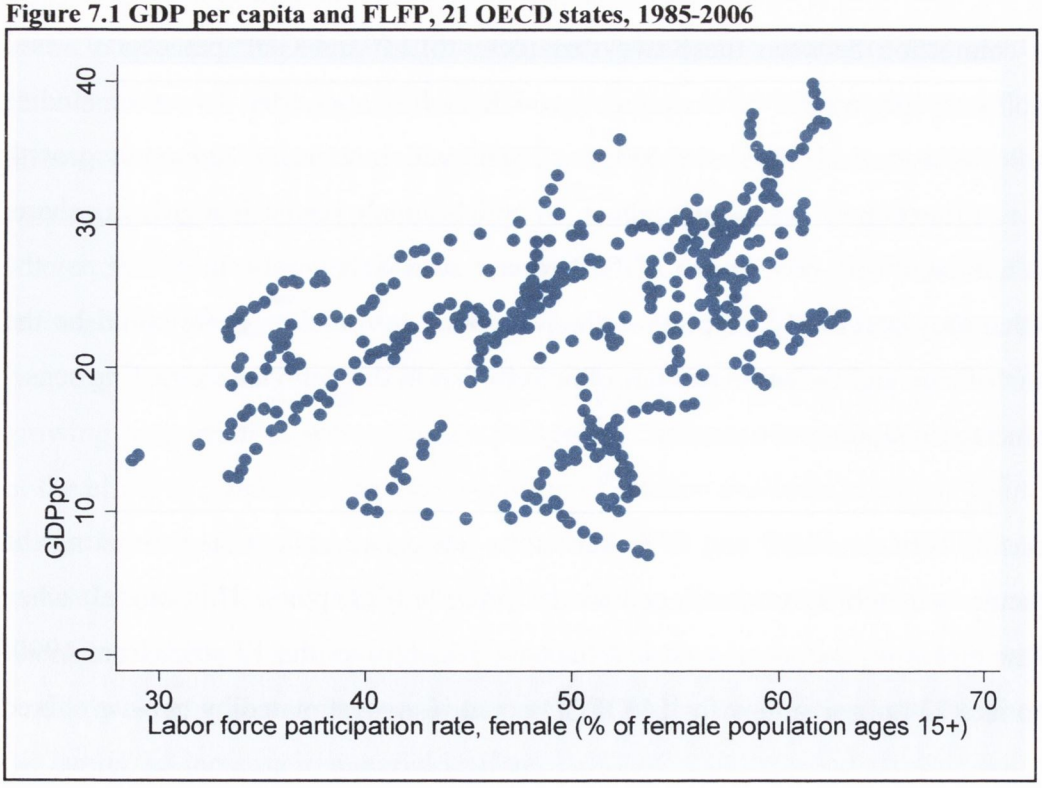
LEBdiff = LEBF − LEBM;

LEBF = Female life expectancy at birth;

LEBM = Male life expectancy at birth

The correlation coefficient of the co-variates GDP p.c. and FLFP in this panel is 0.59, not so high as to render near-collinearity a concern but nonetheless a reasonably strong correlation. Despite the opposing signs of their coefficients in this estimation, their correlation coefficients with the dependent acute bed days per capita variable are both negative; -0.56 for GDP p.c. and -0.40 for FLFP. Their positive correlation to one another is demonstrated for a larger panel over a longer period in Figure 7.1.

Figure 7.1 GDP per capita and FLFP, 21 OECD states, 1985-2006



The premise that FLFP and GDP p.c. are not independent covariates is supported by an estimation employing the same panel and methodology which yields:

$$\text{GDPpc} = 17.5 + 0.21\,\text{FLFP}^{***} + ... + \beta_i \text{state}_i + \beta_j \text{year}_j$$

This is a reductive model for the drivers of GDP, more typically represented as a function of capital, labour and technology/knowledge which enhances the productivity of both capital and labour. While estimation of the coefficient of FLFP is likely to differ in a more comprehensive model, the evidence and logical premise for a strong link between the GDP measure and FLFP remain. In Chapter 4 I discussed the theoretical and methodological issues that arise when estimating a system of simultaneous equations in which a regressor can be expressed as a function of another regressor, as is the case of GDP and FLFP as regressors in an acute utilisation model. Although described as an instance of endogeneity in traditional economics, this form of simultaneity does not necessarily meet the econometric definition of endogeneity, which is the correlation of a regressor with the error term of the equation, in which it appears as a right-hand side variable. The simplified system of simultaneous equations is:

$$Y = \beta_1 X + \beta_2 Z + \beta_3 Q + \nu \qquad (13)$$

$$X = \gamma_1 Z + \gamma_2 W + \mu \qquad (14)$$

Where:

Y = Acute bed days per capita (endogenous)
X = GDP per capita (endogenous)
Z = Female labour force participation (exogenous)
Q = exogenous variables
W = exogenous variables

Chapter 4 demonstrated that by substitution:

$$Y = (\beta_1 \gamma_1 + \beta_2) Z + \beta_1 \gamma_2 W + \beta_3 Q + \beta_1 \mu + \nu \qquad (15)$$

The coefficient for Z in the equation (15) shows the total effect of Z (female labour force participation) on Y (acute bed days per capita). This combines β_2 , the coefficient of Z in equation (13), which is the direct effect of female labour force participation on acute bed days; and the indirect effect through GDP given by $\beta_1\gamma_1$. Unless this indirect effect can be estimated, the full effect of FLFP in the acute model cannot be estimated, and by extension, the effect of GDP incorporates some of the effect of FLFP.

The hypothesis in this chapter is that GDP is a mediating variable of the effect of female labour force participation on acute bed utilisation. The term "mediation" is used to describe such relationships in the psychology literature (Baron and Kenny, 1986). While the relationship between FLFP and GDP can be discussed in terms of a system of recursive equations, alternatively such relationships are understood in terms of path analysis (Baron and Kenny, 1986; Kam and Franzese, 2007). A number of tests of the significance of mediating hypotheses have been developed. The hypothesis to be tested is that "an intervening variable (mediator) transmits the effect of an independent variable to a dependent variable" (McKinnon et al, 2002: 83). The hypothesis that GDP is a mediating variable in the relationship of FLFP to acute bed utilisation is confirmed when tested by applying the Sobel-Goodman test, which indicates that 62% of the effect of female labour force participation on acute bed utilisation is mediated by GDP. The test requires a sequence of pooled OLS regressions of the series of relationships in the path analysis. An estimate of the intervening variable effect is calculated as the product of the coefficient of the independent variable, when regressed on the mediating variable, and the coefficient of the mediating variable, when regressed on the dependent variable in a regression which includes the independent variable. The significance of the intervening variable effect is then calculated by a t-test.

7.3 Relationship of female labour force participation to productivity

A method that could facilitate separating the effect of FLFP from GDP might be to de-couple the element of GDP that represents productivity, or GDP per employed worker, from the element that reflects the employment of more workers. The World Bank's World Development Indicators (WDI) database supplies in addition to female labour force

participation rates: total labour force numbers, which include both the employed and the unemployed; and unemployment rates, expressed as a percentage of total labour force. From these data I calculated an employed labour force series, which enabled me to convert GDP p.c. to GDP per employed worker (GDPpew). These two measures of GDP are highly correlated with each other with a correlation coefficient of 0.90 in the panel of 14 states (now reduced to 280 observations due to more limited data availability). However the productivity measure has a much lower correlation coefficient than GDPpc with FLFP at 0.28. This suggests that by employing GDPpew, FLFP and GDP might be de-coupled. I discovered that this is not the case, however, because female labour force participation also has a significant effect on productivity. The relationship of GDPpew to FLFP for 21 states over a 22 year period is illustrated in Figure 7.2. While clearly heteroscedastic (i.e. with countries' showing differing error variances), examination of these data for the 14 states in the earlier panel reveals a pattern for many countries of a positive relationship of female labour force participation to productivity at lower levels of participation eventually reaching a plateau or shifting to an inverse relationship at higher levels (Chapter 7 Appendix Figures 7.10 - 7.12).

Figure 7.2 GDP per employed worker and FLFP, 21 OECD states, 1985-2006

These observed effects suggest a quadratic expression might best fit the relationship of participation to productivity, as expressed by:

$$\text{GDPpew} = \beta_1 + \beta_2\text{FLFP} + \beta_3\text{FLFP}^2 .... + \beta_i\text{state}_i + \beta_j\text{year}_j$$

Estimating this model for the panel of 14 states over the years 1985-2006 suggests that up to a female labour force participation rate of 30.5%, women's participation is an upward driver of productivity. Once the participation rate increases beyond this point there is a downward effect on productivity with the downward effect canceling the upward contribution when participation exceeds 61% (Table 7.1). Country-specific and time effects vary this relationship but the curve is not incompatible with the data for the larger dataset in Figure 7.2.

While this is also a reductive model, the mechanism it describes is inherently logical. Female earnings are typically on average lower than male earnings. The measure of productivity, GDP per employed worker, derives from GDP which values activity according to how it is reimbursed. It might be expected that when more women are gainfully employed, productivity should appear lower; whereas when fewer women are gainfully employed, productivity should appear higher. Moreover, when more women are employed, more care is supplied formally by paid care workers in a low-paid sector, a further reason for productivity to appear lower. Conversely, when fewer women are gainfully employed, more care is supplied informally by unpaid workers thereby reducing the ranks of low paid workers and increasing measured national productivity. A further contributory explanation for this association between rising FLFP and reduced productivity may be supplied by increased part-time working by women, discussed by Yoo et al (2004) and recognised in the analysis in Chapter 6 as a potential factor underlying the diminishing returns relationship of FLFP to formal long-term care utilisation.

Table 7.1 Productivity and female labour force participation, HMD14 panel, alternative years; dependent variable: GDP per employed worker

	1990-2006	1985-2006
FLFP	1.33***	0.61*
	[0.001]	[0.022]
FLFP-squared	-0.02***	-0.01***
	[0.000]	[0.000]
Constant	34.42***	49.49***
	[0.001]	[0.000]
Observations	230	280
R^2	0.97	0.95

*p-values in brackets: * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$; estimation by PCSE, country and year dummies not shown. In a quadratic, the point at which the negative effect outweighs the positive is given by -b/a, where b is the coefficient for FLFP, and a is the coefficient for FLFP-squared. The point at which the positive effect of FLFP becomes negative is given by -b/2a. These values for FLFP are: -b/a=66.5% and -b/2a= 33.25% in the 1st column; and -b/a= 61% and -b/2a= 30.5% in the 2nd.*

The gap between productivity and GDP per capita narrows as female labour force participation increases. There is a strong inverse correlation between the ratio of productivity to national income and FLFP (Figure 7.3, correlation coefficient: -0.89). This is immediately explicable: when a higher proportion of the population is gainfully employed, the employed labour force converges towards the population, so that GDP per employed worker will converge to GDP per capita. The relationship of the inverse of this ratio to FLFP comes close to an identity. The inverse can be reduced to the employed labour force divided by total population. FLFP is the female labour force (employed and unemployed) divided by the adult female population. The two measures show a predictably close correspondence (Figure 7.4).

$$\frac{\text{Productivity}}{\text{national income}} = \frac{\text{GDPpew}}{\text{GDPpc}}$$

$$\text{GDPpew} = \text{GDP per employed worker} = \frac{\text{GDP}}{\text{employed labour force}}$$

$$\text{GDPpc} = \text{GDP per capita} = \frac{\text{GDP}}{\text{total population}}$$

$$\Longrightarrow \frac{\text{Productivity}}{\text{national income}} = \frac{\text{GDP}}{\text{employed labour force}} \div \frac{\text{GDP}}{\text{total population}}$$

$$= \frac{\text{GDP}}{\text{employed labour force}} \times \frac{\text{total population}}{\text{GDP}}$$

$$\Longrightarrow \frac{\text{Productivity}}{\text{national income}} = \frac{\text{total population}}{\text{employed labour force}}$$

$$\Longrightarrow \frac{\text{national income}}{\text{productivity}} = \frac{\text{employed labour force}}{\text{total population}}$$

Figure 7.3

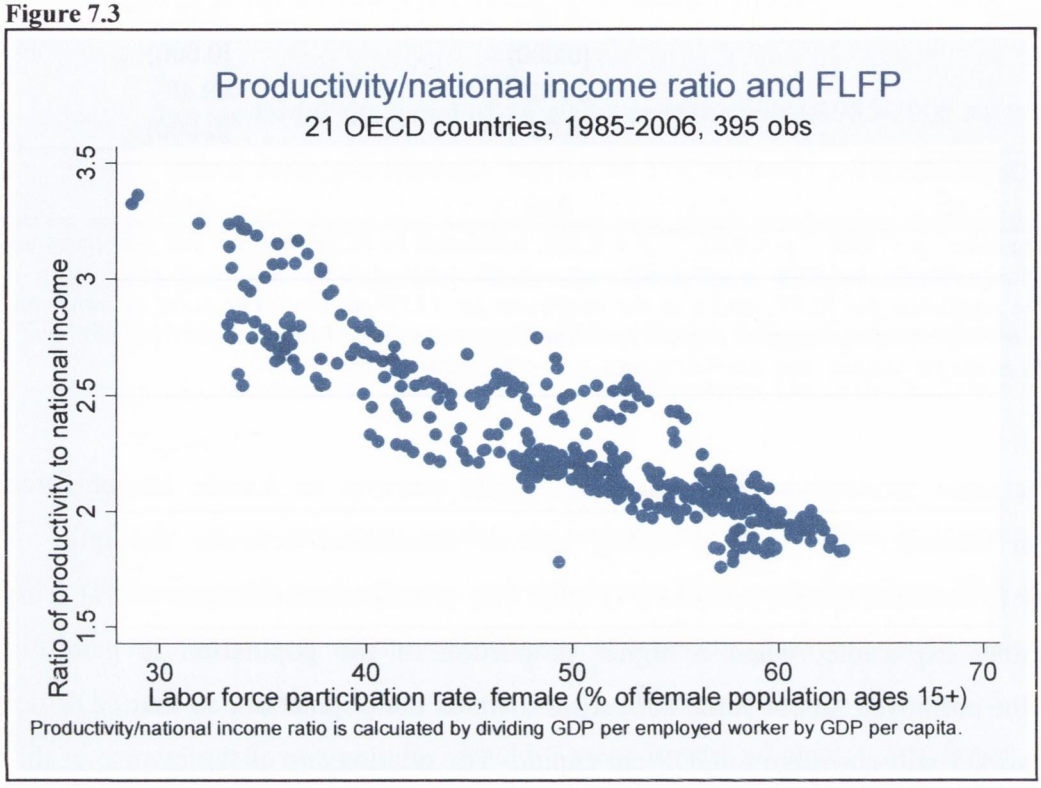
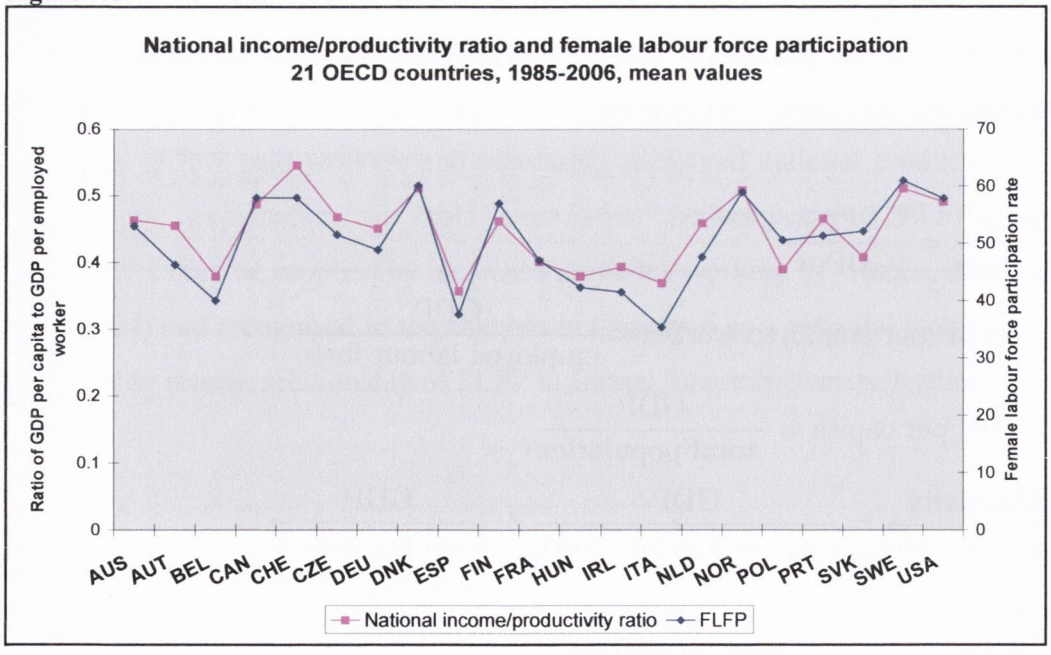


Figure 7.4



This examination of the relationship of FLFP to GDP per capita and productivity indicates that substituting productivity for GDP per capita will not circumvent the challenge of

estimating a measure of GDP with FLFP in the same equation. This attribute of female participation may be gender specific. If the labour force is separated by gender into two variables, it appears that the male labour force is not a driver of productivity whereas the female labour force is. The World Bank's WDI database supplies a series for the female labour force as a percentage of the total labour force, which combined with its series for labour force numbers allows the generation of the variables:

$$\text{FLFpop} = \frac{\text{Female labour force}}{\text{Population}}$$

$$\text{MLFpop} = \frac{\text{Male labour force}}{\text{Population}}$$

Modelling productivity as a function of these two variables by two-way fixed effects for the 14-country panel over the years 1985-2006 shows productivity as either entirely inversely related or at some point becoming inversely related to growth in the female labour force whereas growth in the male labour force is not significant. The results for the FLFpop variable, in which the female labour force is expressed as a proportion of total population, are compatible with the results for the FLFP variable, in which the female labour force is expressed as a proportion of the adult female population. A linear specification shows a significant inverse coefficient for the female labour force whereas a quadratic specification shows an initially positive relationship reaching a plateau and becoming inverse (Table 7.2).

The observation that increased labour force participation has been accompanied by reduced productivity in industrialized countries is not new (Beaudry and Collard 2002); nor is it new to perceive the increase in female labour force participation as playing an important role in this development (Boeri et al. 2005; Dew-Becker and Gordon 2008). A partial explanation for the effect of female participation on productivity is provided by Baumol's "cost disease" which he identified in labour-intensive sectors of the economy such as health and education, in which "production processes ...are inconsistent with standardization" and "quality is, or at least is believed to be, inescapably correlated with the amount of human labor devoted to their production" (Baumol 1993).

Table 7.2 Productivity and the labour force, gender differences, HMD14 panel, 1958-2006; dependent variable: GDP per employed worker

	Model One	Model Two	Model Three
Female LF/population	-56.85**	527.14***	537.93***
	[0.008]	[0.000]	[0.000]
Male LF/ population	53.56	15.54	-299.13
	[0.154]	[0.601]	[0.128]
(FLF/pop.)-squared		-1499.28***	-1524.06***
		[0.000]	[0.000]
(MLF/pop.)-squared			578.19
			[0.111]
Constant	50.92***	7.45	49.01
	[0.000]	[0.421]	[0.084]
Observations	280	280	280
R^2	0.96	0.96	0.97

p-values in brackets: * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$; *estimation by PCSE, country and year dummies not shown.*

The movement from informally supplied care in the community to formally supplied care by reimbursed women workers adds to the categories of economic activity that Baumol identified as having limited scope for productivity growth and in so doing reduces overall productivity. This observation does not only apply to long-term care. Care in acute hospitals was a largely 20th century development, which substituted for care of the sick in their own homes typically by female family members (Mpinga et al. 2006). Whereas the earlier movement of women into the paid labour force formalised production processes such as baking and dress-making (Goldin 1986) that are amenable to mechanisation and standardisation, and have been associated with rising productivity, the absorption of a higher proportion of women into the labour market has necessitated the formalisation of care - with lower potential for productivity gains. This sequence of consequences of rising female labour force participation is compatible with a quadratic specification of the relationship of productivity to female participation.

However, the limitation of the measurement of welfare to reimbursed activities may render opaque the true effect of women's participation on productivity. Whereas a woman engaged solely in home duties is available to care for her ageing parent, a woman care worker (community care attendant or home help) or hospital nurse will care for more than one recipient. This formalisation of care represents a productivity gain but because the former, less productive activity was not measured as a component of GDP or material

welfare, the subsequent increase in labour productivity and addition to welfare is paradoxically recorded as a productivity decline.

7.4 From productivity to a new measure of national income

The challenge remains to find a way to estimate the effect of both reduced numbers of informal carers (proxied by FLFP) and changes in national welfare. It is as a measurement of welfare that GDPpc is typically included in the health spending model and has been included in the acute bed utilisation model in this analysis. As Sen pointed out:

> "there is little doubt that the significance that is attached to comparisons of real national income depends greatly on their implicit welfare content....The welfare theory of real national income comparisons is, however, incomplete in several important ways...Perhaps the most serious difficulty is with the treatment of income distribution." (Sen 1976: 388)

Sen suggested that real national income comparisons should be weighted to take into account distribution of income within countries, employing distributionally-adjusted national income as a comparator. A further complexity is that comparisons of national income involve different groups of people and different times:

> "Are we comparing the welfare of one nation with that of another or the welfare of one nation with what the welfare of that nation *would have been* if it were placed 'in the position of' the other nation?" (Sen 1976: 389)

Sen's argument for measures of national welfare weighted according to distribution finds echoes in the literature on female labour force participation. Carter made a case for "inclusion of child care and household maintenance into an index of material well-being" which would include goods and services provided by women in and outside of the market (Carter 1986); Beneria advocated "a concept of economic activity related to human welfare rather than economic growth and accumulation" (Beneria 1981); other authors have suggested that measurement of national welfare should aggregate household welfare in a social welfare function that values leisure as well as income (Boeri et al. 2005). The erosion of social capital has been linked to increased female labour force participation (Bartolini and Bonatti 2008).

Quah (1989) reviewed 20 empirical studies on housework evaluation in North America, Europe and Asia, which attempted to include non-marketed activities in the measurement of national income/GNP. This literature was a product of "the new home economics" which developed the idea of the household as both producer and consumer (Gronau, 1973; Netten and Davies, 1990). Netten and Davies (1990) formulated the theory of the "social production of welfare", reviewed in Chapter 2, which explicitly recognises the delivery of informal care as a source of welfare or utility. Although the studies reviewed by Quah (1989) recognise the deficiency of Gross National Product as a measure of national production when it excludes home production, wide variability in their estimates of the value of household production as a share of GNP led Quah to conclude that the "serious questions of what is to be measured and how are still far from being resolved" (Quah, 1989).

In a discussion of data for development economics, Deaton observed that the decision of what values to impute to non-monetized transactions in measures of consumption or income is "largely arbitrary":

> "By convention most home-produced goods are included, but most home produced services are excluded. Meat and vegetables from the home farm are added to both consumption and income, but no similar allowances are made for the value of work in the home, child-minding, or the preparation of meals. While there is a good deal of agreement on the desirability of including these services, and while it is clear that there are systematic biases from failing to do so ...there is little agreement on how to value time." (Deaton 1995: 1801)

Since the intention of including GDP per capita in the acute utilisation model is to provide a control for national welfare, this analysis suggests that it would be preferable to employ a measure of national welfare weighted according to female labour force participation. An abstract example illustrates the proposition. Let us imagine that country A produces the same national income as is produced by country B. In each country that income is shared across identically sized populations, generating an equal GDP p.c. But in country A there is 35% female labour force participation and in country B 60% female labour force participation. Has not country A greater national welfare? In particular, if countries A and B have ageing populations with equal numbers of frail older people requiring care, country

A has greater potential resources to devote to their care: 65% of adult women as potential informal carers compared to 40% in country B; while both countries have the same national income from which to allocate a budget for the provision of formal care.

A dissenter might argue that in country B women may be more empowered whereas in country A, they are dependent and underemployed; and that while income may be shared equally in the two countries, work and social participation may not. In most countries preferences for female participation are much higher than actual participation rates (Jaumotte 2004), so the welfare of the citizens in country A may be diminished by a denial of choice of occupation. Furthermore, the value of women's availability as informal carers may differ depending on the demand for informal care within countries. Notwithstanding these reservations, the significance of increased female labour force participation, in particular as an upward driver of long-term care utilisation, necessitates some recognition of the welfare effect on a country of the availability of non-participating women as informal carers.

In this analysis therefore I weight national income by female labour force participation and employ this measure within the acute utilisation model. Variants of such a measure are suggested by the relationship between measures of income, participation and productivity. In an analysis of the drivers of health and long-term care expenditures, the OECD formulates these relationships as:

$$\frac{Y}{N} = \frac{Y}{L} \times \frac{L}{N}$$

Y = Real income; N = Population; L = Labour force;

$\frac{Y}{L}$ = Labour productivity, assumed exogenous;

$\frac{L}{N}$ = Labour force as proportion population, assumed exogenous

(OECD, 2006: 15)

This formulation can be restated as:

$$\text{GDP p.c.} = \text{GDP per worker} \times \frac{\text{Labour force}}{\text{population}}$$

This formulation defines productivity as GDP per labour force member (OECD 2006), whereas the analysis above defined productivity as GDP per employed labour force member. A series of approximate relationships as opposed to equations emerge:

$$\text{GDPp.c.} \approxeq \text{GDP per employed worker} \times \frac{\text{Labour force}}{\text{population}}$$

$$\implies \text{GDP per employed worker} \approxeq \text{GDP p.c.} \div \frac{\text{Labour force}}{\text{population}}$$

As discussed above, FLFP closely mirrors overall labour force participation, so we can substitute it to generate a new welfare index, which approximates to the productivity measure:

$$\implies \text{GDP per employed worker} \approxeq \text{GDP p.c.} \div \text{FLFP}$$

$$\implies \text{GDP per employed worker} \approxeq \text{GDP p.c.} \div \frac{1}{\text{availability of female carers}}$$

$$\implies \text{GDP per employed worker} \approxeq \text{GDP p.c.} \times \text{availability of female carers}$$

The productivity variable or the closely corresponding (although not identical) variable which is the product of GDP per capita and the inverse of female labour force participation are potential measures of national income weighted by FLFP. Introducing such measures in the acute utilisation model will capture the joint effects of reduced availability of carers and increased national income but not their separate effects. A possible methodology now emerges to isolate the impact on acute utilisation of FLFP from the effect of changes in national welfare by comparing models employing GDP per capita and either GDPpew or this new welfare index.

I investigated the possibility of employing a further variant of this welfare index which would include men who do not participate in the labour force and are therefore available to provide informal care. The WDI supplies a measure for male participation in the labour force. In general, the WDI database cautions that definitions of labour force and unemployment differ by country. By comparing the WDI measure of non-participating men to the detailed Irish statistics for men and women by principal economic status, it was apparent that whereas 60-70% of women who were not participating in the labour force (not at work/unemployed) were in a category described as being "engaged in home duties",

only 1-2% of non-participating men were in this category. Men also comprised approximately 1% of all people engaged in home duties (CSO). On this evidence the measure for non-participating men is not a good proxy for the availability of informal male carers. I instead generated a further variant of the welfare index employing an alternative measure of the availability of female carers expressing non-participating women as a proportion of total population, whereas FLFP and its inverse express female participation and non-participation as a proportion of all women aged 15 and over. In this analysis I therefore employ two measures of carer availability:

$$\text{Availability of female carers (AVC)} = 100 - \text{FLFP};$$

$$\text{Availability of female carers as proportion of population (AVFCP)} = \frac{(\text{NPFLF})}{\text{Population}} \times 100$$

Where:

NPFLF = Non-participating female labour force, i.e. women aged 15 and over and not in the paid workforce.

From these measures of carer availability I generated two measures of national income weighted by carer availability:

$$\text{GDPAVC} = \text{GDPpc} \times \text{AVC};$$

$$\text{GDPAVFCP} = \text{GDPpc} \times \text{AVFCP}$$

The AVFCP measure is broader because by capturing the ratio of available carers to total population, it represents a dependency ratio (i.e. relationship of available potential carers to people with potential care needs - the young and the old). The AVC measure expresses available female carers only as a percentage of the adult female population. In the 17 countries in the HMD17 panel GDP per capita shows quite a degree of variability in its rate of change over the years 1985-2006, whereas the slopes for the welfare indices are much less steep (Figure 7.5). Mean values for GDP per capita are more variable than for the welfare indices and to some extent shadow variability in FLFP (Figures 7.6 and 7.7). There is a high degree of correlation between the productivity measure and the welfare indices (Figures 7.8 and 7.9). These alternative measures of national welfare are remarkably even across countries.

Figure 7.5

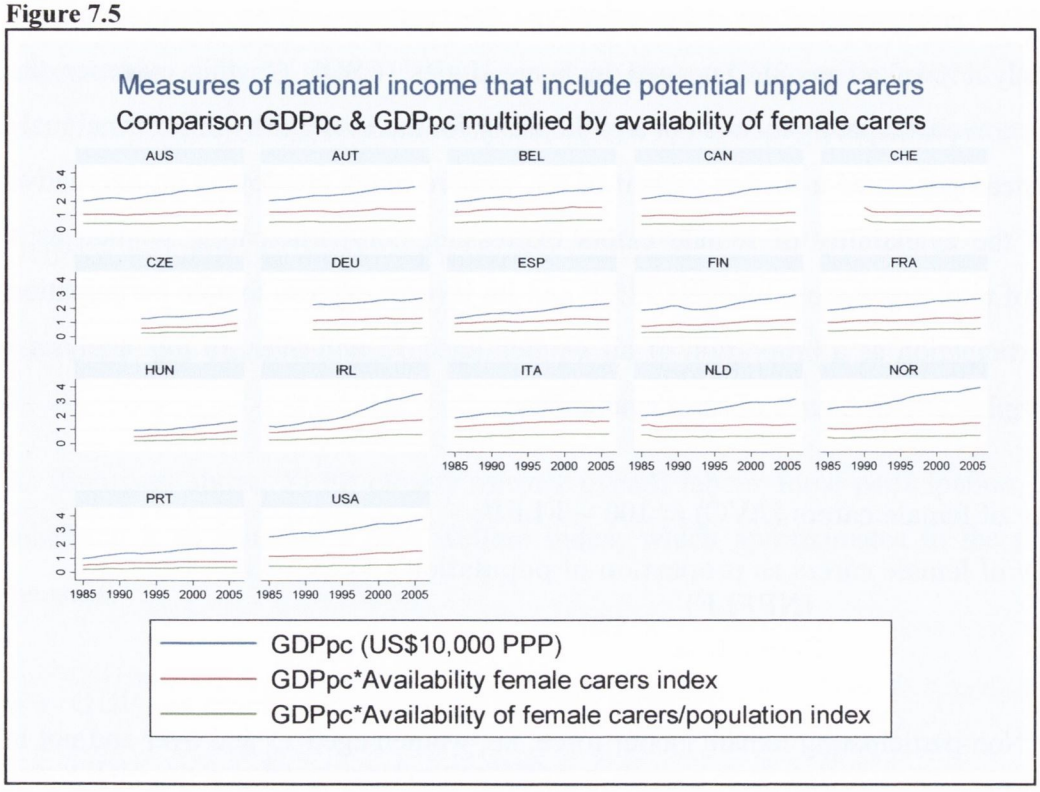


Figure 7.6

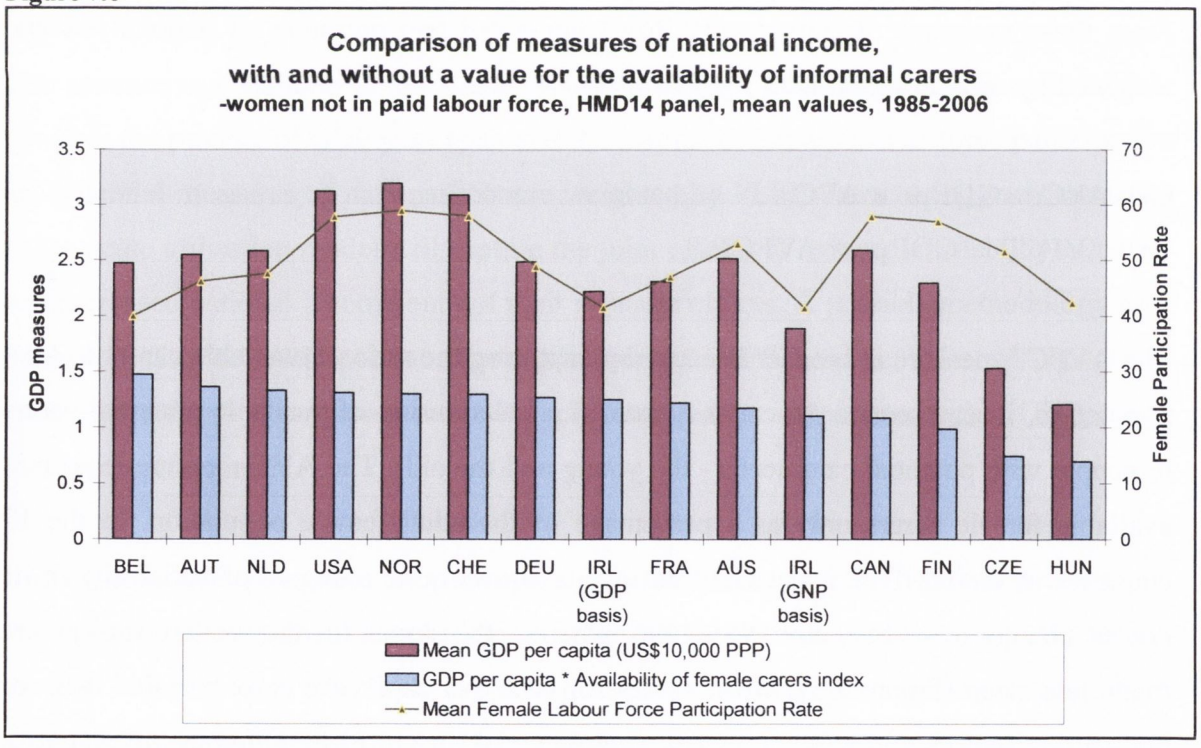
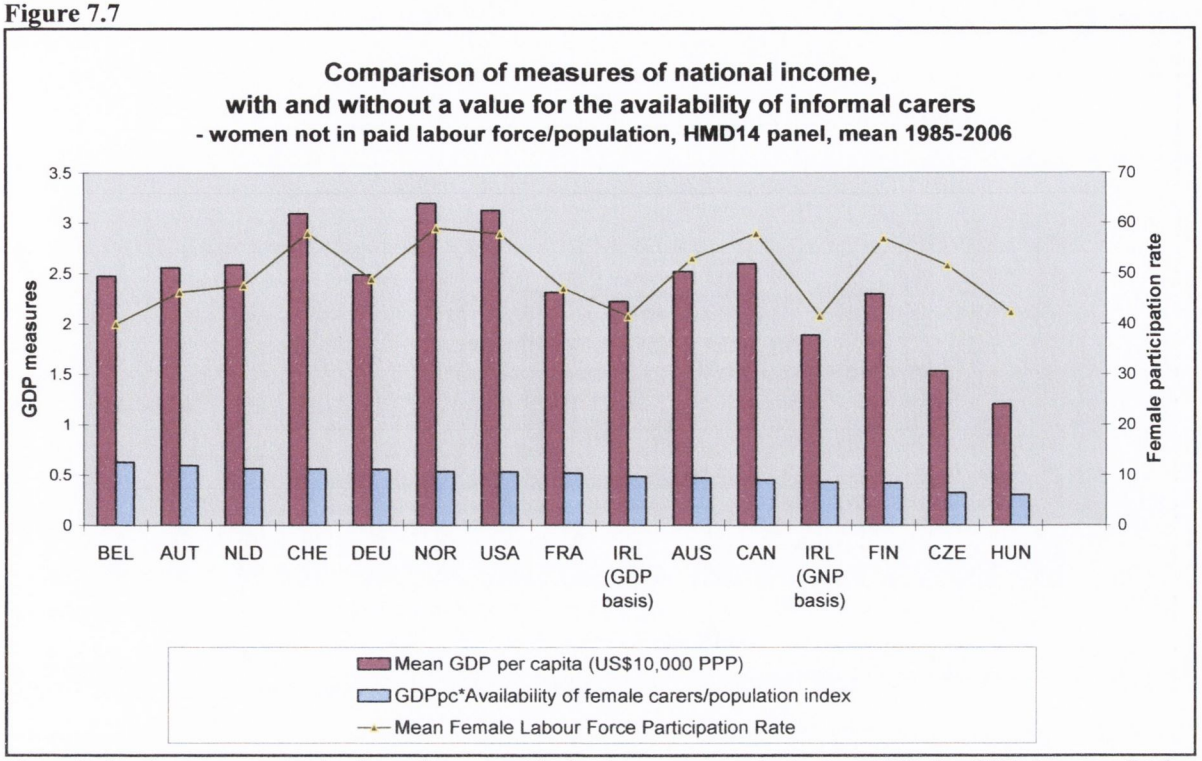


Figure 7.7



Note: Ireland appears twice in these figures, with the lower entry substituting GNP for GDP because Irish GDP is an inflated measure of national income due to the high rate of profit repatriation by multinational companies which have operations in Ireland but are based elsewhere.

Figure 7.8

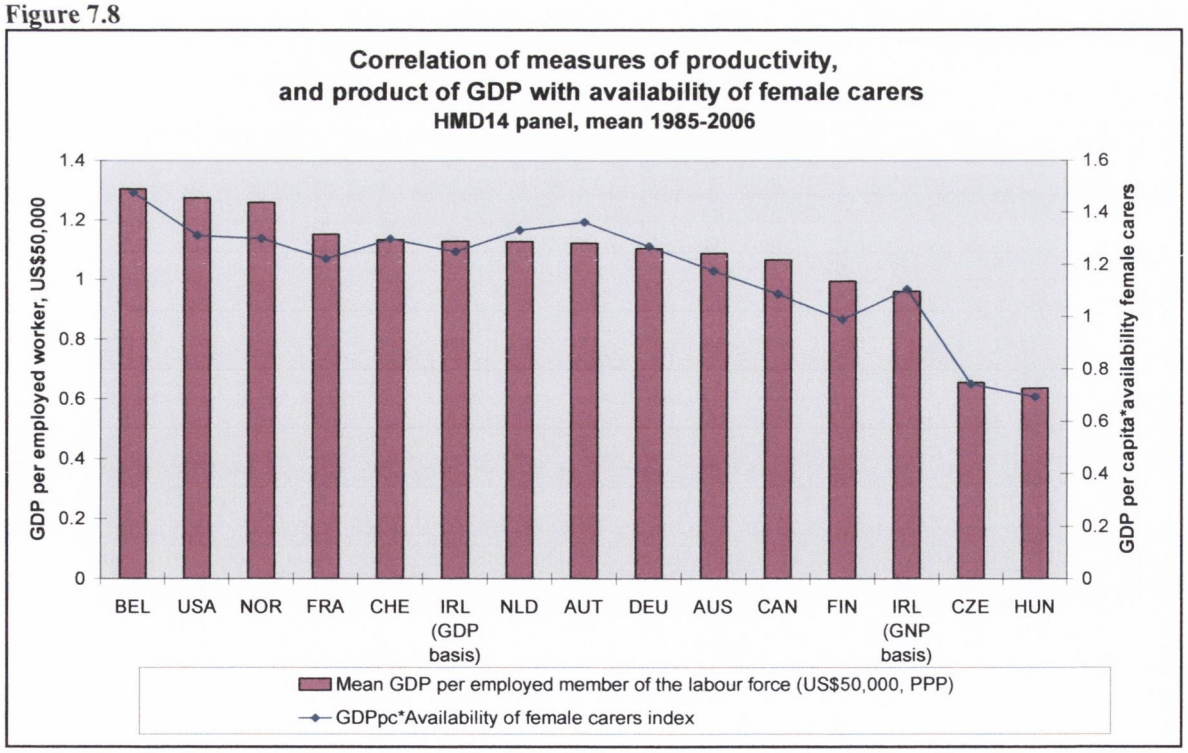
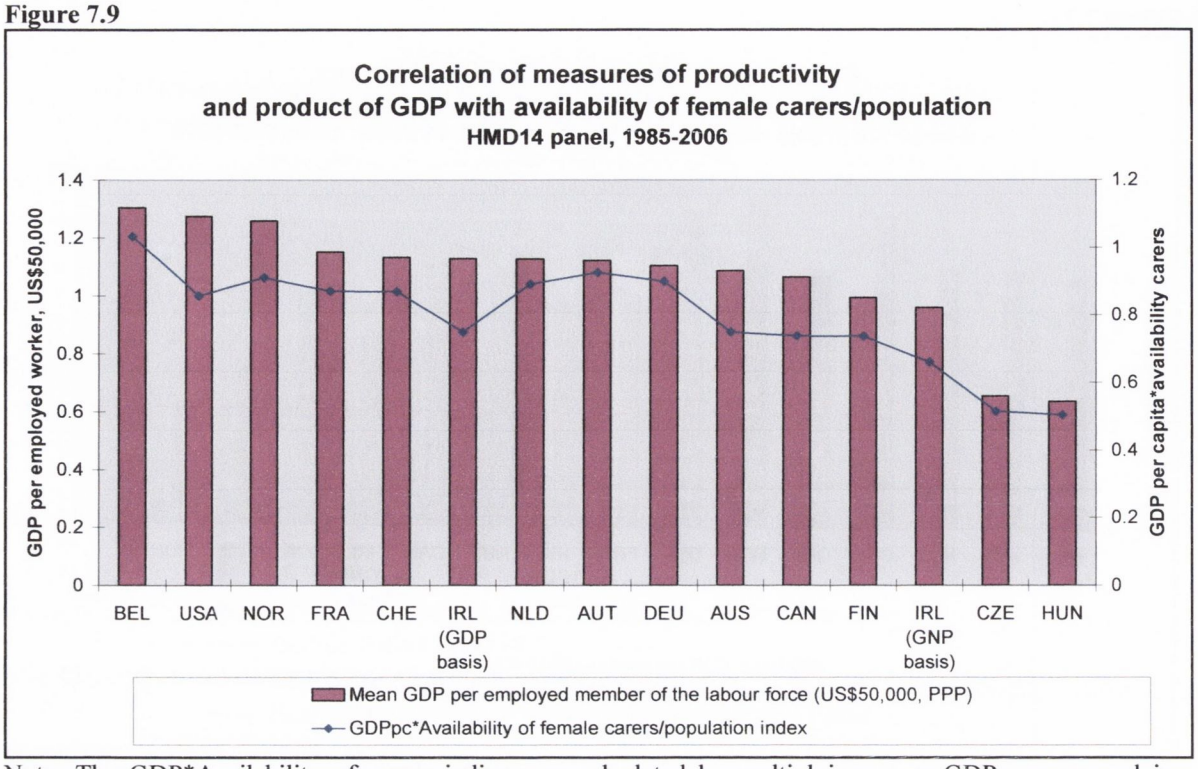


Figure 7.9



Note: The GDP*Availability of carers indices are calculated by multiplying mean GDPpc expressed in US$10,000 PPP by the availability of carers expressed as percentages, and dividing the product by 100, in order to reduce their scales to facilitate comparison with GDPpc and GDPpew in Figures 7.5 to 7.9.

Before employing these welfare indices in the acute utilisation model, it is important to be clear about what they are measuring. For a panel extending over the years 1 to j, GDP per capita in the final year can be computed as:

$$GDP_j = GDP_1 \times (1 + i_{GDP})^j$$

Where $i_{GDP} =$ the annual average rate of change in GDP

The percentage change in the welfare index at the end of the period is a function of the relative rates of change of its two component variables over the period. This is derived as follows:

$$\delta GDPAVC = \frac{(GDP_j \times AVC_j) - (GDP_1 \times AVC_1))}{(GDP_1 \times AVC_1)}$$

$$= \frac{(GDP_j \times AVC_j)}{(GDP_1 \times AVC_1)} - 1$$

Substituting the equation for GDP in the final year and the equivalent for AVC:

$$\implies \delta GDPAVC = (\frac{(GDP_1 \times (1+i_{GDP})^j) \times (AVC_1 \times (1+i_{AVC})^j)}{(GDP_1 \times AVC_1)}) - 1$$

$$\implies \delta GDPAVC = ((1+i_{GDP})^j \times (1+i_{AVC})^j) - 1$$

This formula for the percentage change in the welfare index is a function of the annual average rates of change of GDP per capita and AVC, each raised to the power of the number of years over which the change is being measured. In the countries in this analysis these rates typically (but not always) move in opposite directions. When this is so, if the rate of positive change of GDP per capita exceeds the negative change in AVC, the welfare index increases in percentage terms; and vice versa. If the opposing rates of change are the same magnitude, the welfare index changes in the direction of change in the reducing variable. This mechanism is the same for the GDPAVFCP variable.

Change in either welfare index is a measurement of a welfare change. We know that increased FLFP adds to GDP but beyond a certain point, this is at a decreasing rate because of the quadratic relationship of FLFP to productivity. We know that reduced AVC is the inverse of FLFP. If the GDPAVC variable is not showing a percentage increase, we can say that the relationship of the change in AVC to the change in GDP is at a point where the loss in carers exceeds the addition to production in proportionate terms. To value those two effects even in caring terms requires knowing the need for care and the costs of care in the formal and informal sectors. The AVFCP welfare index gives some indication of the need for care because it includes a dependency ratio measure. It could be that the loss of carers is still not a net welfare loss because the GDP gained is sufficient to provide more caring than was being provided by the lost carers. It is difficult to factor this calculation into our measure. In a sense the test of the efficacy of the measure is in how it relates to other measures of caring such as acute or long-term care utilisation.

When the GDPAVC welfare index is included in the model, it introduces two effects: one is a measure of welfare, qualified by the effect of increased labour force participation on the availability of informal carers; the second is a measure of the reduction of informal carers, which may be translated into greater or lesser acute utilisation depending on the country and its balance of care and caring infrastructure. When the GDPAVFCP variable

is substituted, this adds the further dimension of relating changes in the availability of carers of working age to the potential need for care (of both children and older people).

7.5 Alternative measures of welfare in an acute utilisation model

Regression analysis of the acute utilisation model including alternative welfare measures and comparing them to the model including GDP per capita with and without FLFP confirms the inverse effect of FLFP on acute bed utilisation. I employed the HMD14 panel over the years 1985-2006 to estimate five different models (Table 7.3). The estimates for Models 1 and 2 show that including FLFP as a co-variate with GDPpc (Model 2) when compared to excluding FLFP (Model 1) has very little effect on either the country or year coefficients. Including FLFP does, however, increase the significance and coefficients of the death and converging life expectancy variables in this panel. (Some of the coefficients and their significance for Model 2 differ slightly from those for the same model in the HMD14 panel in Chapter 6 because the panel in this chapter has fewer observations due to limited availability of some labour force data.)

The three alternative specifications - Models 3, 4 and 5 - substitute for GDPpc and FLFP the variables that mediate changes in GDP by: the effect of changing FLFP/availability of female carers as a proportion of adult women (Model 4); the effect of changing availability of female carers as a proportion of population (Model 5); and the effect of change in the ratio of population to the labour force, since the productivity measure approximates to GDP per capita divided by labour force participation (Model 3). Growth in each of these welfare measures still has a positive and significant effect on acute bed utilisation. Their inclusion improves the significance and increases the coefficient of the decedent variable and, in the cases of Models 3 and 5, increases the coefficient and significance of the converging life expectancy variable. Model 5 includes the broadest weighting of GDP, the product of GDP per capita and the availability of women carers in proportion to overall population. In the models employing these measures age is a significant inverse driver of acute utilisation. If my hypothesis is correct that GDP is an inappropriate measure of welfare in an acute utilisation model and these alternative measures are an improvement, then the increased significance of these other covariates might be regarded as a consequence of the removal of bias in their coefficients caused by the inappropriate inclusion of GDP in Models (1) and (2), which could be regarded as a form of

measurement error. The growth in significance of the age and converging life expectancy variables suggests that substituting these measures of welfare mediated by participation rates in place of GDP is enabling a clearer identification of the factors affecting acute utilisation in these countries.

The unobserved country-specific and time effects, captured in the coefficients of the country and year dummy variables, differ markedly between the models. The unobserved effects are in general greatest in Model 1 for individual countries and over time. This model does not take female labour force participation into account. The effects are marginally lower in Model 2, in which FLFP simultaneously drives GDPpc and acute utilisation. Inclusion of the mediated measures of welfare explains a substantial portion of the unobserved effects in the first two models. This diminution in unobserved effects occurs to the greatest degree in Model 5, which employs the broadest weighting of national welfare according to availability of female carers and potential demand for care. In Model 5 the unobserved time effect reduces acute utilisation in 2006 by 0.41 days compared to 1985 whereas in Model 1, the unexplained reduction is 0.72 days. Divergence between countries due to unobserved country-specific factors is also substantially reduced.

These effects are most readily understood by comparing the time effects in Models 1 and 4. In Model 1, there is no variable to capture separately changes in female labour force participation. GDP, including within it the effect of FLFP increases, is an upward driver of acute utilisation but a significant unexplained factor is driving down acute utilisation over time. In Model 4 the welfare index is the product of GDP per capita and the availability of female carers, with GDPpc reduced in proportion to their reduction. By applying the estimated coefficients in the models to the change in mean values of the variables across the panel and over the years 1985 to 2006, the predicted effect on mean acute bed days of the co-variates can be compared (Table 7.4). Three major changes are evident between Models 1 and 4:

(i) The new measure of welfare in Model 4, which is GDP adjusted for the loss of informal carers due to rising FLFP, increases acute bed days per capita by 0.12 days compared to an increase of 0.29 days attributed to GDP in Model 1. This reduction in the effect of increased national welfare on acute bed days confirms

Table 7.3 Acute utilisation model, varying income & participation measures, HMD14 panel, 1985-2006, dependent variable: Acute bed days per capita

Model	1	2	3	4	5
GDPpc	0.03***	0.03***			
	[0.000]	[0.000]			
GDPpew			0.01***		
			[0.000]		
GDPAVC				0.0005***	
				[0.000]	
GDPAVFCP					0.0007***
					[0.000]
FLFP		-0.01**			
		[0.003]			
percent65	-0.01	-0.01	-0.03**	-0.04***	-0.05***
	[0.384]	[0.350]	[0.004]	[0.000]	[0.000]
percentDecedents	0.28	0.31*	0.44**	0.38*	0.34*
	[0.071]	[0.036]	[0.007]	[0.014]	[0.026]
LEBdiff	0.04	0.05*	0.06*	0.04	0.06*
	[0.074]	[0.048]	[0.011]	[0.065]	[0.023]
AUS	0.52***	0.52***	0.51***	0.42***	0.39***
AUT	1.40***	1.34***	1.38***	1.29***	1.30***
BEL	0.74***	0.63***	0.58***	0.57***	0.61***
CAN	0.60***	0.64***	0.62***	0.57***	0.52***
CHE	0.79***	0.79***	0.92***	0.83***	0.82***
CZE	1.50***	1.53***	1.46***	1.32***	1.20***
DEU	1.39***	1.35***	1.38***	1.31***	1.30***
FIN	0.42***	0.45***	0.39***	0.39***	0.32***
FRA	0.63***	0.58***	0.52***	0.52***	0.50***
HUN	1.36***	1.32***	1.20***	1.13***	1.00***
IRL	0.42***	0.35***	0.28***	0.19***	0.19***
NLD	0.38***	0.34***	0.37***	0.25***	0.25***
NOR	0.27***	0.27***	0.34***	0.36***	0.39***
1997	-0.47***	-0.46***	-0.42***	-0.35***	-0.30***
1998	-0.52***	-0.51***	-0.46***	-0.39***	-0.33***
1999	-0.57***	-0.55***	-0.49***	-0.42***	-0.36***
2000	-0.59***	-0.57***	-0.49***	-0.43***	-0.36***
2001	-0.61***	-0.60***	-0.51***	-0.45***	-0.37***
2002	-0.61***	-0.60***	-0.51***	-0.44***	-0.37***
2003	-0.65***	-0.63***	-0.54***	-0.47***	-0.40***
2004	-0.66***	-0.64***	-0.55***	-0.47***	-0.39***
2005	-0.69***	-0.68***	-0.57***	-0.49***	-0.41***
2006	-0.72***	-0.71***	-0.59***	-0.51***	-0.41***
Constant	0.03	0.23	-0.09	0.34	0.62*
	[0.930]	[0.393]	[0.781]	[0.181]	[0.015]
Observations	280	280	280	280	280
R^2	0.96	0.96	0.96	0.96	0.96

p-values in brackets: * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$; estimation by PCSE, earlier year dummies omitted. Omitted year in regression is 1985, omitted state is USA.

that the effect of increased FLFP and the consequent loss of informal carers - here incorporated in the welfare measure - is to *reduce* acute bed utilisation;

(ii) Increased effect on acute bed days of the age and death variables: the combined effect of the age, death and converging life expectancy variables reduces acute bed days by 0.10 days in Model 1 and by 0.18 days in Model 4 - a reduction by a further 0.08 bed days - again attributable to the substitution for GDP of a measure of welfare mediated by the availability of carers;

(iii) The unexplained negative time trend in acute bed days falls from 0.72 days in Model 1 to 0.51 days in Model 4 - suggesting that a reduction of 0.21 bed days that Model 1 did not explain has been explained in Model 4, in part because of the mediation of the effect of GDP by weighting it by the reduced availability of female carers, and in part because substitution of this conceptually more appropriate measure of welfare increases the reducing effect on acute bed days of the age and death variables.

In Model 5 compared to Model 1, the unexplained negative time trend is 0.41 compared to 0.72, a reduction of 0.31 days. In Model 5 growing national welfare is an even less significant upward driver of acute bed utilisation than in Model 4 and increases per capita acute bed days by only 0.08 days compared to 0.29 days in Model 1. This measure of welfare which weights GDP with the availability of carers relative to population shows the greatest reducing effect on acute bed utilisation in response to the reduced availability of carers. In Model 5, the age, decedent and converging life expectancy variables have a much more significant downward effect on acute bed utilisation, reducing it by 0.13 additional per capita days in Model 5 compared to Model 1. In Model 5 there is also a much reduced unexplained downward time trend in acute bed utilisation, suggesting that when the measure of national welfare has been mediated by the reduced availability of carers relative to population, the model better explains cross-country trends in acute bed utilisation over time.

Table 7.4 Effect on acute bed days of alternative model specifications

Variables	Absolute change mean value 1985-2006	Effect of mean change in variables on acute bed days, according to differing model estimations				
		Model 1	Model 2	Model 3	Model 4	Model 5
GDP per capita $10,000	9.71	0.29	0.29			
GDP per employed worker $10,000	14.00			0.14		
Welfare index: GDP p.c. by availability of female carers as % adult female pop.	239.95				0.12	
Welfare index: GDP p.c. by availability of female carers as % pop.	109.9					0.08
Female Labour Force Participation Rate %	9.18		-0.09			
Percentage aged 65 & over	2.35	-0.02	-0.02	-0.07	-0.09	-0.12
Deaths as a percentage of population	-0.08	-0.02	-0.03	-0.04	-0.03	-0.03
Difference between male and female life expectancy, years	-1.33	-0.05	-0.07	-0.08	-0.05	-0.08
Dependent variable: Acute bed days per capita	-0.43					
Difference in acute bed days in 2006 compared to 1985 due unobserved time effects		-0.72	-0.71	-0.59	-0.51	-0.41
Effect on acute bed days of GDP, FLFP and welfare measures		0.29	0.20	0.14	0.12	0.08
Reduction in impact of GDP, FLFP and welfare measures on acute bed days compared to Model 1			-0.09	-0.15	-0.17	-0.21
Combined effect of age, death and converging life expectancies on acute bed days		-0.10	-0.12	-0.19	-0.18	-0.23
Increase in combined negative effect of age, death and converging life expectancies compared to Model 1			-0.02	-0.09	-0.08	-0.13
Reduction in negative time trend compared to Model 1			-0.01	-0.13	-0.21	-0.31
Combined effect on acute bed days of all covariates and unobserved time trend		-0.53	-0.63	-0.64	-0.57	-0.56

Note: The changes in the means of the covariates are calculated for the HMD14 panel over the years 1985-2006. Their effect on acute bed days is calculated by multiplying these mean changes by the co-variates' estimated coefficients in the five models, as in Table 3.

The progressively reducing impact of the variants of GDP on acute bed utilisation appears to confirm that the effect of reduced carer availability on utilisation is negative. Conversely, when reduced carer availability is accounted for to a greater degree in the model, while avoiding the double counting of the upward effect of FLFP on GDP when both are separately in the model in Model 2, the impact of GDP growth becomes progressively less important. The sustained inverse effect of FLFP on acute bed utilisation in this exercise appears to support the hypothesis that FLFP plays a pivotal role in the balance of care model, with increased FLFP causing an increase in formal long-term care provision and utilisation and a consequent reduction in acute utilisation.

Reduction in 12 out of 14 country coefficients in Models 4 and 5 compared to Model 1 demonstrate that these models with GDP weighted by carer availability are more successful in explaining differences between countries in acute utilisation, with Model 5 performing best in this respect. Yet there remain cross-country differences for unidentified reasons. Recognition of the importance of the relationship of FLFP to GDP suggests other country-specific unobserved factors that may contribute to unidentified differences between countries. Where a much higher proportion of women work part-time, they may contribute to the measures of FLFP and GDP but the assumption that they are unavailable to care informally may be misplaced. In some countries, women in informal caring roles receive significant state transfers such as the Allocation Parentale d'Education (APE) paid to women of children aged under 3 in France (Boeri et al. 2005). This is in effect a payment for the delivery of informal care, which via the national accounts incorporates it in the measure of GDP. While women of very young children are not typically also the carers of ageing parents, there are other payments more directly targeted to informal care-givers of older people such as state carers' allowances or reimbursement under social insurance for care of relatives or friends. These too would appear in the national accounts and in the measure of GDP. The measures of GDP weighted by the availability of informal carers may be distorted by such country-specific factors that add to the complexity of the relationship between female labour force participation or non-participation and GDP.

In the Netherlands over the years 1985-2006, there is a greater proportionate reduction in AVFCP, the broader measure of carer availability, than the proportionate increase in GDP per capita. If the estimated coefficient in Model 5 for the GDPAVFCP welfare index is applied to the sample data for the Netherlands the mean change in this variable predicts a reduction in acute bed utilisation, implying that the loss in carer availability has been so

great as to negate the impact of growth on acute bed utilisation. Yet the Netherlands has a relatively high rate of part-time employment of women (Boeri et al. 2005), who may still be available to provide informal care, which would mean that this weighted measure is over-estimating the impact of female labour force participation on the availability of carers and therefore on the balance of care and acute utilisation.

Another possible approach to developing an alternative measure of national welfare would be to follow the methodology adopted by the United Nations to generate its series of human development indices (HDI) (United Nations, 2010). These indices provide bases to compare development across countries. The indices are composite measures which combine Gross National Income (GNI) per capita with indices of life expectancy, education, inequality, gender inequality or health depending on the emphasis of the particular index. The current methodology applied by the UN is to calculate sub-indices for each dimension according to the formula:

$$\text{Dimension index} = \frac{\text{actual value - minimum value}}{\text{maximum value - minimum value}}$$

Maximum values are observed maxima while minimum values are conceived as the "natural" zero for that dimension below which it is unlikely to fall. The UN indices apply a log specification for GNI. The composite index is the geometric mean of the dimension indices. The composite index expression is designed to embody "imperfect substitutability across all HDI dimensions" (United Nations, 2010: 216).

$$\text{Index} = (I_a \times I_b \times I_c)^{\frac{1}{3}}$$

By applying this methodology an index can be created comprising sub-indices for GDP per capita and the availability of female carers (AVC) where:

$$\text{AVC Index} = \frac{\text{AVC- 20}}{\text{66.6-20}}$$

The choice of a minimum at 20% carer availability compares to an actual minimum within the HMD14 panel of 37.8%. The GDP index is created by the same formula using the actual maximum and minimum values in logs. The welfare index is:

$$\text{Welfare Index} = (\text{AVC Index} \times \text{GDP Index})^{0.5}$$

Substituting this index in an estimation of the acute utilisation model has a remarkably similar outcome to the estimation with the previous measure of welfare which is the product of GDP per capita and the widest measure of carer availability (Table 7.5). The UN-method index reduces the unexplained time effects further. This exercise in applying the UN methodology to this model suggests that adopting a similar approach in models of health expenditure could be useful.

Table 7.5 Acute utilisation models, alternative welfare indices, HMD14 1985-2006; Dependent variable: acute bed days per capita

	UN-method welfare index	Original method welfare index
Welfare Index_AVC_lnGDP	0.420**	
	[0.007]	
GDPAVFCP		0.001***
		[0.000]
Percent65	-0.062***	-0.050***
	[0.000]	[0.000]
PercentDecedents	0.319	0.340*
	[0.051]	[0.027]
LEBdiff	0.057*	0.053*
	[0.040]	[0.035]
2006	-0.309***	-0.418***
	[0.000]	[0.000]
Observations	279	279
R^2	0.96	0.96

p-values in brackets * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$ Source: HMD14 panel Note: sample drops by one observation compared to estimations in Table 7.3 as a consequence of the methodology for creating the GDP sub-index.

7.6 Reflections

Analysis of the effect of female labour force participation on acute bed utilisation remains challenging. In Chapter 6, I hypothesised that the significant, negative coefficient for FLFP in this model when applied to the HMD14 panel indicates that it plays a pivotal role in the balance of care in ageing societies; that when ageing of population combines with rising female labour force participation, societies are likely to develop formal long-term care, which operates as an alternative to acute care as a setting in which to meet the demands for care of older people.

The causal relationship of FLFP to GDP, however, means that in a model with both as covariates, the full, separate impact of FLFP on acute utilisation cannot be estimated; and, furthermore, GDP is an overstated measure of welfare because it does not take into account the loss of welfare implicit in the reduced availability of informal care options with rising female labour force participation. This chapter introduces measures of GDP weighted by measures of carer availability, a form of weighting designed to make this measure of welfare more comprehensive. Their substitution for GDP and FLFP in the acute utilisation model has the effect of reducing unobserved and unexplained negative time effects, which suggests that in the models including GDP, the effect of GDP on acute utilisation is inflated and requires an offsetting negative time trend, effectively representing the welfare loss caused by the reduced availability of informal carers.

In the model including GDP and FLFP, FLFP is by design a proxy variable intended to capture the effect of reduced informal care availability on acute utilisation but it cannot also capture the welfare loss this represents, which is still absent from GDP. This interpretation appears compatible with the almost exactly equal offsetting negative time trend in the models with GDP alone and with GDP and FLFP. The regressions with the welfare indices in place of GDP and FLFP contain a more appropriate measure of welfare reflecting the loss in availability of informal carers. This weighting does not purport to be exact. There is no doubt that a better and more targeted measure would be a measure of GDP that imputed a value to the actual informal care delivered but, as Deaton observed, despite the biases caused by omitting unremunerated services within households from measurement of national income, there is little agreement on how to do so. A disadvantage of the inclusion of these welfare indices is that because they combine measurement of changes in material welfare and reduction in availability of informal carers, it remains impossible to separate the two effects.

The question remains whether FLFP is a pivotal variable for the balance of care as hypothesised in Chapter 6. The further possibility remains that the significant, negative coefficient for FLFP arises because it is also proxying the key omitted variable in the acute utilisation model - a variable for long-term care utilisation. Given the evidence of an inverse association between acute and long-term care utilisation, the coefficient for LTC utilisation in an acute utilisation model would be expected to be negative. A strong positive correlation was demonstrated between FLFP and LTC recipients in the small

panel for which LTC utilisation data are available. It follows that when, due to data deficiency, LTC utilisation is omitted from the acute utilisation model, a variable such as FLFP with which it has a strong positive correlation will have a negative bias (Dougherty, 2007). This omitted variable bias may also contribute to the significant, negative coefficient for the age variable in the regressions for models (3) to (5) in Table 7.3 since age too has a positive correlation with LTC utilisation.

Whether it is correct to describe FLFP and/or population age as pivotal variables with a negative association to acute utilisation, or whether these apparently significant, negative associations are overstated due to omitted variable bias, either proposition has the same implication for the balance of care. The variable whose omission is postulated to cause this bias or these biases is LTC utilisation. Either a negative bias exists which confirms an inverse association between acute and long-term care; or significant, negative coefficients are correctly attributed to FLFP and age in the acute utilisation model. Given the role of FLFP and age as positive drivers of LTC utilisation, it can be concluded that, with increased female labour force participation and an increased age share of population, LTC utilisation increases and this causes acute utilisation to decrease.

A case for re-examining the income elasticity of health care expenditure

There is a considerable literature on the relationship between health spending and national income, only briefly reviewed in Chapter 2. Early studies on the income elasticity of demand for health services found evidence that it is elastic: i.e. as income rises, the quantity of health care consumed rises more than proportionately. More recent studies designed to address concerns about non-stationarity and spurious regression estimate income elasticity at less than or close to unity, which suggests a long-run equilibrium between health spending and GDP (Gerdtham and Jonsson 2000; OECD 2006). It can be observed that countries with higher GDP spend more on health services. This analysis of the inter-relationship of health and long-term care utilisation and GDP, taking female labour force participation rates into account, at the very least raises questions about the appropriateness of GDP as a measure of national welfare in analyses of drivers of health expenditure as well as utilisation.

Increased female labour force participation has the effect of formalising and causing the economic enumeration of a range of caring activities, which then are included in both the GDP and health care expenditure functions. It would appear to follow that the form of growth observed in developed economies in recent decades, which is associated with rising female labour force participation and increased formalisation of care, will cause these newly enumerated activities to comprise an increasing proportion of GDP. The apparent income elasticity of health spending may reflect a tautology. Growth that derives from increased female labour force participation is by definition growth that brings with it a high proportion of newly formalised care. Not only might the apparent income elasticity of health expenditure derive from a tautology but the very role of national income as a driver of health expenditure may be questionable, if in the formulation of such a model, income is conceived as a measure of national welfare.

Since national income and health expenditure are both functions of female labour force participation, national income must be endogenous in any model that expresses health expenditure as a function of national income but this is, in a sense, beside the point. The more fundamental issue is that the concept of elasticity of demand assumes some element of choice about how to spend income, whether at an individual or national level. If both increased national income and increased health expenditure are inevitable consequences of increased female labour force participation - in effect the result of unremunerated activity becoming remunerated and "visible" in the economic sense - then there has not been an exercise of choice to devote a higher share of national income to health expenditure. In such circumstances both the increase in national income and the higher health expenditure are pre-determined consequences of increased FLFP. Insofar as choice has been exercised, it is in the choice of women to move from unpaid to paid employment.

There appear to be good grounds to re-visit analysis of the impact of GDP on health expenditure substituting measures of national welfare that take into account the impact of rising female labour force participation on informal care. There is a case to be made for developing from such measures new indicators of the relative wealth of nations and the proportion of nations' wealth that they devote to health care. The analysis in this chapter suggests that indicators of national welfare that impute a value to unremunerated, informal care rank countries' per capita material welfare as more equal than when their material welfare is ranked by conventionally measured GDP per capita.

Figure 7.10 FLFP/Productivity relationship shows plateau effect

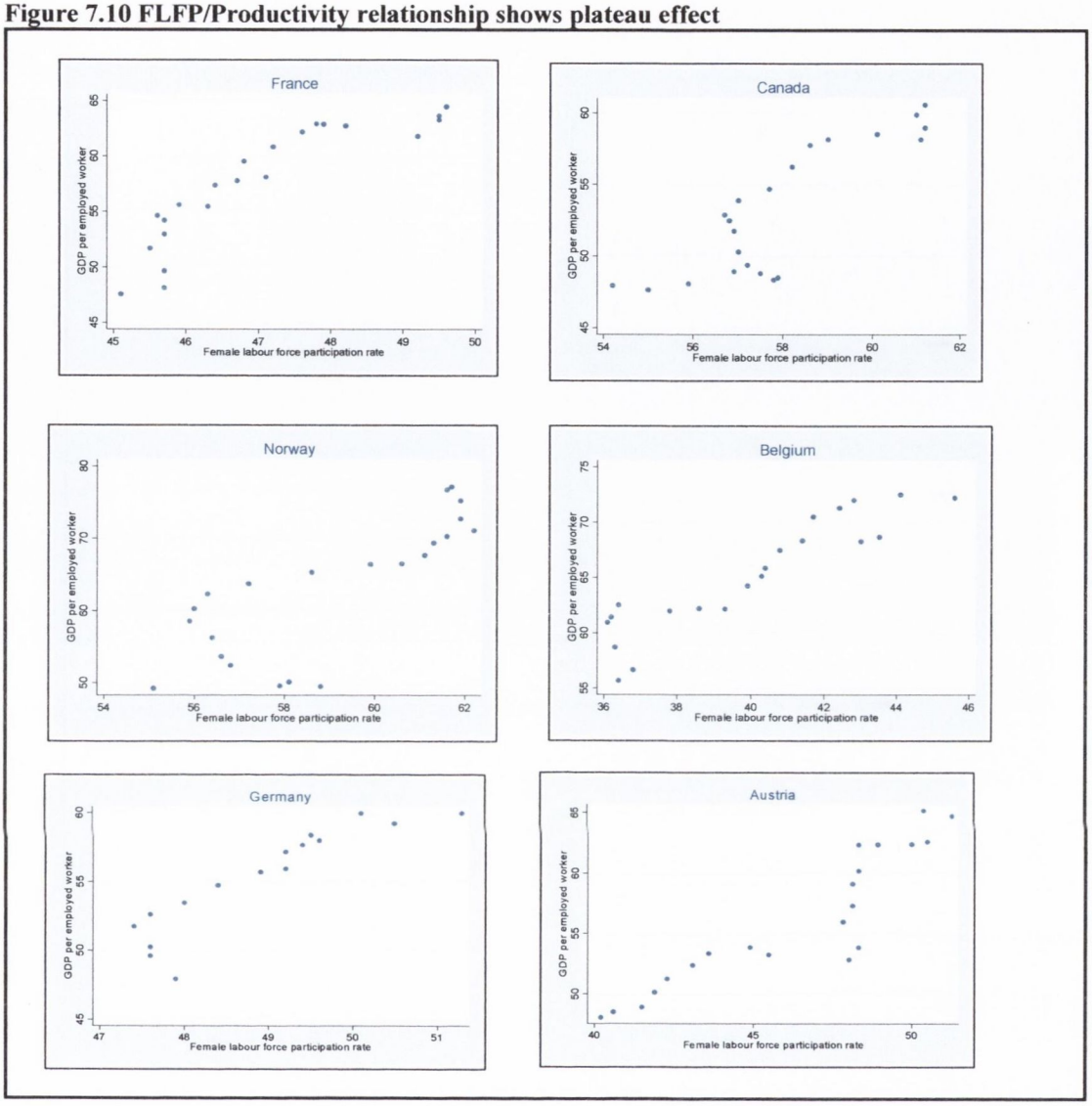


Figure 7.11 FLFP/Productivity relationship shows inverse effect

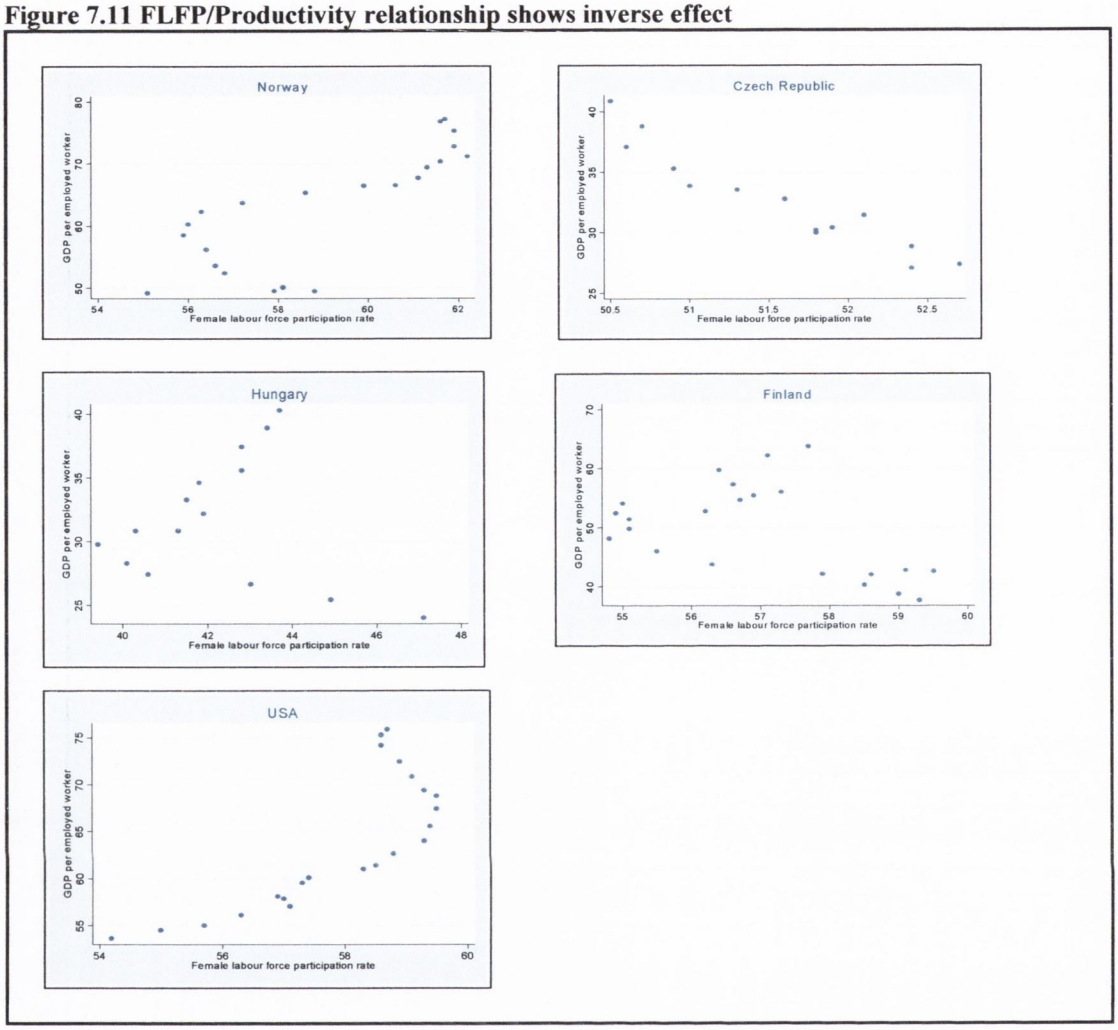
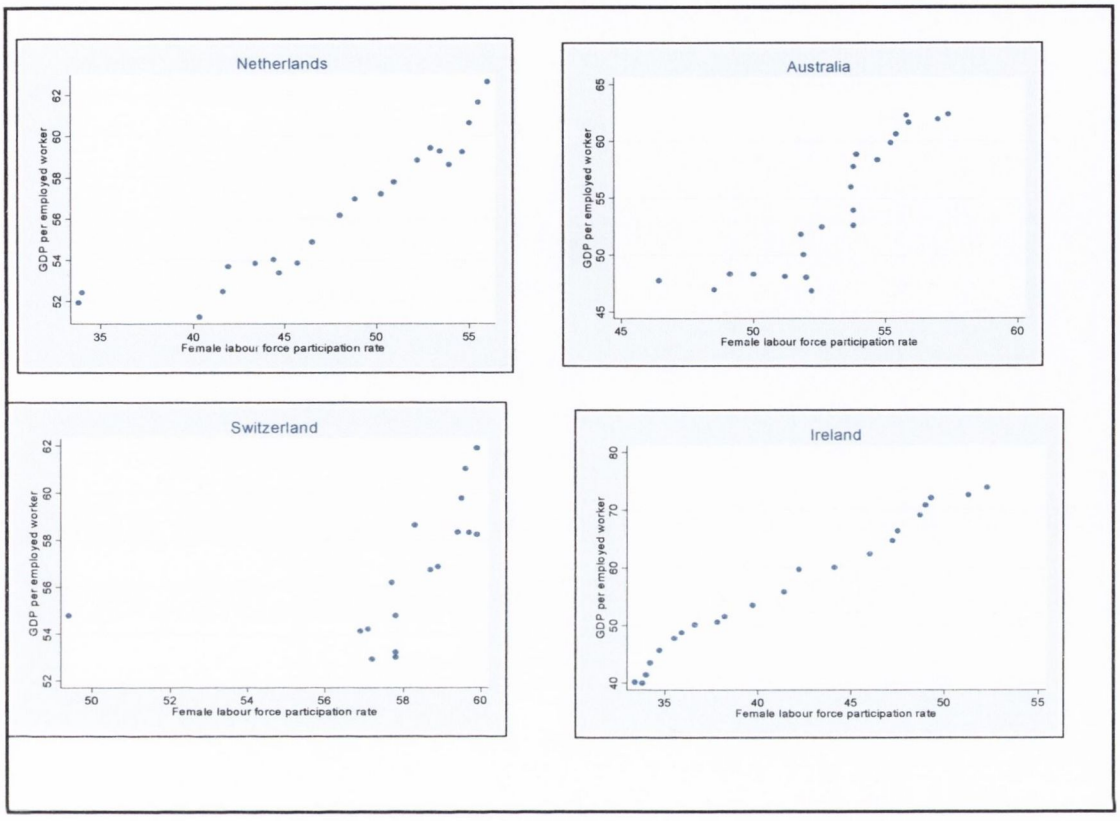


Figure 7.12 FLFP/Productivity relationship shows positive effect



SECTION THREE: LONG-TERM CARE IN IRELAND

Chapter 8 Long-term care in Ireland - Introduction

Section 3 of this thesis is a country-specific analysis of long-term care in Ireland. The chapters in this Section comprise: an analysis of available data on formal and informal LTC utilisation and supply in the years 2001-2006 in Ireland (Chapter 9); and statistical forecasts of disability rates for older people and demand for residential LTC in Ireland in the years 2007-2021 (Chapter 10). The forecast of disability rates in Chapter 10 is based on an analysis of the first comprehensive, longitudinal data on age and gender-specific disability rates in Ireland covering the years 2002-2006.

This country-specific analysis for Ireland preceded and, to a considerable degree, motivated the econometric, cross-country analysis of the balance of care in the chapters in Section 2. My research into long-term care provision and need in Ireland took place against the backdrop of a Government policy of reducing acute bed capacity and care provision. This policy was influenced by a series of studies, discussed in Chapter 2 Section 2.8, which contributed to a view of the Irish health care system as over-endowed relative to Ireland's comparatively young demographic profile. The Health Service Executive (HSE) commissioned a study of the potential for reducing acute care utilisation, PA Consulting Group (2007a), which projected two alternative acute bed capacity requirements, based on current practice or a preferred health system (PHS), which would reduce the role of the acute hospital. As discussed in this Section, the PHS became Government policy.

Having pursued an analysis of long-term care and its relationship to acute care in the interests of better understanding comparison of health spending in Ireland and other countries with differing age profiles, I found that understanding the balance of care was necessary for a more immediate reason - to assess the impact on long-term care and care of older people of a reduction in acute care capacity. My analysis and projection of long-term

care demand in Ireland was therefore framed against this policy backdrop and informed by international comparison.

In my analysis in Chapter 10, I observe that it would be helpful to policymakers if there were a formula relating acute care need and provision to long-term care need and provision at different points on the curve of population ageing. Without such a formula, my analysis in this Section was based on simple cross-sectional comparisons of countries' long-term and acute care provision. I subsequently undertook my analysis in Section 2 in pursuit of such a formula, in effect a balance of care model, to enable me and other forecasters to project long-term care demand based on international evidence of the inter-relationships of such factors as acute and long-term care utilisation rates, ageing, female labour force participation and convergent life expectancies. I was initially sceptical that available international data could support such an analysis, which explains my relatively unambitious, cross-sectional approach in this Section. Although I found that the cross-country data could not support estimation of a balance of care model, the degree to which the data could support cross-country analysis of separate models of the determinants of acute bed and long-term care utilisation, albeit qualified by the methodology in their applicability to forecasting, has been a more rewarding outcome than I expected when researching the chapters that make up this Section.

When it became apparent that aspects of my research for this thesis were relevant to a study of the impact of demographic change on the demand for and delivery of health care in Ireland to 2021, commissioned by the Irish Heath Research Board (HRB), I was invited to contribute to that study. In consequence, earlier versions of much of my analysis in this Section of long-term care in Ireland and of the potential impact of acute sector changes on long-term care demand has been published in Layte et al (2009a; 2009b).

In Chapter 10, I develop alternative forecasts for required residential LTC demand in Ireland. The initial preferred forecast suggests a requirement for an additional 13,324 residential LTC places from 2007-2021, or approximately 888 per annum, implying a residential LTC utilisation rate in 2021 of 4.5% of people aged 65 and over. This forecast is qualified by an assessment that if Irish governments pursue a policy of reducing acute care capacity in line with professed HSE policy, and labour force participation rates among younger women are substantially sustained as they became older, based on international

experience, the additional capacity requirement in residential LTC would increase by at least two-thirds to over 21,000 places or in excess of an additional 1,400 per annum, increasing residential LTC utilisation to 5.5% of people aged 65 and over. To develop care in the community to the levels of other Western European states, the current level of home help provision would also have to increase substantially. This Section and Appendix B in Section 5 describe the data, methodology and process of analysis, which informs these projections.

Chapter 9 Long-term Care Demand and Supply in Ireland

9.1 Introduction

The purpose of this chapter is to examine the demand for and supply of long-term care (LTC) in Ireland. The chapter is structured as follows. This introduction reviews definitions and concepts relating to long-term care. Section 9.2 reviews factors influencing demand for LTC in Ireland: demography, disability and household composition. Section 9.3 reviews data on the supply of informal care under the headings of female labour force participation and unpaid carers. Section 9.4 reviews international and Irish data on the supply of residential LTC. The following section describes the characteristics of Irish longstay residents under the headings of: age, gender, dependency level, disability/illness and length of stay (Section 9.5). Section 9.6 reviews evidence of regional variations in the relationship between acute hospital and long-term care utilisation. Section 9.7 discusses long-term care in the community, while Section 9.8 reviews evidence on numbers in receipt of formal home care. The final section summarises and concludes this chapter.

Chapter 3 discussed the OECD's efforts to develop internationally accepted definitions of LTC services and expenditure under medical and social headings, work which remains ongoing. There is no general, internationally comparable definition of LTC need. In Germany, the social dependency insurance act includes a definition of people in need of long-term care: "persons with a physical or mental disability, who need assistance in normally and regularly recurring activities of daily living on a longterm basis, prospectively for at least 6 months, to a substantial or exceeding degree" (Schulz 2004: 55). In Ireland, the Mercer Report defined long-term care as "care provided to those who are unable to look after themselves without support due to long-term physical disability or cognitive impairment disability" (Department of Social and Family Affairs 2002). Long-term care could include:

- Assistance with the instrumental activities of daily living i.e. activities such as cooking, cleaning and shopping (personal help);

- Assistance with the activities of daily living such as eating, dressing and bathing (personal care);
- Paramedical services such as chiropody, physiotherapy, speech therapy and occupational therapy;
- Medical services, including skilled nursing care and services provided by general practitioners and consultant geriatricians and encompassing assessment and rehabilitation as well as ongoing medical care. (Department of Social and Family Affairs 2002: 55)

The OECD defines assistance with activities of daily living as social care services whereas it defines paramedical and medical services as health services, which are delivered in the community by primary care practitioners or in hospitals or long-term care settings. Although the OECD's System of Health Accounts (SHA) excludes social services from accounting for health care expenditure, OECD and other analysis recognises the importance of social care services and their close relationship to the health care system (OECD 2006; European Commission 2001). This chapter primarily examines the demand for and delivery of social care services but refers also to those nursing and paramedical services which are most closely linked with social care. The majority (92%) of recipients of LTC in institutions in Ireland are aged 65 and over and require care because of disabilities associated with ageing. This chapter discusses factors influencing the demand for care by such older people rather than demand for care for younger people with disabilities.

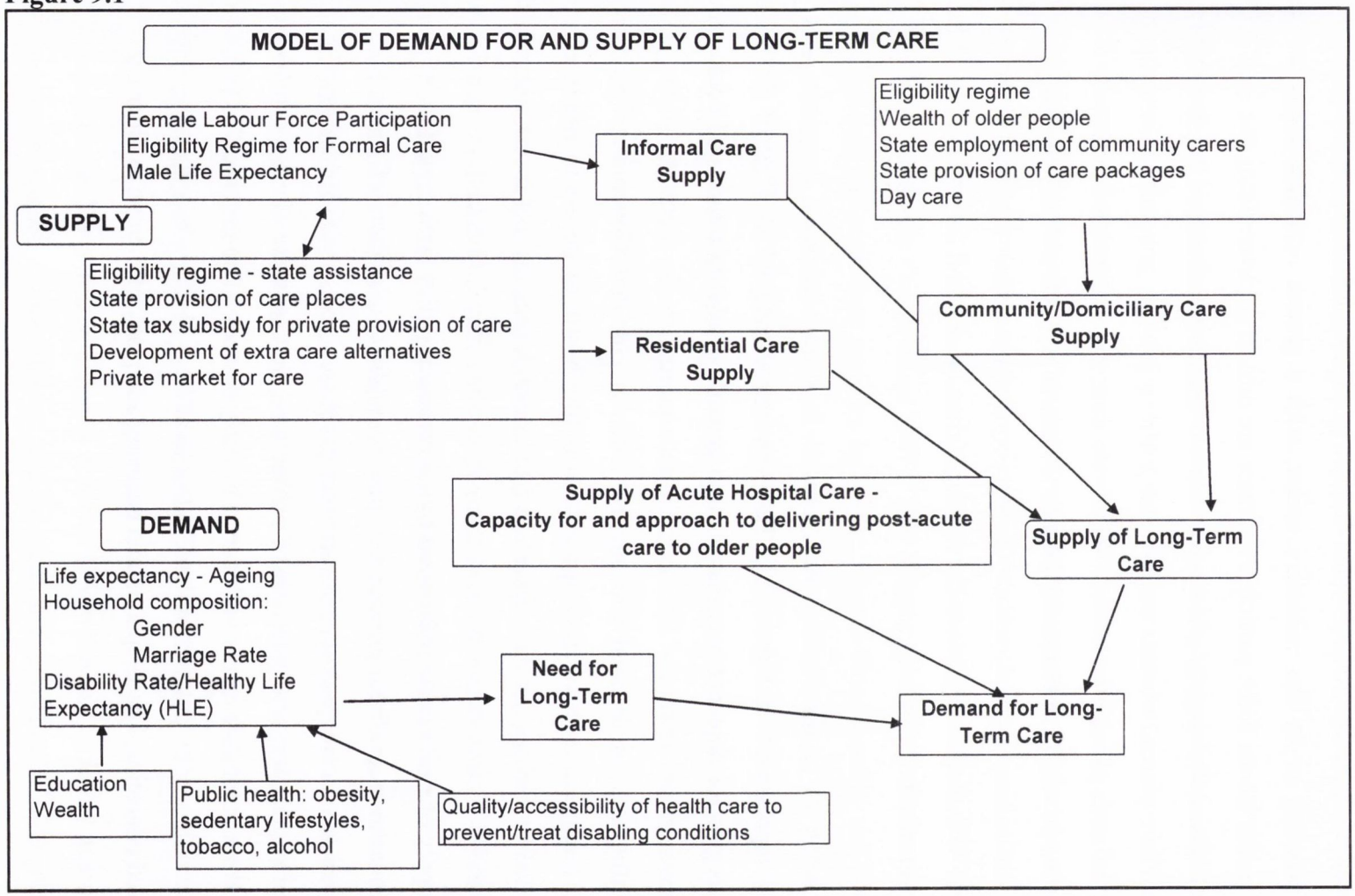
The demand for LTC is most immediately driven by: population growth, developments in life expectancy, disability trends, and trends in household composition. In addition, rising expectations may convert hitherto unmet need into active demand for care. Requirements for a higher standard of care may increase the cost of care and, in particular, the staffing levels required to deliver care. Developments in the acute sector, such as reduced length of stay, may translate into increased demand for long-term care. Severe disability is generally considered a reasonable proxy for the need of long-term care, thus defining and measuring disability is important in assessing LTC demand (Schulz 2004).

Long-term care can be provided either at home or in institutions, including nursing homes and long-stay hospitals. As new forms of residential arrangements for older people have

emerged in many OECD countries over the past 15 years, the OECD observes that it is increasingly difficult to distinguish home care from institutional care within countries. Cross-country comparisons encounter difficulties because the same term may describe a different kind of institution in different countries (OECD 2007d). On occasion long-term care is provided in acute hospitals due to the unavailability of care in appropriate long-term institutions or the community. In the community, long-term care may be supplied by informal carers, typically family members, or by formal carers. It may be delivered publicly, privately or by the voluntary sector, with a greater or lesser degree of state subsidy. Female labour force participation rates are critical to determining the availability of informal carers. The supply of long-term care is therefore influenced by: the supply of institutional care places, whether public, non-profit or private; government investment in or subsidy of such places; the market for private care; the institutional arrangements and policy approach which determines the mix between institutional and home care; the availability of informal carers; and the availability and accessibility of formal care in the community. This chapter examines the available data on demand for and supply of long-term care in Ireland.

The interaction of factors influencing demand for and supply of long-term care is graphically represented in Figure 9.1. The forecasts developed in Chapter 10 do not include every factor depicted here. Population growth, disability trends and acute sector developments are the drivers of LTC demand incorporated in the forecasts. Although less tangible influences on demand and supply, such as potential Government policies in relation to long-term care, or developments in public health or access to health care, or wider influences such as trends in income or education levels, are not incorporated in the forecasts, this depiction shows the points at which they may influence LTC demand and supply. Supply of care can be influenced by Government policy with regard to: eligibility regimes; investment in direct provision of places; public employment of community care staff; provision of care packages for private purchase; tax subsidy/direct grant aid of privately provided care; state purchase of private care; development of extra care/sheltered housing. Demand for care can be influenced by early detection and treatment of potentially disabling conditions; by public health measures to address obesity and encourage exercise; by improved educational participation and ensuring adequacy of income in older age.

Figure 9.1


MODEL OF DEMAND FOR AND SUPPLY OF LONG-TERM CARE
Female Labour Force Participation
Eligibility Regime for Formal Care
Male Life Expectancy
Informal Care Supply
Eligibility regime
Wealth of older people
State employment of community carers
State provision of care packages
Day care
SUPPLY
Eligibility regime - state assistance
State provision of care places
State tax subsidy for private provision of care
Development of extra care alternatives
Private market for care
Residential Care Supply
Community/Domiciliary Care Supply
Supply of Acute Hospital Care - Capacity for and approach to delivering post-acute care to older people
Supply of Long-Term Care
DEMAND
Life expectancy - Ageing
Household composition:
Gender
Marriage Rate
Disability Rate/Healthy Life Expectancy (HLE)
Need for Long-Term Care
Demand for Long-Term Care
Education
Wealth
Public health: obesity, sedentary lifestyles, tobacco, alcohol
Quality/accessibility of health care to prevent/treat disabling conditions

9.2 Factors influencing the demand for long-term care

9.2.1 Demography of older people

The almost static proportion of people aged 65 and over in the Irish population over the decade 1996-2006 cloaks a considerable increase in the absolute numbers in these age groups (Table 9.1). Over these years the number of people aged 85 and over increased by nearly 39%, reflecting increased life expectancy. While this increase was from a low base, the absolute addition of over 13,000 people aged 85 and over, and of nearly 37,500 people aged 70 and over, is significant, particularly when over the decade the supply of public long stay beds showed virtually no change.

Table 9.1 Numbers aged 65 and over by Five-Year Cohort, 1996-2006

	1996	2002	2006	Increase 1996-2006	% growth rate
65 - 69 years	126,809	133,474	143,396	16,587	13.1%
70 - 74 years	112,542	112,129	119,152	6,610	5.9%
75 - 79 years	84,097	89,815	92,466	8,369	10.0%
80 - 84 years	55,771	58,857	64,884	9,113	16.3%
85 +	34,663	41,726	48,028	13,365	38.6%
65 +	413,882	436,001	467,926	54,044	13.1%
70 +	287,073	302,527	324,530	37,457	13.0%
Total population	3,626,087	3,917,203	4,239,848	613,761	16.9%

Whereas numbers of people aged 85 and over increased in greater proportion than the population, the 70-79 year old cohorts showed low percentage increases, reflecting the ageing of a generation depleted by a very high emigration rate in the 1950s when they reached adulthood.

9.2.2 Disability trends

The degree to which the increases in absolute numbers of people in older age brackets will translate into demand for long-term care will largely be determined by developments in the disability rate. Evidence from the Census of Population in 2002 and 2006 shows declining disability prevalence in people aged 72 and over (Central Statistics Office Ireland 2002; and 2006: analysed in detail in Chapter 12). The most influential recent assessment of demand for long-term care, the Mercer report, did not have the benefit of the Census 2002

findings on disability and therefore estimated disability prevalence in Ireland by adapting a UK study (Department of Social and Family Affairs 2002).

9.2.3 Household composition

Accompanying the absolute growth in numbers of older people has been an increase in the proportion of older people living alone. The proportion of the population aged 70 and over who were living alone rose from 22.5% in 1986 to 29% in 2006. The increase in the proportion of people living alone over the years 1986-2006 largely occurred in the first decade with the rate stabilising in the 1996-2006 period. More women than men live alone. The proportion of women aged 70 and over who were living alone increased from 32.8% in 1996 to 34.1% in 2006 (Figures 9.2 - 9.4). The high incidence of women living alone may explain why older women have a higher average length of stay in acute hospitals than men of the same age (Layte et al. 2009a). Such women have no one at home to provide informal care during a period of convalescence or disability following discharge from hospital.

Figure 9.2 Persons aged 70 and over living alone or not in private households 1986-2006

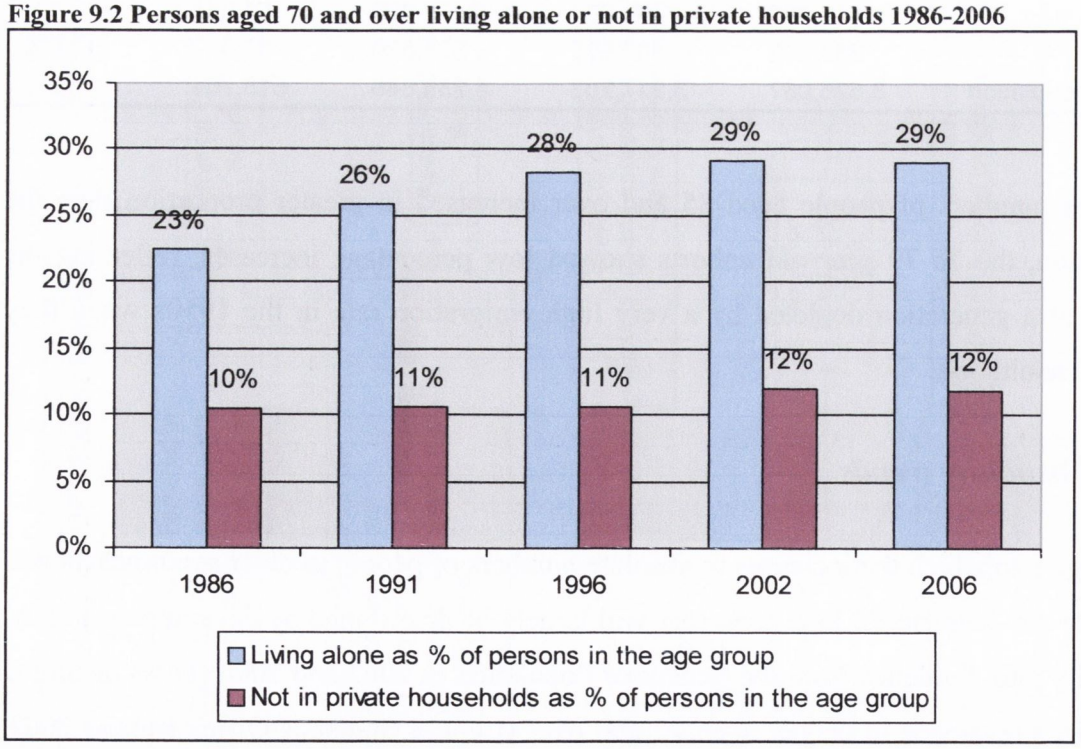


Figure 9.3 Women aged 70 and over living alone or not in private households 1986-2006

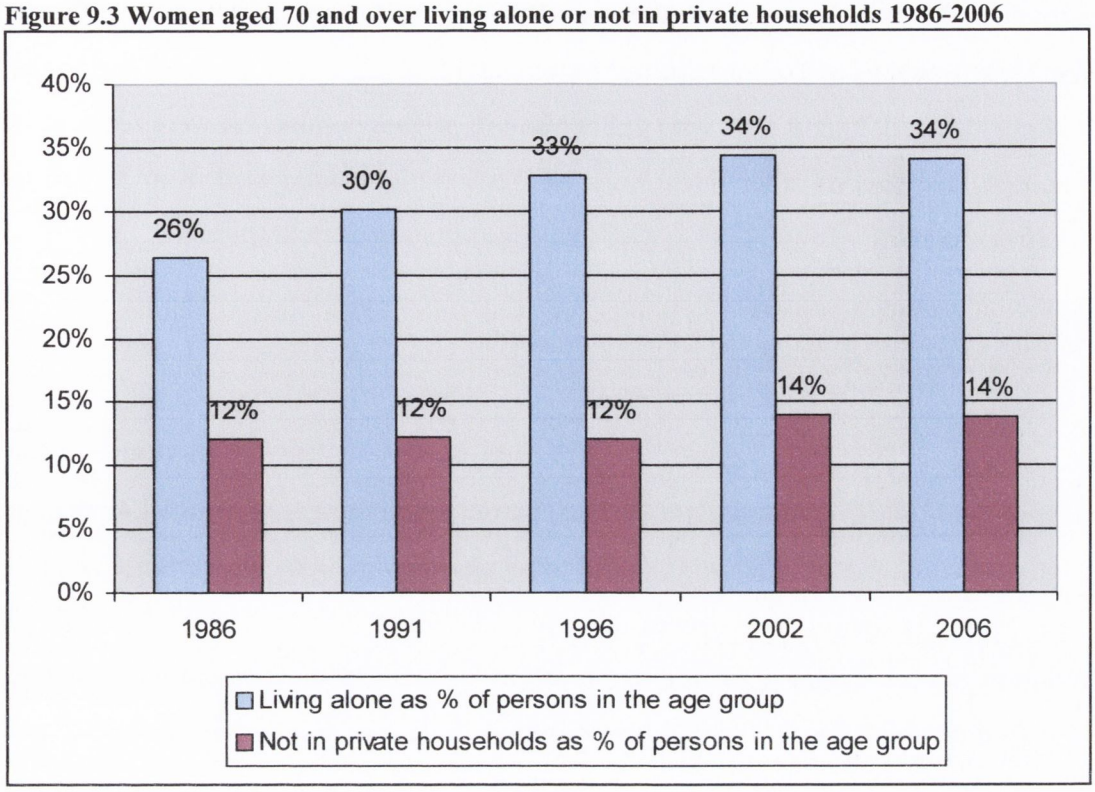
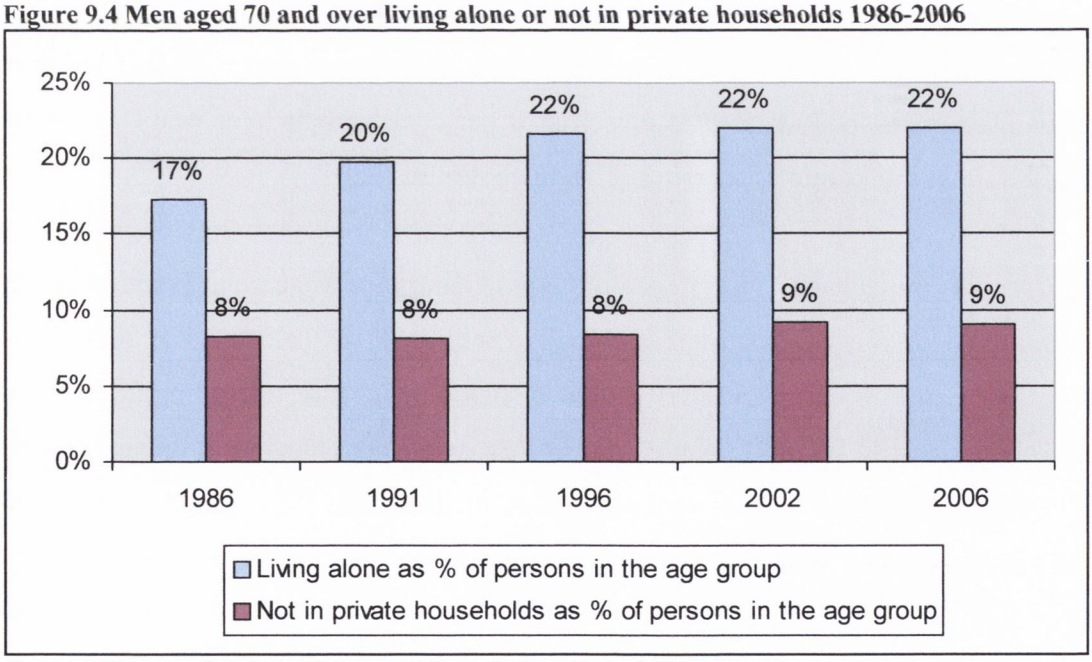


Figure 9.4 Men aged 70 and over living alone or not in private households 1986-2006



Source Figures 9.2-9.4: Census of Population for relevant years.

Combined with the increase in absolute numbers of people living to older ages in Ireland, the growth in the proportion living alone implies significantly increased demand for professionally delivered long-term care services in the community or in institutions. While

81,121 people aged 70 and over lived alone in 1996, this had risen to 94,137 by 2006, an additional 13,016 people or 16 per cent increase over 10 years. Over the same period the number of people aged 70 and over who did not live in private homes (i.e. were resident in nursing homes, hospitals or other institutions on Census night) increased from 30,416 to 38,336, a 26% increase.

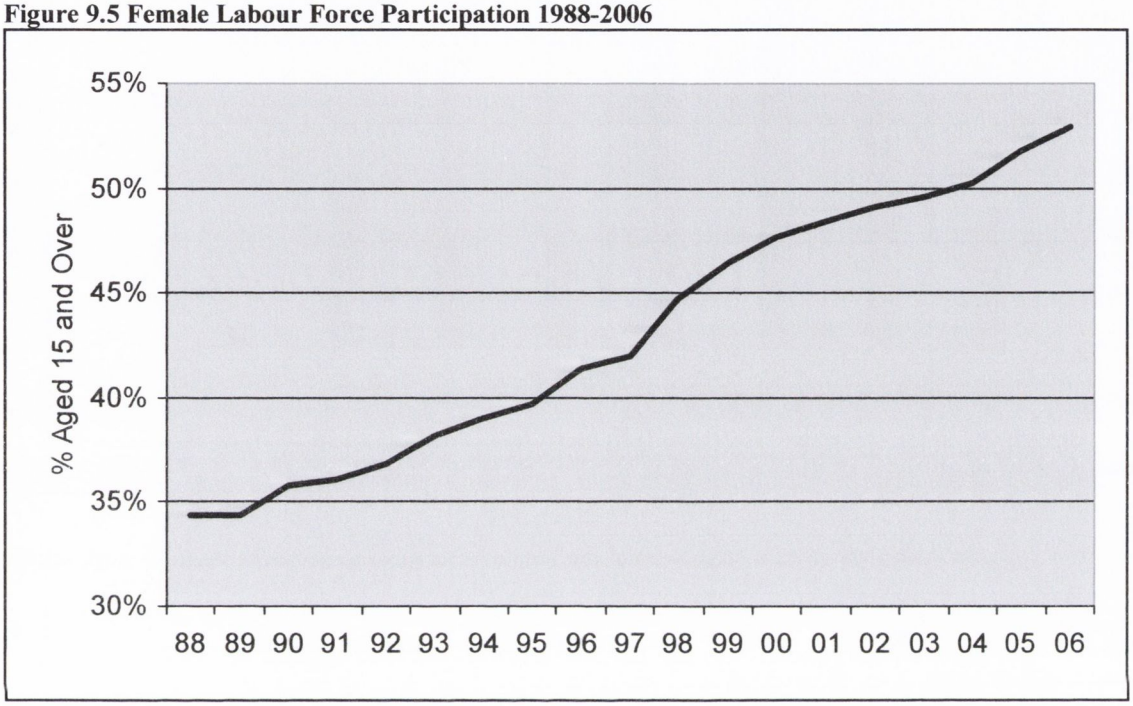
9.3 The supply of long-term care -informal care

A steep increase in female labour force participation rates in Ireland has reduced the potential supply of informal carers. Labour force participation increased from 34.4 per cent of women in Ireland aged 15 and over in 1988 to 53 per cent in 2006 (Figure 9.5). The full significance of this increase is revealed by examining increases in labour force participation by cohort (Figure 9.6). While the cohort aged 20-24 shows a marginal decline in participation in the years 1997-2006, the rate nonetheless remains high at over 71 per cent. In 2006 the 25-34 year old cohort has the highest participation rate of nearly 79 per cent, compared to 67 per cent for the 35-44 year old age cohort, who are most likely to have family-rearing demands. Their participation rate contrasts with rates of 48 per cent for the cohort aged 55-59 and 29 per cent for women aged 60-64, many of whom may have abandoned formal remunerated employment on marriage or parenthood. If younger cohorts maintain participation rates of close to 70 per cent in their later years, as seems probable, the supply of potential carers will be much diminished.

Chapter 2 reviewed evidence that reliance on unpaid carers for the care at home of older, ill and disabled people is common internationally (Schulz 2004). In Ireland in 2006 4.8% of the total population aged 15 and over provided some unpaid care, according to the 2006 Census. This represents 160,900 people who in that year were engaged in unpaid care of friends or family members with long-term illness, or disability. Of these, nearly 41,000 (1.2% of the population) were providing 43 or more hours care per week; almost 10,000 were providing between 29 to 42 hours; and a further 17,000 were providing 15 to 28 hours care weekly. More women than men provided this informal care (Figure 9.7). Over 11% of women aged 45-54 were providing unpaid care in 2006. Nearly 5% of this cohort of women were providing 15 or more unpaid hours of care each week. The proportion of the Irish population and the peak cohort engaged in unpaid care fall within the EU average. In 2001 across the EU (excluding Luxembourg and Sweden) 4% of the population aged

over 15 looked after the old and disabled, and this peaked at 9% of women aged 45-59. These EU averages disguise great cross-country differences in the proportion of the population engaged in informal care. In the UK in 2001 16% of the population was engaged in the informal care of older people compared to 2% in Germany (Schulz 2004).

Figure 9.5 Female Labour Force Participation 1988-2006



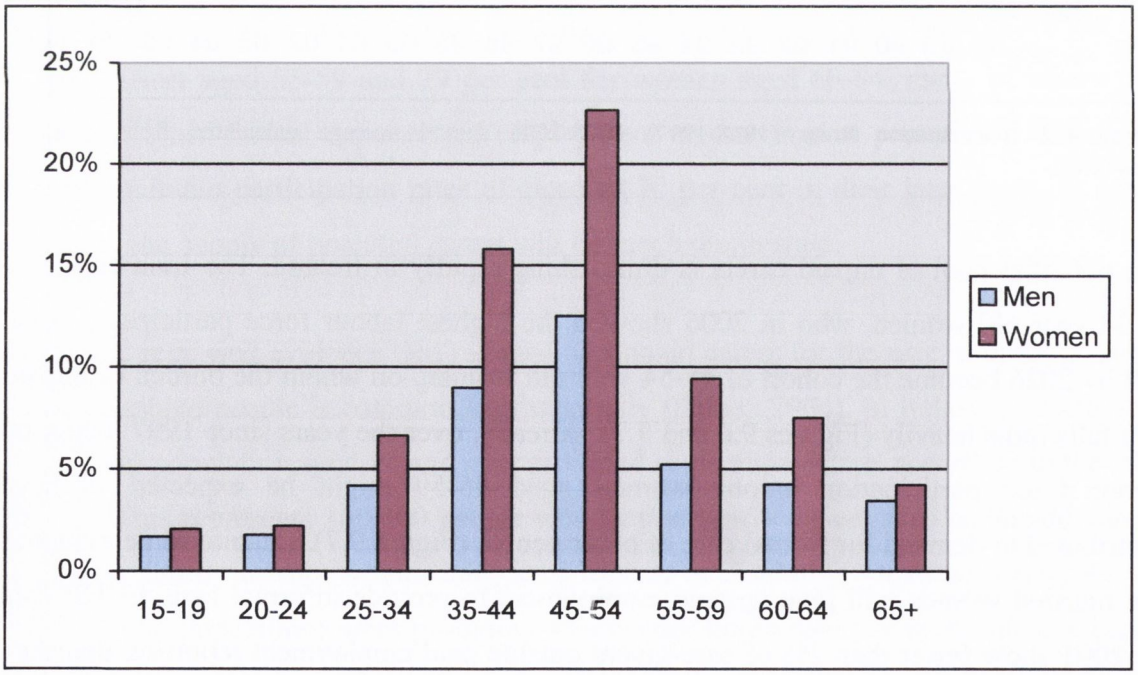
Source: ILO Participation Rates (1988-1997) 1998-2006 annual average calculated from quarterly rates(CSO).

The potential pool of unpaid carers is diminishing rapidly in Ireland. The Irish cohort of 25-34 year old women, who in 2006 showed the highest labour force participation rate, will by 2026 become the cohort of 45-54 year old women, on whom the burden of unpaid care falls most heavily (Figures 9.6 and 9.7). Already, over the years since 1997 increased labour force participation among women aged 45-59 might be expected to have contributed to demand for formal care of older people (Figure 9.7). Despite some evidence that married women will give up paid employment to provide informal care, ECHP data for 2001 show fewer than 2% of care-givers outside paid employment reporting that they gave up their job to look after older people. The majority of care appears to be given by women already working in the home (Schulz 2004). It has been estimated for Germany that by 2050 the proportion of informal care-givers could rise to 25% of non-employed women and 9% of employed women aged 40-64, and to 9% of women aged 65-80. Demographic pressures are expected to lead to increased demand for professional caregivers at home and in institutions (Schulz et al. 2004).

Figure 9.6 Female Labour Force Participation Rate by age cohort 1997-2006

Source: Central Statistics Office QNHS, rates for fourth quarter.(CSO)

Figure 9.7 Unpaid carers of ill and disabled by age cohort and gender as percentage of population, Census 2006

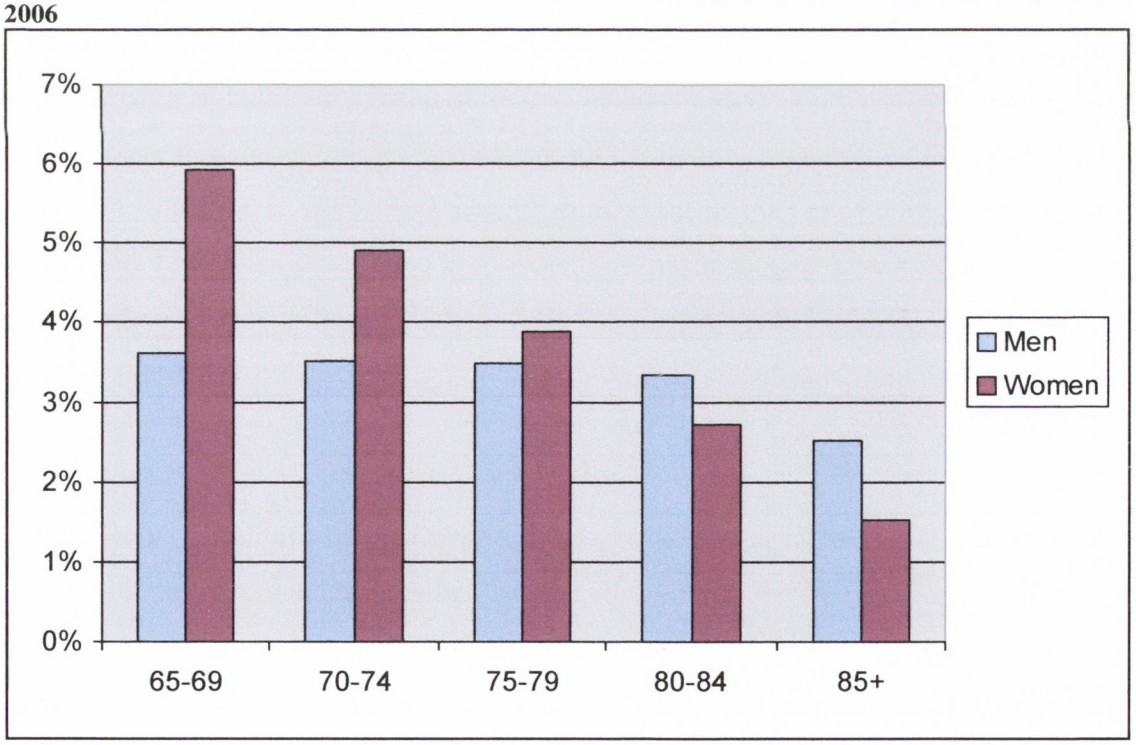


While women and men in late middle age care for ageing parents, increasingly due to increased life expectancy older people also care for their ill or disabled spouses. Thus 4.2% of women and 3.4% of men aged 65 and over were in caring roles in Ireland in 2006. There are significant numbers of carers even amongst the oldest old, with proportionately more men than women in these roles at ages of 80 and above, reflecting the much higher

proportion of women than men who live alone due to widowhood at these ages, and conversely the much higher proportion of men than women who may live with an ill or disabled spouse at these ages (Figure 9.8).

Even at advanced age some carers carry heavy burdens. Of the nearly 40,000 Irish men aged 80 and over in 2006, nearly 1,200 (3%) were carers, of whom nearly 700 (1.7%) were providing 29 or more hours unpaid care a week. In absolute terms there were still more women than men at these ages in caring roles. Of the 73,400 women aged 80 and over in 2006, nearly 1,600 (2.2%) were carers, of whom 900 (1.2%) were providing 29 or more hours unpaid care a week. Although these carers at advanced age were few in proportion to the population of their age, without their unpaid labours there could conceivably have been an additional 1,588 people requiring nursing home care, increasing the estimated population of 22,500 people aged 65 and over receiving care in institutions by 7% in 2006.

Figure 9.8 Unpaid carers of ill and disabled as percentage of population in older age cohorts, Census 2006



Some recipients of care in institutions are stated to require care for "social reasons". In the Dublin/ North-East HSE region of the country 7.1% of patients occupied limited stay beds for "social reasons" compared to 3.4% in the West in 2006 (Department of Health and Children 2006c). Such regional variations warrant further examination as potential

emerging evidence of the effect of increased female participation and/or dispersion of generations on the availability of informal care for older people.

9.4 The supply of care - residential care

9.4.1 International data

It has been observed above that cross-country comparisons of institutional care rates are difficult because of differing definitions of care. Available data do, however, reveal considerable divergence in institutional care rates. Earlier discussions in this thesis of differing rates of informal care availability, such as in the Southern European countries, or a policy of reducing acute hospital care provision, such as in Sweden, suggest a range of reasons for this divergence. The econometric analysis in Section 2 has demonstrated a range of factors which have a significant impact on acute and long-term care utilisation. While OECD data for many countries are not directly comparable due to differences in the data supplied to the OECD, such as the inclusion solely of residents in public institutions in Ireland and some other countries (Table 9.2), among those countries for which broadly comparable data are available (Table 9.3), the percentage of the population aged 65 and over who receive long-term care in institutions ranges from 7.5% in Sweden to 0.5% in Korea. From national data sources discussed below, it is possible to calculate that 4.8% of the Irish population aged 65 and over were in receipt of long-term care in an institution in 2006, placing Ireland close to the average (excluding Korea) among countries with broadly comparable data.

It should be recalled that what constitutes a long-term care institution in any of these countries may range from retirement villages to sheltered accommodation to private nursing home care to a long stay ward in a hospital. The scatter diagram (Figure 9.9) shows the variable relationship between the proportion of people aged 65 and over in long-term care institutions and the proportion of the population aged 80 and over among countries with comparable data (Table 9.3), illustrating the importance of influences other than the age profile of the population in determining the utilisation rate of residential LTC by older people (OECD 2007b). Econometric analysis in Chapter 6 demonstrated that reduced availability of informal carers, proxied by increased female labour force participation, was significant in driving formal LTC utilisation. Italy in particular is an

outlier with a very low rate of institutional care for people aged 65 and over (1.5%) relative to its share of population aged 80 and over (4.7%).

Table 9.2 Residential LTC recipients, percentage of population aged 65 & over

	2004/2003	Percentage of population aged 80 and over, 2004/2003
Australia*	5.3	3.4
Austria* a)	*3.6*	4.2
Belgium* a)	6.6	-
Canada	*4.2*	*3.3*
Czech Republic b)	*4.9*	*2.8*
Denmark	4.4	4.1
Finland	*4.9*	*3.7*
France	*6.3*	4.4
Germany	3.4	4.2
Hungary b)	*8*	*3.3*
IRELAND*	1.8	2.7
Italy	*1.5*	*4.7*
Japan*	3	*4.4*
Korea	0.4	1.2
Luxembourg*	3.9	3.1
Netherlands	5.6	*3.4*
New Zealand*	4.5	3.1
Norway	*5.8*	*4.5*
Slovak Republic b)	*5.1*	*2.2*
Sweden	7.5	5.3
Switzerland	*6.6*	*4.3*
UK* c)	4.2	4.4
USA d)	3.6	*3.5*

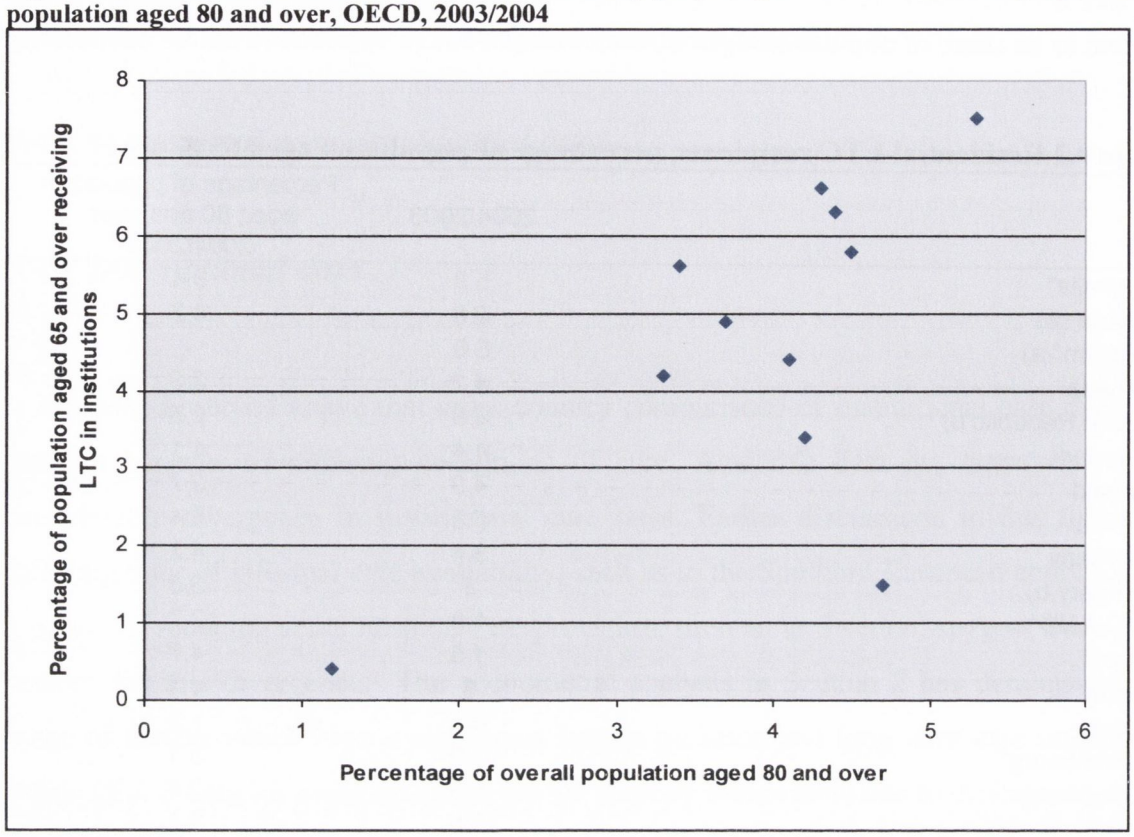
Source: OECD Health Data, 2007. Note: figures in italics are for 2003. ****Only residents of publicly-funded institutions- this applies to Ireland in these data.*** *a) Aged 60 and over. b) Recipients of all ages. c) Estimated from English data. d) 1.5% of recipients excluded due missing age data*

Table 9.3 Residential LTC recipients, countries with more comparable data

	2004/2003	Percentage of population aged 80 and over, 2004/2003
Canada	*4.2*	*3.3*
Denmark	4.4	4.1
Finland	*4.9*	*3.7*
France	*6.3*	4.4
Germany	3.4	4.2
Italy	*1.5*	*4.7*
Korea	0.4	1.2
Netherlands	5.6	*3.4*
Norway	*5.8*	*4.5*
Sweden	7.5	5.3
Switzerland	*6.6*	*4.3*
Average	4.6	3.9
Average excluding Korea	5.0	4.2

Source: OECD Health Data, 2007. Note: figures in italics are for 2003.

Figure 9.9 Utilisation rate of residential LTC among people aged 65 and over and proportion of population aged 80 and over, OECD, 2003/2004



9.4.2 Residential care - Irish data

There are a number of sources of data for long-term residential care in Ireland. The Census of Population for 2002 and 2006 counted numbers living in public and private nursing homes in a count of "persons enumerated in communal establishments". Detailed examination of the Census data reveals a substantial population at younger ages, suggesting that this category includes institutions that are not LTC facilities, which limits the usefulness of these data. The Department of Health and Children (DOHC) has published Longstay Activity Statistics since 1980 based on a survey of public, voluntary and private, long-stay institutions (Department of Health and Children 1997-2006). The response rate to the survey has been variable, and it tends to understate the private nursing home population, in particular. The Irish Nursing Homes Organisation has published annual surveys of all registered private nursing homes since 2003 (Irish Nursing Homes Organisation 2003-2007). This survey includes homes run by voluntary and religious groups. A further study based largely on these surveys and focusing on the cost of appropriate care has been published by Age Action Ireland (McEnery 2007).

The annual Longstay Statistics volumes published by the DOHC and compiled by surveying all longstay units nationally, show the public longstay bed stock fluctuating between approximately 8,700 and 9,700 from 1995 to 2006 (excluding years with atypical survey response rates); and the voluntary longstay bed stock fluctuating at between 3,000 and 3,800 (Table 9.4). The DOHC has stated that there were 9,488 beds in public longstay units in 2006 (Department of Health and Children 2006). Public long-stay units include HSE welfare homes and newly defined "HSE extended care units", which umbrella definition encompasses former Health Board geriatric homes, geriatric hospitals, district hospitals and community hospitals. Since 2004, the DOHC has distinguished between longstay (over three months) and limited stay beds. That distinction is not made in this discussion.

While the DOHC records increasing numbers of private nursing home beds, its count is not complete. A complete count of beds in all registered private homes published by the Irish Nursing Homes Organisation (INHO) shows a steady growth of private and voluntary beds from some 15,000 in 2003 to nearly 18,000 in 2006 (Table 9.5). Given the relative stability of numbers of beds in the voluntary sector, this effectively represents a growth in private beds. It has been estimated that in 1995 the combined private and voluntary bed supply was slightly in excess of 10,500 (McEnery 2007). The increase by more than 70% in private and voluntary beds over a decade has largely been driven by the introduction of tax incentives in 1997, which afford investors potential 47% tax savings against income and profits. While an effective policy if judged solely by the rapid increase in supply, the consequent influx of inexperienced operators in an under-regulated area has provoked expressions of concerns about standards of care and staffing ratios (O'Neill 2006; McEnery 2007). The HSE also regularly contracts private beds from the private sector. It has been argued that the HSE contract price is set too low to maintain adequate staffing ratios (McEnery 2007).

With 17,909 beds and an occupancy rate of 89.4% (Irish Nursing Homes Organisation 2003-2007), private and voluntary nursing homes can be estimated to have had an average population of some 16,000 in 2006. If the 9,488 public long-stay beds in 2006 had the 88.5% occupancy rate recorded for the units surveyed (Department of Health and Children 2006c), they would have accommodated 8,396 patients. Thus it would appear that private,

public and voluntary sectors combined had approximately 27,400 beds accommodating approximately 24,400 patients in 2006.

Table 9.4 Public and voluntary LTC bed capacity, 1994-2006

	Public	Voluntary	Survey Response Rate
1994	9278	3290	-
1995	9261	3385	-
1996	9573	3786	-
1997	9716	3676	86.6%
1998	9138	3019	77%
*1999**	*6158*	*1137*	*46.9%*
*2000**	*8318*	*2150*	*68.3%*
2001	8671	2945	84.9%
2002	8671	3227	87.3%
2003	8773	2717	87.3%
2004	9498	3280	85.4%
2005**	7699	3429	80%
2006**	8007	2212	80.1%

Source: DOHC Longstay Activity Statistics

* These years' low survey response rates related to the establishment of the Eastern Regional Health Authority. ** The low response rate in 2005 and 2006 relate to the establishment of the HSE.

Table 9.5 Growth in private and voluntary nursing home capacity, 2003-2006

	2003	2004	2005	2006	Increase 2003-2006
Beds	14946	16461	17722	17909	19.8%
Occupancy	89.0%	86.8%	86.1%	89.4%	
Estimated Residents	13301	14288	15258	16011	20.4%

Source: Irish Nursing Home Organisation, 2006; Residents estimated by applying occupancy rates to bed numbers.

The variability of the survey response rate to the DOHC's Longstay Statistics renders it difficult to analyse the trend in demand for LTC from this source. It can, however, be estimated from the INHO surveys that the population resident in private and voluntary facilities increased by 20% in the years from 2003 to 2006 (Table 9.5). If it is assumed that public long-stay units had an approximately constant population of some 8,400 over this period, the overall number of residents would have increased from 21,700 to 24,400, a 12.4% increase. In this period the number of people aged 65 and over increased by 6% and numbers aged 80 and over by 10%, suggesting that utilisation rates of residential long-term care have been increasing.

While the DOHC's Longstay Statistics do not offer precise totals of either capacity or patients because of variable coverage, they do nonetheless provide a very detailed survey of the characteristics of recipients of long-term institutional care. The Irish Nursing Home Organisation's Surveys also provide details of patients' characteristics. The INHO's 2006 survey received a 33% response rate from the registered and private voluntary homes.

9.5 Characteristics of long-stay residents

9.5.1 Age

The majority of residents of long and limited stay institutions are aged 65 and over. Only in voluntary homes/hospitals for older people are a substantial proportion of residents aged under 65 at 26.4% and under 40 at 7.1%. In HSE extended care units, 9% of residents are aged under 65 and 2.4% under 40. LTC institutions largely cater for people who are in need of care due to the disabilities and illnesses consequent on ageing. The DOHC's survey across all categories of unit, including private and voluntary nursing homes, found 92.3% of residents to be aged 65 and over and 65% aged 80 and over in 2006. This is a marginal increase from 63.1% of patients who were aged 80 and over in 1997. Assuming these age profiles hold true of the estimated 24,400 patients in all categories of long-stay unit in 2006, this implies that approximately 22,500 residents were aged 65 and over, representing 4.8% of the population of 467,926 in that age bracket (Central Statistics Office Ireland 2006).

Table 9.6 Age profile of residents of private and voluntary nursing homes, 2006

Age category	Under 65	65-75	76-85	Over 85
	3.8%	12.4%.	41.2%	42.6%

Source: INHO, 2006

Table 9.7 Age profile of residents of public longstay units, 2006

Long-stay	Under 65	65-74	75-84	85-94	95 and over
HSE extended care unit	8.8%	14.0%	38.1%	35.8%	3.2%
HSE welfare home	2.5%	14.8%	42.0%	37.7%	2.9%
Limited-stay					
HSE extended care unit	10.8%	18.4%	42.2%	26.6%	2.0%
HSE welfare home	6.4%	27.6%	35.7%	29.4%	0.9%

Source: DOHC Long-Stay Activity Statistics, 2006

9.5.2 Gender

The majority of residents of long-stay units of every type are female, although this percentage varies by bed and unit type. While 10.7% of male patients across all units are aged 90 and over, 22.0% of female patients are of this age, reflecting women's longer life expectancy, and greater probability of living alone and needing formal care.

Table 9.8 Gender profile of residents of longstay units, 2006

Category of Unit	Male	Female
HSE extended care unit	38.6%	61.4%
HSE welfare home	40.7%	59.3%
Voluntary Home/Hospital for Older People	38.0%	62.0%
Voluntary Welfare Home	35.1%	64.9%
Private Nursing Home	29.9%	69.9%
Total All Beds	33.7%	66.2%

Source: DOHC Long-Stay Activity Statistics, 2006

9.5.3 Dependency Level

The DOHC asks long-stay units to describe their residents' level of dependency according to four definitions: low, medium, high and maximum dependency (Box 9.1). These definitions respectively broadly imply: relative independence; impaired mobility and absence of support/care at home; multiple disability but not bed bound; and likely to be bed bound and requiring nursing care and assistance with all personal care. The largest proportion of residents (39.6%) was in the maximum dependency category requiring a high degree of nursing care and assistance. HSE extended care units had the highest proportion of maximum dependency residents (43.9%) and of maximum and high dependency residents combined (76.7%). Private nursing homes had a lower level of maximum dependency residents (38.2%) and of maximum and high dependency residents combined (69.4%). Voluntary welfare homes reported the lowest proportion (33.6%) of residents in the high and maximum dependency categories. Almost three quarters (72.7%) of residents in long-stay beds are in the high or maximum dependency categories compared to just over half (50.7%) of residents in limited-stay beds (Department of Health and Children 2006c).

Box 9.1

The DOHC uses the following definitions of dependency:

- **Low dependency**: This category refers to people who need some support in the community and the more independent residents in residential accommodation who require little nursing care. They are usually independently mobile but may use a walking stick and have difficulty managing stairs.
- **Medium dependency:** Person whose independence is impaired to the extent that he or she requires residential care because the appropriate support and nursing care required by the person cannot be provided by the community. Mobility is impaired to the extent that the person requires supervision or a walking aid.
- **High dependency:** Independence is impaired to the extent that the person requires residential care but is not bed bound. The person may have a combination of physical and mental disabilities, may be confused at times and be incontinent. He/she may require a walking aid and physical assistance to walk.
- **Maximum dependency**: Person whose independence is impaired to the extent that he/she requires nursing care. The person is likely to be bed bound, requires assistance with all aspects of personal care and may be ambulant but confused, disturbed and incontinent. (Department of Health and Children 2006c)

9.5.4 Disability/Illness

The DOHC also elicits information about residents' medico/social status or "main reason for residence" under 11 possible headings: respite, chronic mental illness, chronic physical illness, convalescence, rehabilitation, dementia, physical disability, intellectual disability, social reasons, palliative care, and other reasons. The largest proportion of residents require care because of chronic physical illness (34.5%) with dementia (24.1%) as the second largest reason for residence (Table 9.9). These reasons for residence apply to over 40% of residents in all categories of long-stay unit except for voluntary welfare homes, where 54% of residents were present for social reasons in 2006, 22% due to chronic physical illness and 12% due to physical disability (Department of Health and Children 2006c). Private nursing homes report significantly more residents suffering from dementia (29.9%) than any other category of institution. A further 6.8% of their residents suffer from chronic mental illness. In the INHO survey of private and voluntary homes in 2006, 36.8% of residents had been formally diagnosed with dementia, which the INHO suggested might be understated because residents with dementia might not be formally assessed or categorised as dementia residents (Irish Nursing Homes Organisation 2003-2007).

Table 9.9 Medico/social status of residents of longstay units, 2006

	HSE extended care unit	HSE welfare home	Voluntary Home/Hospital for Older People	Voluntary Welfare Home	Private Nursing Home	**Total All Beds**
Respite	6.3%	3.0%	3.2%	2.5%	3.1%	4.0%
Chronic mental illness	5.8%	11.4%	2.2%	3.8%	6.8%	6.4%
Chronic physical illness	44.1%	33.9%	30.1%	22.3%	30.8%	34.5%
Convalescence	4.7%	0.4%	3.5%	0.3%	2.0%	2.7%
Rehabilitation	3.0%	3.3%	6.1%	0.0%	1.0%	2.1%
Dementia	18.6%	15.1%	12.5%	5.0%	29.9%	24.1%
Physical Disability	5.0%	7.4%	5.5%	11.9%	11.4%	8.9%
Intellectual Disability	5.8%	3.1%	25.0%	0.0%	2.1%	4.9%
Social Reasons	3.7%	19.3%	8.6%	53.9%	8.1%	8.3%
Palliative Care	1.5%	0.8%	0.7%	0.3%	0.9%	1.0%
Other	1.6%	2.5%	2.5%	0.0%	4.0%	3.1%

Source: DOHC Long-stay Activity Statistics, 2006

9.5.5 Length of Stay

Of residents in all long-stay units who were discharged during 2006, including those who died, the majority (78%) had been present for less than three months (Table 9.10). Voluntary homes/hospitals and HSE extended care units had the greatest proportion of such short-stay discharges at 89.2% and 83.2% respectively, while private nursing homes had the lowest proportion at 65.4%. Correspondingly, only 5.5% of voluntary home residents and 8.4% of residents of HSE extended care units were discharged following a stay of over one year, compared to 19.8% of residents of private nursing homes (Department of Health and Children 2006c). The average length of stay for residents in the private and voluntary nursing homes surveyed by the Irish Nursing Homes Organisation was 3.6 years in 2006. The apparent contradiction between this high average length of stay and the fact that over a year the majority of residents discharged have been present for less than three months reflects differences in survey methodology. The DOHC reports on all discharges over a year, while the INHO reports on the length of stay of all residents present at a point in time, the majority (93.2%) of whom are considered to be long-stay. Over half of long-stay patient stays (51.3%) end with death compared to 3.7% of patient stays in limited-stay beds. The majority (83.9%) of patients in limited-stay beds are discharged into the community.

Table 9.10 Proportion of residents of longstay units discharged (including deaths) during 2006 by length of stay

	HSE extended care unit	HSE welfare home	Voluntary Home/Hospital for Older People	Voluntary Welfare Home	Private Nursing Home	**Total All Beds**
Under 3 months	83.2%	73.3%	89.2%	74.4%	65.4%	78.0%
3 - 6 months	5.7%	4.6%	3.6%	1.5%	7.6%	5.9%
6 - 12 months	2.8%	3.0%	1.7%	3.0%	6.7%	3.9%
1- 2 yrs	3.3%	3.6%	1.6%	4.1%	6.5%	4.1%
2-4 yrs	2.8%	6.7%	1.8%	5.6%	7.2%	4.2%
4 -6 yrs	1.0%	4.8%	0.8%	3.5%	3.4%	1.9%
6-10yrs	0.9%	2.5%	0.8%	7.6%	2.0%	1.3%
10+ yrs	0.4%	1.4%	0.5%	0.3%	0.7%	0.5%

Source: DOHC Long-stay Activity Statistics, 2006

9.6 Relationship between acute and long-term care – regional variations

Significant variation is evident in regional patterns of admission to and discharge from long-stay units. In 2006 48.5% of residents were admitted from the community within the Western region compared to 69.1% in the Dublin / Mid-Leinster region. Correspondingly, the proportion admitted from acute hospitals also varied from 22.0% in Dublin / Mid-Leinster to 44.5% in the West. A higher proportion of patients (16.0%) died when resident in long-stay units in Dublin/Mid-Leinster compared to 14.5% in the West, whereas 14.3% of residents were discharged to acute hospitals in the West, compared to 4.4% in Dublin/Mid-Leinster (Department of Health and Children 2006c).

A pattern thus emerges in the 2006 data which show long-stay units in the West playing a more integrated role with hospital services than in the Dublin/Mid Leinster region. Residents in the West were much more likely to be admitted to a long-stay unit from hospital and to be discharged to an acute hospital. Residents in Dublin/Mid-Leinster were much more likely to be admitted to a long-stay unit directly from the community and to die there. It would appear that in long-stay units in the West residents who become very ill are more likely to be discharged to hospital and to die there. There has been official recognition for some time that the supply of stepdown facilities from acute hospitals is a particular problem in the East. Difficulties in accessing acute care have also been most pronounced in the East, as evidenced by waits in Emergency Departments (Tussing and Wren 2006). It was noted in Layte et al (2009a) that patients in acute hospitals in the East

had the longest average duration of hospitalisation, staying in hospital for more than 8 days on average in 2004, which was approximately 28 per cent longer than the figure across all health boards, an observation which might partially reflect complexity of conditions but could also reflect difficulties in accessing appropriate long-stay or limited stay accommodation on discharge.

9.7 Long-term care in the community

No definition of "community care" appears in Irish legislation. Eligibility for services is unclear. The National Economic and Social Forum (NESF) has published a broad definition:

> As part of the services for older people, community care generally means helping people who need care and support to live with dignity and independence in the community, usually in the person's own home or the home of a relative. But it could also include care provided in specially provided facilities within the local community, for example in some form of sheltered or supported housing with varying degrees of supervision and /or nursing care. The care involved may be provided by a combination of sources: family members or voluntary carers, public health nursing, home help, day centres, paramedical services such as occupational therapy and chiropody, meals on wheels, etc. (National Economic and Social Forum 2005: 24).

This definition can be further broadened beyond health and social services to include income maintenance, housing, transport and life-long education, all of which contribute to the ability of an older person to remain in the community. This section concentrates on care services in the community.

The majority of older people do not need care services, live fully independently and may indeed themselves care for younger and older relatives and friends (Timonen et al. 2006). The objective of maintaining older people with care needs in their own homes for as long as possible has been Irish Government policy since the publication of *The Years Ahead: A Policy for the Elderly* (Working Party on Services for the Elderly 1988). The social partnership agreement, *Towards 2016,* asserted a shared "vision of an Ireland which provides the supports, where necessary, to enable older people to maintain their health and

well-being, as well as to live active and full lives, in an independent way in their own homes and communities for as long as possible" (Department of the Taoiseach 2006: 60).

The agreement lists among its 10-year goals:

> Every older person would have adequate support to enable them to remain living independently in their own homes for as long as possible. This will involve access to good quality services in the community, including: health, education, transport, housing and security, and;
>
> Every older person would, in conformity with their needs and conscious of the high level of disability and disabling conditions amongst this group, have access to a spectrum of care services stretching from support for self-care through support for family and informal carers to formal care in the home, the community or in residential settings. Such care services should ensure the person has opportunities for civic and social engagement at community level. (Department of the Taoiseach 2006: 60)

Evidence suggests that much more needs to be done to make this a reality (National Economic and Social Forum 2005). A traditional reliance on the family to care for frail, older people has led to the underdevelopment of formal community services (Convery 2001). Barriers to the development of better community care, identified by the NESF, include: its weak legal underpinning; a bias in funding and incentives towards institutional care; uncoordinated and patchy service provision; shortages of community staff (particularly social workers, chiropodists and physiotherapists); and a lack of clarity about the respective caring roles of the family and the State. Such are the shortcomings of the existing community care system that it remains valid to ask:

> ...is it possible, within the Irish context, to increase service provision to the level where even persons with extensive care needs, and especially those who lack informal supports, can be facilitated to live in their own homes? (Timonen et al. 2006: 203)

Sources of data on long-term care in the community in Ireland are limited. These include: the HARP-Hessop surveys, the 2006 National Disability Survey; and a minimum data set on services for older people, under development by the HSE.

HESSOP (Health and Social Services for Older People) is a longitudinal study of community-dwelling older people designed to identify their health and social needs, service use, and challenges to service delivery and take-up. Repeated studies were conducted in 2000 and 2004 (Garavan et al. 2001; O'Hanlon et al. 2005). The 2004 study was commissioned as part of the Healthy Ageing Research Programme (HARP), a cross-institutional, cross-border project which aims to provide continuity in knowledge of health and social service usage for older people in Ireland. Cross-border comparisons were published in a separate study (McGee et al. 2005). Samples in the HARP/HESSOP studies are close to or under 1,000 randomly selected people aged 65 and over. Only 314 of the original participants from HESSOP 2000 provided full responses to the follow-up longitudinal study in 2004.

The 2006 National Disability Survey has the benefit of a much larger sample than HARP-Hessop. The survey covers 17,000 people of all ages, randomly sampled from respondents who indicated in the 2006 Census of Population that they had a disability or longstanding health condition. The survey includes detailed questions about met and unmet need for aids to daily living and care services in the community.

In 2006 the HSE developed a minimum data set on services for older people, with monthly data collection on: number of home help hours provided; number of recipients of home help; number of persons in receipt of home care packages; and number of persons in receipt of day care (Health Service Executive 2005). For purpose of this study, the HSE supplied data for 2006 and provisional data to June 2007 for home helps and home care packages.

While national quantitative data are limited, recent valuable qualitative research has explored the nature of and inter-relationships within the rapidly evolving system of domiciliary (at home) care in Ireland (Timonen et al. 2006).The key providers of formal care services in the home are: public health nurses, home helps, health care assistants (formerly known as home care attendants) and privately employed carers and nurses. Social workers and publicly employed paramedical staff, such as physiotherapists, occupational therapists and speech and language therapists, also play an important role in enabling older people to return home from hospital or to remain in their homes. The health boards formerly and now the HSE employ public health nurses (PHNs) and community

general nurses (RGNs). In addition to clinical care, PHNs assess and re-assess clients for home care services. The combined effect of reduced hospital stays for older people and a public sector recruitment embargo from 2002 subsequently greatly increased demands on a stretched community nursing service (Timonen et al. 2006).

The home help service was initially developed by voluntary, non-profit organisations. From the 1970s, health boards also came to employ home helps directly. Home helps generally provide domestic services like cleaning, shopping, doing laundry and making meals. Some home helps also provide personal care and companionship. The establishment of the health care assistant role in the 1990s was the first publicly financed and publicly-provided, non-medical, home care service in Ireland. Community health care assistants provide personal care services, like washing, dressing and lifting, and helping in and out of bed (Timonen et al. 2006).

In 2001, health boards began to pilot home care packages, which have since become a rapidly growing conduit for state funding of home care. As pressures mounted on acute hospitals in the winter of 2004/2005, these packages were expanded by the HSE as part of an initiative to speed discharge of older people from acute hospitals and reduce pressures on Emergency Departments. Home care packages can vary greatly. The HSE has supplied the following definition:

> These packages should comprise services such as Public Health Nursing, Day Care, Occupational Therapy, Physiotherapy, Home Help Services and Respite are, whether drawn from the existing pool of services or any additional resources which might be put in place. If appropriate they should also take account of requirements for specialised equipment or adaptations to the house, and the availability of sheltered housing options.
>
> Each package will be tailored to the needs of the recipient taking account of his or her particular circumstances and the presence or otherwise of a carer. It could involve the provision of services by public and / or private providers, voluntary groups and individuals. In most cases, this should be through direct reimbursement of the service provider by the HSE. However, in order to maximise flexibility it may be appropriate, in certain circumstance, to make a cash payment to the care recipient on the basis of receipted and approved expenses.

Thus, home care packages may encompass a range of services from home help to care attendant to nursing care. The providers may be private, voluntary or public. The package may take the form of a cash grant, so-called "cash-for-care", directly supplied to a client by the HSE to enable them to purchase their own care; or, more frequently, the HSE instead purchases care directly from a provider on a client's behalf. This provider may be a non-profit or, increasingly, a private home care provider. Private home care organisations offer more flexible care workers, who are usually expected to combine personal and domestic care, and to be willing to work at night. Private home care agencies offer domestic care, personal care, day sitting/companionship service, night sitting service, night waking service, respite care and live-in care (Timonen 2004; Timonen et al. 2006).

9.8 Numbers in receipt of home care

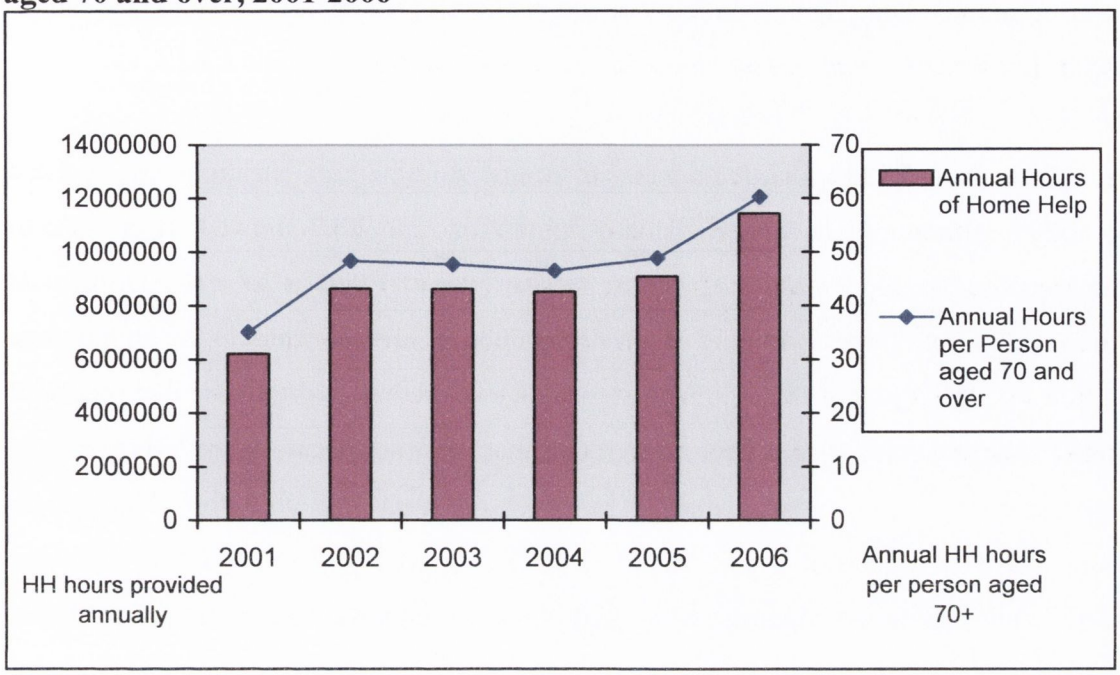
In December 2006, 49,578 people were receiving home help services. Aggregate home help hours provided nationally were 1,044,382 in that month, implying an individual average of 21 hours monthly. This was the first year covered by the HSE's new data set, collected monthly. Previously the DOHC recorded annual totals of home help hours provided (Table 9.11 and Figure 9.10).

Table 9.11 Hours of home help provided annually and in proportion to population aged 70 and over, 2001-2006

Year	Annual Hours of Home Help	Population aged 70 and over	Annual Hours per Person aged 70 and over
2001	6211657	177000	35.1
2002	8639010	178600	48.4
2003	8629561	180900	47.7
2004	8513448	183200	46.5
2005	9096000	186100	48.9
2006	11430570	189600	60.3

Source: DOHC for home help hours; Central Statistics Office for population.

Figure 9.10 Hours of home help provided annually and in proportion to population aged 70 and over, 2001-2006



Source: DOHC

The notably increased delivery of domiciliary care in 2006 reflected a new commitment from Government to supporting alternatives to institutional care, expressed in additional funding in the 2006 Budget. This followed a reduction in home help hours provided annually in 2003 and 2004. In health board areas outside the East there had been a 19% drop in the number of whole-time equivalent home helps employed from 2001 to early 2005 (Tussing and Wren 2006).

The HARP-Hessop study reported that in 2004 7% of people aged 65 and over in the Republic of Ireland had received home help services in the preceding 12 months compared to 17% in Northern Ireland; 2% of those interviewed in the Republic had received meals-on-wheels compared to 6% in Northern Ireland. These differences remained significant even when known demographic differences between the samples were taken into account (McGee et al. 2005). Home help service provision in 2004 was about half that of comparable European countries (O'Hanlon et al. 2005).

Other research has described a high level of unmet care needs among older people living in the community (Timonen 2004). There has been survey evidence of significant differences in provision of home help services, depending on area of residence, with residents in the East more likely to avail of such services than their counterparts in the

West. Over the four-year period of the two Hessop surveys, a trend emerged of increasing numbers of people paying for community-based health and social care services (O'Hanlon et al. 2005).

In December 2006, 5,283 individuals were in receipt of home care packages, as recorded in the HSE's minimum data set. Provisional figures for June 2007 showed an increase to 7,469 recipients. These increases came from the low base of 1,000 in 2004 (Department of Health and Children 2006b). A study of ten private home care providers in the Dublin area found that for all but two of them home care packages were becoming their main source of clientele (Timonen et al. 2006). This study found that most home care grants were secured through hospital discharge procedures. The level of grant available for older people returning home from hospital was higher than that offered to older people who were assessed as needing home supports, when still in the community. There were fewer home care grants available to people in the community. This discrepancy has provoked concerns about a perverse incentive for hospital admission as a route to assistance in remaining at home (Timonen et al. 2006).

Eligibility for and the amount of a home care package is subject to a means test. Eligibility requirements have been variable over time and across areas. The value of the package and its duration may vary (Timonen 2004; Timonen et al. 2006). In the case of home help services, user fees are inconsistently imposed. While the services of health care assistants are free to the client, and private services are either funded by the HSE through home care packages or purchased privately, the home help services supplied by not-for-profit organisations may or may not incur a charge and the amount charged varies greatly depending on area. Availability of home help services is also very variable. Such inconsistencies can make accessing home care a confusing and daunting process for older people and their families.

The rapid increase in state funding of privately delivered home care has provoked concern about the unregulated nature of the sector, frequently expressed by directors of private companies (Timonen et al. 2006), echoing the concerns expressed about rapid expansion and lack of regulation in the private nursing home sector (McEnery 2007). The new emphasis on home care has been driven by an imperative to speed discharges of older people from acute hospitals and by a perception that it is not only preferred by older

people themselves but that it is also cheaper. This may not be the case for people with higher levels of care needs. Furthermore, if the opportunity costs of informal care (i.e. the loss to the workforce of the unpaid, informal carer, or the loss to the carer of potential earnings) are taken into account, care in the home has been shown to be more expensive than nursing home care (Timonen et al. 2006; Hughes et al. 2004).

The population of 49,578 in receipt of home help services in December 2006 was approximately twice the population of 24,400 resident in long-stay units in that year. To estimate the total population in receipt of community care services, some proportion of those receiving home care packages should be added but, given that many packages include an element of home help, there is overlap between the two populations. There is no official count of individuals purchasing care privately either from commercial providers or in the "grey" market, who should also be included in a comprehensive count.

9.9 Summary and conclusion

The decade to 2006 saw a marked rise in the population in older age cohorts in Ireland. Although there is evidence of declining disability among older people, analysed in Chapter 10, demand for long-term care increased, as evidenced in the increasing numbers of residents in private nursing homes and growing numbers availing of home help services. Further factors driving this demand were the increase in the proportion of older people living alone and the rise in female labour force participation, which reduced the potential supply of informal carers in the community.

The population receiving long-term care in institutions rose by an estimated 12.4% in the years 2003-2006, a period when population aged 80 and over increased by 10%. With little change in public long-term care provision, most of this demand was met by rapid increases in the supply of private nursing home beds. Pressure to facilitate discharge of older people from acute hospitals was the catalyst for increased public spending on care in the community, delivered primarily in the form of additional home help hours and home care packages. While in 2006 the rate of residential care for older people in Ireland was close to the OECD average, community care remained under-developed and there was evidence of continued unmet need.

The rapid increase in public funding to private providers in an under-regulated sector has provoked concerns about quality of care, staff training and ratios in institutions and in the community. The desirability of more demanding care standards suggests that projection of the future cost of care in Ireland should not be predicated on current prevailing costs. Long-term care is a sector of health and social services in Ireland that is undergoing and will continue to undergo rapid change, driven by population growth and ageing, further shrinking in the pool of informal carers, and government policies of reducing acute care provision, promoting independent living in the community, and private provision of community and institutional care. The introduction of a new system of eligibility and state support for long-term care in institutions, (Department of Health and Children 2006b) in the absence of a similar system for funding community care, may reinforce the existing bias towards institutional care. The next chapter develops alternative forecasts for LTC demand in Ireland in the years to 2021.

Chapter 10 Projection of long-term care demand in Ireland

10.1 Introduction

This chapter forecasts demand for long-term care (LTC) in Ireland over the period 2007-2021. A range of forecasts takes into account: forecast demographic change; evidence on the evolution of disability rates in Ireland; and the potential effect on long-term care demand of policy developments in acute hospital care. The chapter develops disability rate forecasts based on analysis of disability prevalence deriving from Census 2002 and 2006 and the National Disability Survey (Central Statistics Office Ireland 2008). The majority of recipients of LTC in institutions in Ireland are aged 65 and over and require care because of disabilities associated with ageing. This chapter forecasts the demand for care by such older people rather than demand for care for younger people with disabilities.

In sequence, this chapter describes: the data sources used (Section 10.1); the forecast methodology (Section 10.3 and 10.4); and relevant population and household composition forecasts (Section 10.5). Detailed disability rate forecasts are then developed and form the basis for forecast population with severe disability (Sections 10.6 and 10.7). From these forecasts residential LTC demand is forecast for the country as a whole (Section 10.8) and for HSE regions (Section 10.9). The potential effect on LTC demand of proposed reductions in acute care services is analysed (Section 10.10). There follows a review of a range of combinations of residential and community care that Ireland would require to offer the level of services for older people in some other European states (Section 10.11). The final section summarises and concludes (Section 10.12).

10.2 Data Sources

This chapter analyses and forecasts need for LTC and the pattern in which LTC need has translated and may translate into formally supplied demand, either in institutions or the community. The measure of need is numbers of older people with severe disability. Measures of demand are numbers resident in LTC institutions, numbers in receipt of home help services and numbers experiencing delayed discharge from acute care to LTC.

The 2006 Census of Population provides the baseline Irish population data. This chapter employs the demographic forecasts of Morgenroth (2009) for population growth by year of age and gender to 2021. Morgenroth in turn employs the mortality forecasts in Whelan (2008). Census 2002 and Census 2006 provide data on the evolution of disability in the years 2002-2006, while the 2006 National Disability Survey provides data on the prevalence of severe disability by age. The rate of utilisation of residential LTC in older age cohorts is derived from the Longstay Activity Statistics Series (LSAS) published by the Department of Health and Children (DOHC), which surveys the capacity of and population resident in public, voluntary and private long-stay institutions. Annual surveys conducted by the Irish Nursing Home Organisation supplement the LSAS to generate a more comprehensive capacity count.

For the purpose of international comparison of the relationship between acute hospital care and LTC, OECD Health Data 2007 provides measures of acute and residential LTC capacity. To compare LTC intensity internationally, numbers in receipt of residential LTC, numbers of home help recipients and the average hours of home help received are employed. A new HSE database (Health Service Executive 2007) provides data on Irish home help recipients and home help hours, while Rauch (2007) is the source for such cross-country data. Female labour force participation rates are sourced from the World Bank's World Development Indicators (WDI) database.

10.3 Methodology

The alternative approaches to modelling LTC demand have been characterised as micro-simulation or macro-simulation models (Wittenberg et al, 1998). Micro-simulation models are based on representative samples, which are employed to simulate changes in

individuals' disability status and long-term care utilisation. Such models require regular surveys of the same large sample of individuals and have been employed in the US (Wiener et al, 1994) and in the UK (Forder and Fernandez, 2009). Macro-simulation models group the population into sub-groups or cells. In a cell-based model the unit of analysis is aggregates of individuals grouped by characteristics such as age and gender. Cell-based, macro-simulation models have been employed in the UK (Nuttall et al., 1994; Richards et al., 1996; Wittenberg et al, 1998 and 2006; Malley et al, 2006; Wanless et al, 2006) and Ireland ((Department of Social and Family Affairs 2002) Department of Health and Children, 2008). The development of a model to project need and demand for long-term care in Ireland is constrained by data availability. Appendix B reviews a range of models and the data requirements to develop such models in Ireland.

The model developed in this chapter is a cell-based macro-simulation, in which the eventual projections of demand for residential long-term care are highly aggregated at the level of a single cell for population aged 65 and over but the analysis underlying the projections employs disaggregated data for disability rates by single year of age and gender. The disability rate data would support developing a more disaggregated model, with multiple cells in which population is divided by age and gender and to which predicted disability rates are assigned. However, assigning projected long-term care utilisation rates to these disaggregated cells requires prior analysis of cross-sectional or, optimally, longitudinal data from which the probability of utilisation of alternative forms of long-term care services can be estimated by econometric, multi-variate regression analysis. The most developed models predict utilisation based on analysis of existing LTC utilisation patterns as a function of age, gender, disability rates, and other variables such as household composition, informal care availability and housing tenure (Malley et al, 2006; Wittenberg et al, 2006).

This chapter forecasts need for LTC based on demographic forecasts and disability rate forecasts. This relationship can be summarised as:

LTC need = Population aged 65 and over **X** Severe disability rate

This formula (applied across years of age for men and women) gives the forecast population with severe disabilities in any year. This chapter develops a number of

assumptions about how disability rates might evolve, which are employed in alternative forecasts of the population with severe disabilities. The methodological basis for these forecasts is explained in Sections 10.6 and 10.7 below.

A range of forecasts for residential LTC demand is generated by first assuming that the relationship of the population with severe disabilities and the population resident in LTC institutions remains as in 2006. A further range of forecasts for residential LTC demand incorporates unmet need. Developments in acute care can substantially increase LTC care demand, at any given rate of disability prevalence. A change in the relationship between acute and long-term care may occur because of reduced acute bed capacity and/or a reduction in acute average length of stay (AVLOS). The potential impact of changing acute care provision on residential LTC demand is analysed in the light of international experience. After other factors influencing LTC demand are taken into account, there remains this influence:

LTC Demand (with reduced acute care) > LTC Demand (with current acute care)

Many people in the forecast population with severe disabilities may receive care in the community, possibly from family members, whereas others receive care in institutions or from formal care-givers. Forecast demand for residential LTC should not be solely based on an assumption that the current proportion of the population with severe disabilities that is resident in LTC institutions will prevail at the end of the forecast period, given the potential effect of changes in the supply of care in the community. While factors such as female labour force participation rates and household composition, that influence how LTC need translates into demand for formal care, are discussed but not incorporated into this forecasting model, a cross-country comparison of intensity of LTC supply is employed to discuss the varying ways in which LTC demand is met internationally and could be met in Ireland.

10.4 Past utilisation trends

Available data are insufficient to support a forecast of demand for residential or community LTC based on past trends in utilisation. Variability of returns to the DOHC's Long-Stay Activity Statistics series (LSAS) hampers analysis. While the DOHC's series

and the Irish Nursing Home Organisation's annual surveys provide data on numbers of LTC residents and their age profiles, deriving age-specific utilisation from these surveys requires an assumption that they are representative of the population in LTC as a whole. This is assumed below in estimating older LTC residents in 2006, the baseline year for this forecast. The degree of estimation involved in generating such a count for preceding years would undermine a trend analysis. In analysing the level of community LTC provision this chapter employs a HSE database, which commenced in 2006.

Chapter 9 estimated that private, public and voluntary long-stay units had 27,400 beds and accommodated approximately 24,400 residents in 2006, of whom approximately 22,500 were aged 65 and over, which implies a residential LTC utilisation rate of 4.8% of people aged 65 and over. Utilisation rates range from 0.8% of those aged 65 to 69 to 33.7% of people aged 95 and over. Utilisation rates rise sharply with age but the greater numbers of LTC residents are aged 80 to 89 rather than older. The majority of LTC residents (65%) are aged 80 and over.

Table 10.1 Age utilisation rates of residential long-term care, Ireland 2006

	Aged 65 to 69	Aged 70 to 74	Aged 75 to 79	Aged 80 to 84	Aged 85 to 89	Aged 90 to 94	Aged 95 years and over	Aged 65 years and over
LTC resident population	1,098	1,976	3,562	5,612	5,807	3,538	903	22,500
Population	143,396	119,152	92,466	64,884	33,302	12,045	2,681	467,926
Utilisation Rate	0.8%	1.7%	3.9%	8.6%	17.4%	29.4%	33.7%	4.8%

Source: Age profile of residents from the DOHC's Long-Stay Activity Statistics for 2006 applied to the estimated LTC resident population of 24,400 gives estimated LTC resident population by age cohort. Age utilisation rate is this population as a percentage of the population of that age, as in Census 2006. Rounded totals.

The estimated age-utilisation rate of residential long-term care for people aged 85 and over in Ireland at 21% is above the US and UK with rates of 14% and 17%. Since this is an estimate, actual utilisation may be somewhat lower. In the US and UK, public sector cost containment and the development of alternatives to institutional care have contributed to this decline (Laing and Buisson 2007). Further factors in the US have been reduced age-specific disability rates and increased wealth, with concomitant increased care options,

among older people. The population of older people in nursing home care in the US dropped from 1.44 million in 1999 to 1.32 million in 2004 (Alecxih 2006). As discussed in Chapter 9, the Irish utilisation rate of 4.8% for people aged 65 and over is close to the average for comparable OECD countries.

10.5 Projecting Need for Long-Term Care

10.5.1 Population

Morgenroth (2009) forecasts that from 2006 to 2021 population will increase by 21%, the proportion aged 65 and over will increase from 11% to 15.4%, and the proportions aged 80 and over and 85 and over, respectively from 2.7% to 4.0% and 1.1% to 2.1%. The growth in numbers of older people is considerable, with numbers aged 85 and over more than doubling from 48,000 to nearly 106,000 and those aged 74-84 increasing by over a half from 157,000 to 248,000. These forecasts are largely independent of assumptions about growth rates and consequent immigration patterns. The implication of these forecasts is that whereas Ireland has had one of the younger age profiles within the OECD, over the years to 2021 this will change rapidly. In 2004 on average across 30 OECD countries the proportion of population aged 65 and over was 14.1% and the proportion aged 80 and over was 3.5% (Table 10.2), which compare with projected proportions for Ireland in 2021 of 15.4% and 4.0%. On these forecasts Ireland's demographics in 2021 would be similar to those of Denmark, Austria and Finland in 2004.

If the economic downturn in Ireland causes a pattern of sustained net emigration, these older age cohorts would constitute a greater proportion of the population as a whole, bringing Ireland's demographics closer to the mature age profile exhibited in a country such as Sweden where 17.2% of the population is aged 65 and over. Although such a turnaround in migration is not forecast to affect the numbers of people in older age cohorts requiring care over the forecast period, the change in the dependency ratio and reduced numbers in productive work would be expected to impact on the resources available for health and social care.

Table 10.2: Percentage of Population in Older Age Cohorts, OECD, 2004

	2004 Population aged 80 and over as % of total population	2004 Population aged 65 and over as % of total population
Mexico	*1.1*	5.9
Korea	*1.2*	8.7
Slovak Republic	2.3	11.6
Poland	2.5	13
Ireland	2.7	11.1
Czech Republic	2.9	14
Iceland	3.1	11.7
Luxembourg	3.1	14.2
New Zealand	3.1	12
Greece	*3.2*	*17.7*
Hungary	3.3	15.6
Australia	3.4	13
Canada	3.4	13
Netherlands	*3.4*	*13.8*
United States	*3.5*	12.4
Portugal	3.7	16.9
Finland	3.8	15.7
Belgium	*3.9*	*17*
Denmark	4.1	15
Austria	4.2	15.7
Germany	4.2	19.3
Spain	4.2	16.8
France	4.4	16.4
Japan	*4.4*	19.5
Switzerland	4.4	16.2
United Kingdom	4.4	16
Norway	4.6	14.7
Italy	*4.7*	19
Sweden	5.3	17.2
Average	3.5	14.1

Source: OECD Health Data, 2007 Numbers in italics for 2003 or 2002.

10.5.2 Household composition and informal care supply

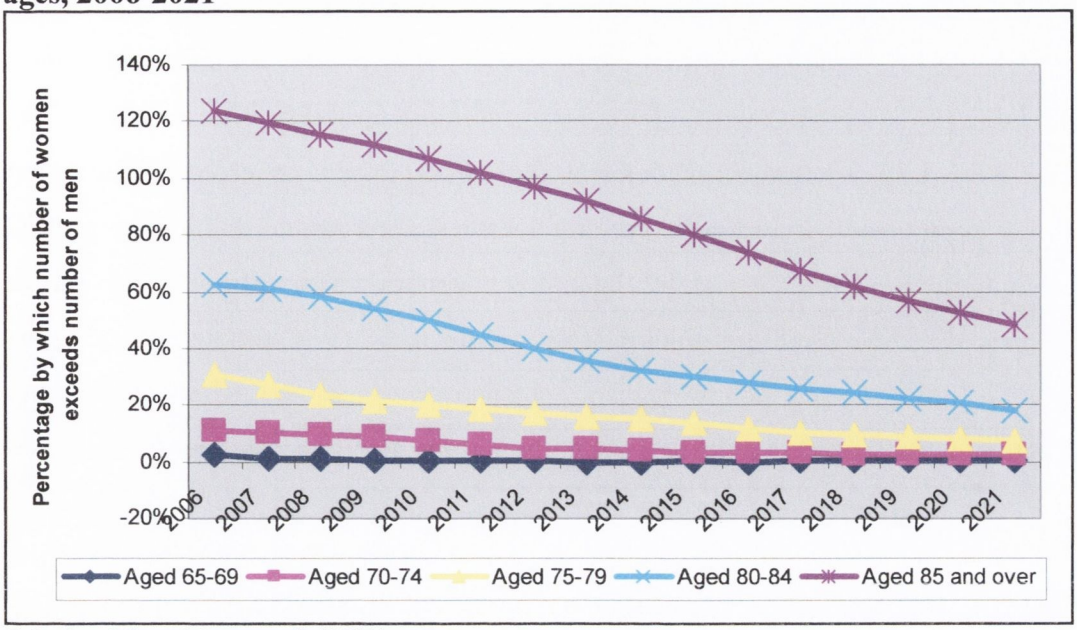
Earlier chapters have reviewed and analysed how the supply of informal care in the community is influenced by female labour force participation rates and trends in household composition. The discussion in Chapter 9 demonstrated that the Irish cohort of 25-34 year old women, who in 2006 showed the highest labour force participation rate at nearly 79%, will by 2026 become the cohort of 45-54 year old women, on whom the burden of unpaid care currently falls most heavily. Although this will reduce the availability of women

working in the home to provide informal care for their ageing parents, there is evidence that Ireland will experience marked convergence between male and female life expectancy, which emerged as a significant downward driver of both acute bed utilisation and long-term care utilisation in the analysis in Section 2. A full assessment of the impact of trends in FLFP on informal care availability should further analyse trends in part-time working, data available for Ireland from the International Labour Organisation's Key Indicators of the Labour Market (KILM) database, given the evidence of differing effects on LTC expenditure of full-and part-time participation by women (Yoo et al. 2004).

Based on recent trends, Morgenroth (2009) forecasts that the proportion of males aged 65 and over and living alone will remain constant, while current rates of reduction and convergence across counties of the proportion of females aged 65 and over and living alone will persist. This reduction in the proportion of older women living alone is partially explained by the reduction in the proportion of never-married among those entering older age. Additionally, the greater increase in male than female life expectancy improves couples' prospects of living longer lives together.

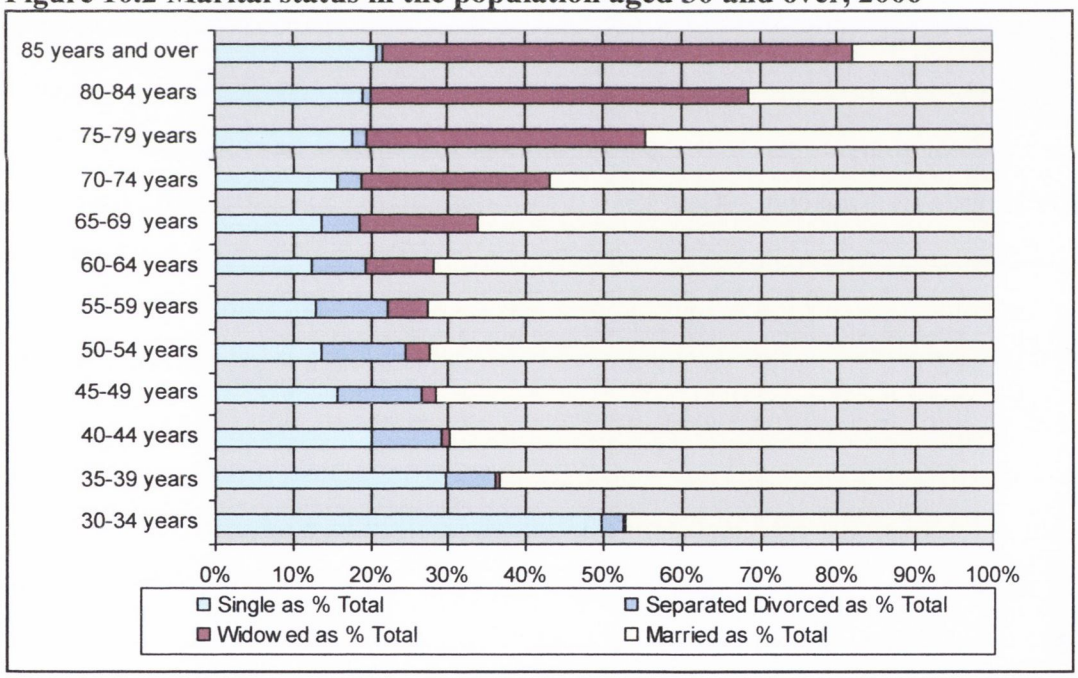
Morgenroth's demographic forecasts suggest that whereas in 2006 the number of women aged 85 and over was 124% of the number of men, by 2021 the percentage difference in numbers of women over men at these ages will have declined to 49%. Reductions in the difference between numbers of women over men occur across all age cohorts over 65 (Figure 10.1). While these trends will maintain more people at home with their spouses and partners during the disabilities and illnesses of older age, offsetting these effects is the rising rate of separation and divorce. In 2006, 24% of people aged 70-74 were widowed and 17% more women survived than men. By 2021, there will be only 3% more women than men in that cohort, with consequent reduction in widowhood. In 2021 those aged 70-74 will be the people who in 2006 were aged 55-59 and had a separation and divorce rate of 9%. While there is insufficient data to support a forecast of their rate of separation, divorce or remarriage, with fewer single people than the 70-74 year olds in 2006, and with the prospect of a much lower rate of widowhood, a higher proportion of this cohort could be expected to remain living with a partner in 2021 (Figures 10.2 and 10.3).

Figure 10.1 Forecast percentage difference in surviving women and men at older ages, 2006-2021



Calculated from Morgenroth (2009)

Figure 10.2 Marital status in the population aged 30 and over, 2006



Source: Census of Population 2006

10.6 Disability trends

The key question for forecasting LTC need is to what degree the increased numbers of older people will experience severe disabilities. In Chapter 2 I reviewed the international debate on the question of whether increased life expectancy will be matched by increased

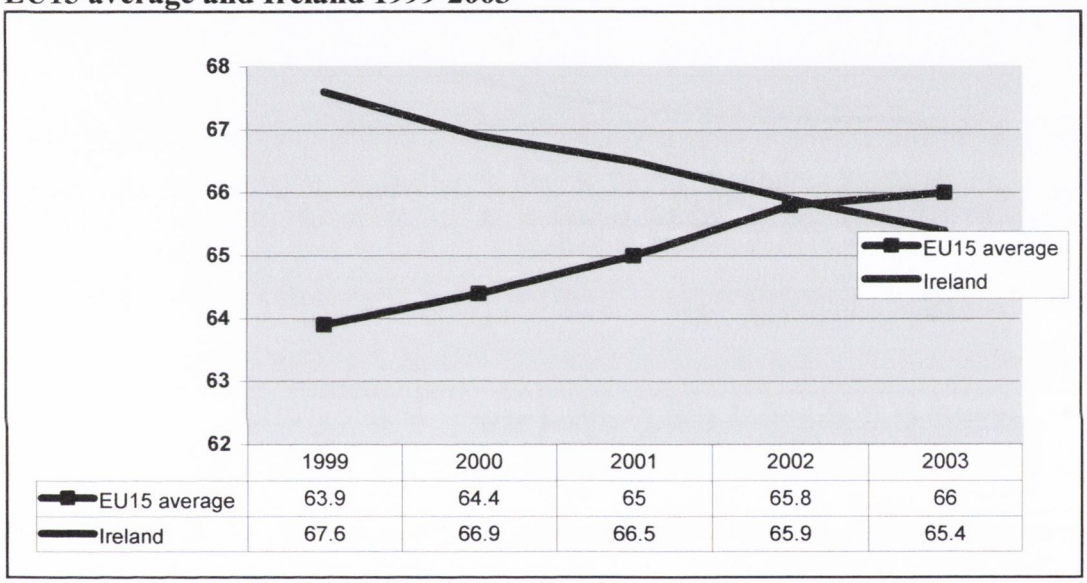
years lived in good health. Although the balance of opinion currently supports a view that both average lifespan and age of onset of poor health or disability will continue to extend leading to deferral of disability, cross-country evidence is mixed (Fogel and Costa 1997; Manton and Gu 2001; Cutler 2001; OECD 2007a). Even if disability is deferred, the key question for LTC need is whether this deferral is of equal, greater or lesser duration than extended life expectancy, accordingly keeping constant, decreasing or increasing LTC need relative to numbers of older people. Since it is uncertain whether future reductions in the prevalence of severe disability among older people will offset completely the rising LTC demand resulting from population ageing, most studies examine the impact on health and LTC demand of alternative assumptions about the evolution of disability.

Whereas a Eurostat measure has shown apparent reductions in disability-free life expectancy in Ireland for the years 1999-2003, this chapter's analysis of the national longitudinal disability data, available through Censuses 2002 and 2006, shows reduced incidence of disability among the population aged 72 and over, which conflicts with the Eurostat trend. The EU indicator measuring healthy life years (HLY), also referred to as DFLE (disability-free life expectancy), is based on mortality data and disability prevalence measures. Eurostat sources its cross-country measures of disability prevalence from the European Community Household Panel (ECHP) for the years 1995-2001, with estimations for 2002-2003 based on the 1995-2001 trends. The ECHP asks the question: "Are you hampered in your daily activities by any physical or mental health problem, illness or disability?" Three responses are possible: "Yes, strongly limited; Yes, limited; No, not limited." This Eurostat measure shows an increase on average in the EU in HLY at birth over the years 1999-2003 for both males and females. However, this measure shows HLY to be declining marginally for Irish men (63.9 years in 1999 to 63.4 years in 2003) and markedly for Irish women over this period (Figure 10.3). Irish HLY is shown to be improbably higher than the EU average in a period when Irish life expectancy is poorer than the EU average.

These findings highlight the limitations of using the ECHP as a basis for cross-country comparisons of disability prevalence. Ahn et al (2004) pointed out that because health and disability status is self-reported "this makes data fraught with problems and hard to compare among countries...using the ECHP data requires being extremely careful as to making country comparison." Ahn et al noted that the Irish along with the Danes reported

the best health status in the 1994 ECHP despite having among the worst life expectancies. Among the population aged 55-59, Ireland reported a 25% disability rate compared to 40% in Germany. For ages 65-69, France reported a severe disability rate of 22% compared to only 10% in Ireland, the UK and Spain. Such improbable differences might partly reflect cross-country differences in the proportion of the older population living in institutions who are not surveyed for the ECHP, an important omission in this context. However, in light of the magnitude of the differences, it seems likely that differing cultural understandings of disability and expectations for activity in older age also play a role.

Figure 10.3: Eurostat measure of Healthy Life Years at Birth -Female EU15 average and Ireland 1999-2003



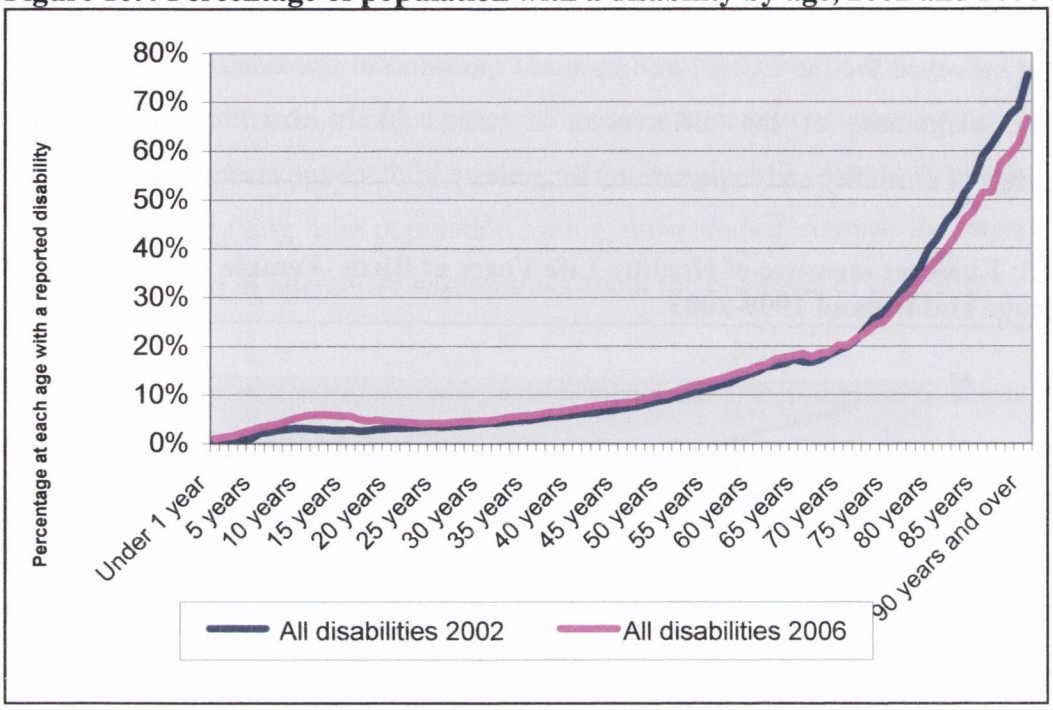
	1999	2000	2001	2002	2003
EU15 average	63.9	64.4	65	65.8	66
Ireland	67.6	66.9	66.5	65.9	65.4

Source: Eurostat.

Given the limitations of cross-country comparisons, national data tend to be used to determine trends within countries in the evolution of disability. The Censuses of 2002 and 2006 afford the first comprehensive, longitudinal evidence on Irish disability trends and support an optimistic view of the evolution of disability. Although Census 2006 records disability in the overall population at 9.3% compared to 8.3% in Census 2002 and increased overall disability prevalence in every year of age up to 71, prevalence is reduced at every age above 71 (Figure 10.4; Table 10.3). This reduced disability rate from age 72 and over between 2002 and 2006 is an important trend in projecting future LTC demand. This improvement is not unexpected given improved life expectancy (Morgenroth 2009) and could be attributable to many factors: growth in income per capita; improved educational attainment; improved access to and greater investment in health and social care. For the first time from 2001 to 2008 all Irish people aged 70 and over had access to

primary care and prescribed drugs free at the point of delivery (means-testing was reintroduced in the 2009 Budget). Public current health spending per capita converged to the EU15 average from 79% in 2000 to 96% in 2006 (OECD 2008).

Figure 10.4 Percentage of population with a disability by age, 2002 and 2006



Source: Census of Population disability volumes, 2002 and 2006

An expansion in 2006 of specified long-lasting disabling conditions is suggested as sufficient explanation for the increase in disability in the population overall and at younger ages. In 2002 respondents were asked in a first question about their experience of "long-lasting conditions" specifying those affecting sight and hearing, and physical activity. A further question enquired if any physical, mental or emotional condition lasting six months or more caused difficulties in a range of everyday activities from "learning, remembering and concentrating" to going outside the home alone or working. In 2006 the range of long-lasting conditions specified in the first question was expanded to include: a learning or intellectual disability, a psychological or emotional condition and "other, including any chronic illness". The subsequent question about difficulties in everyday activities no longer stipulated that this related to a condition lasting 6 months or more but stated that anyone experiencing the long-lasting conditions described in the first question should answer this question. It too was expanded to include a general category "participating in other activities".

Table 10.3 Disability Prevalence, Ireland 2002-2006

	Census 2002	Census 2006	**Annual average percentage increase/decrease**
Age Group	% of persons with a disability %	% of persons with a disability %	2002-2006 %
0-4 years	0.7	1.8	26.6
5-9 years	2.7	4.2	11.7
10-14 years	2.9	5.8	18.9
15-19 years	2.8	4.9	15.0
20-24 years	3.3	4.3	6.8
25-29 years	3.7	4.4	4.4
30-34 years	4.5	5.2	3.7
35-39 years	5.4	6.3	3.9
40-44 years	6.4	7.7	4.7
45-49 years	7.9	9.0	3.3
50-54 years	10.1	11.3	2.8
55-59 years	12.7	14.0	2.5
60-64 years	16.0	17.0	1.5
65 years	16.8	18.4	2.3
66 years	16.7	17.8	1.6
67 years	17.3	18.6	1.8
68 years	18.3	18.7	0.6
69 years	19.2	20.1	1.2
70 years	19.9	20.1	0.2
71 years	21.4	21.6	0.2
72 years	23.4	22.8	-0.7
73 years	25.8	24.4	-1.4
74 years	26.9	25.0	-1.8
75 years	29.0	27.1	-1.7
76 years	31.3	29.6	-1.5
77 years	33.6	31.0	-2.0
78 years	36.1	33.6	-1.8
79 years	40.0	36.0	-2.6
80 years	42.0	37.8	-2.6
81 years	45.5	40.0	-3.2
82 years	47.7	42.7	-2.7
83 years	51.3	45.9	-2.8
84 years	53.8	47.8	-2.9
85 years	58.9	51.4	-3.3
86 years	61.3	51.5	-4.2
87 years	64.2	57.3	-2.8
88 years	67.2	59.2	-3.1
89 years	69.0	61.6	-2.8
90 years and over	75.6	66.6	-3.1
Total	8.3	9.3	3.0

Source: Census of Population Disability Volumes, 2002 and 2006

The expansion of specified long-lasting conditions could be sufficient explanation for the increase in disability recorded in the population overall and at earlier ages, in particular among children. Thus, whereas the percentage of 12-year-olds experiencing sight and hearing disabilities or conditions affecting physical activity (those questions with no change in presentation or wording) remains constant in the two censuses at 0.6%, the specification of additional conditions elicited that over 4% of the age cohort experienced long-lasting learning or intellectual disabilities and 1.2% had conditions in the "other, including chronic illness" category. The increase from 3% to 6% in those 12 year olds experiencing one or more disabilities between the two censuses could thus be entirely explained by the wider range of specified conditions.

Changes in the question asked do not explain the reduced prevalence of disability at older ages in 2006. For conditions where the Census questions remain unchanged, such as impairments of sight and hearing, while there is a marginal drop in disability prevalence overall and in most younger ages, this becomes more marked as age increases. In the case of conditions that substantially limit basic physical activities, there is also an overall decline in disability. The trend is more variable than in the case of sight and hearing but the greater falls in disability prevalence are again recorded among older people. Were these unchanged questions the only two questions asked, the evidence would be of a clear decline in disability prevalence overall, and a more marked decline at older ages (Table 10.4).

Other measures of disability that show similar declines in age-specific prevalence, which broadly increase with greater age, are difficulty in: learning, remembering or concentrating; dressing, bathing or getting around inside the home; or going outside the home alone to shop or visit a doctor's office (Table 10.4). The only difference in reporting methodology for these questions is that in 2002 respondents were asked to report such difficulty if they had had "a physical, mental or emotional condition lasting 6 months or more"; whereas in 2006, respondents were asked to report such difficulties if they had responded "yes" to the previous question which asked inter alia whether they had a psychological, emotional, or physically limiting condition or a chronic illness (without restriction to one lasting 6 months or more). Further evidence of reduced disability prevalence among older people is a decline in the prevalence of multiple disabilities as recorded between the two censuses.

There is a difference in the rate of decline across categories of disability, with the lowest annual average decline experienced in the prevalence of "A condition that substantially limits one or more basic physical activities". Women aged 65 and over experienced an annual average decline of 0.7% per annum in this type of disability while men recorded a 1% p.a. decline. The annual average disability rate decrease is greatest for cognitive disability ("Difficulty in learning, remembering or concentrating") with the overall 65 and over age cohort experiencing an annual average drop in prevalence of close to 6% for both women and men. The 65-74 year old cohort of women experienced a decline in the prevalence of this disability of over 7% per annum over the four years to 2006.

In forecasting long-term care need, and especially the need for residential long-term care, trends in those conditions most associated with institutionalisation are those of greatest relevance. Chapter 9 reviewed evidence that in public and voluntary long-stay institutions in 2006 the largest proportion of residents required care because of chronic physical illness (34.5%) with dementia (24.1%) as the second largest reason for residence. Private nursing homes reported significantly more residents suffering from dementia (29.9%) than any other category of institution. A further 6.8% of their residents suffered from chronic mental illness.

The National Disability Survey of 2006 further expanded the definition of disability and recorded a much higher national disability rate. In addition to surveying the incidence of a wider range of disabilities among a sample of those who had reported a disability in the Census, it surveyed a further sample of those who had not reported a disability. This revealed in particular that when experience of pain or breathing disabilities (such as asthma) are included among disabling conditions, this has a considerable impact on the reported prevalence of disability. Disabilities relating to pain were the most commonly reported. The survey's more embracing definition of disability had the effect of increasing the Irish disability rate from 9.3% to 18.5% of the population, a rate which is closer to international experience (Central Statistics Office Ireland 2008).

The survey also provides data on the severity of disability - an important measure in assessing need for health or social care. For the population aged 65 and over with severe disabilities (with the effect that they have a lot of difficulty in undertaking everyday activities or cannot do them at all), close to or over 40% were resident in communal

establishments (nursing homes and long-term care hospitals), if their disability was in the category of: speech, remembering and concentrating, intellectual and learning, or emotional, psychological and mental health (Appendix C: Table C1). The National Disability Survey affords the first opportunity in Ireland to compare the proportions of people at different ages and with varying levels of disability living in long-term care institutions and in private households. (Only residents in long-term care hospitals or long-term care sections of hospitals were interviewed in the survey i.e. patients receiving acute hospital care were excluded.)

Table 10.4 Annual average disability rate reduction or increase for men and women aged 65 and over in the years 2002-2006

%	*Total with disabilities*		*A condition that substantially limits one or more basic physical activities*		*Difficulty in learning, remembering or concentrating*		*Difficulty in dressing, bathing or getting around inside the home*		*Difficulty in going outside the home alone*	
Gender	F	M	F	M	F	M	F	M	F	M
Total	2.4	3.7	-1.5	-2.2	-2.2	1.4	-1.3	-1.4	-2.3	-1.8
65	2.3	2.3	-1.4	-1.5	-7.0	-4.4	-4.0	-1.6	-4.2	-3.4
66	1.8	1.4	-1.9	-1.9	-6.0	-6.7	-2.6	-2.0	-2.9	-3.0
67	2.8	0.9	-0.3	-2.2	-6.9	-4.6	-0.5	-3.5	-3.9	-6.0
68	0.4	0.7	-2.2	-2.4	-7.5	-5.8	-2.9	-2.1	-4.3	-3.0
69	0.5	1.9	-1.9	-0.5	-6.4	-6.7	-1.9	0.0	-3.3	-3.2
70	-0.1	0.6	-2.0	-1.4	-7.1	-8.1	-1.7	-2.1	-2.6	-4.8
71	-0.6	1.1	-1.1	-2.0	-7.8	-3.6	-2.5	-1.6	-2.4	-3.7
72	-1.0	-0.2	-1.6	-1.3	-8.4	-5.0	-2.7	-1.7	-3.7	-2.1
73	-1.6	-1.0	-1.5	-2.4	-6.7	-6.4	-1.6	-1.7	-2.7	-4.6
74	-2.0	-1.3	-2.0	-2.7	-5.9	-7.6	-1.8	-2.1	-3.7	-4.2
75	-2.0	-1.1	-1.9	-1.2	-9.2	-9.0	-3.2	-2.5	-4.1	-3.2
76	-1.9	-0.6	-1.1	-1.0	-7.8	-5.5	-2.5	-2.6	-2.6	-4.3
77	-2.2	-1.5	-1.3	0.1	-9.1	-7.8	-2.7	-0.2	-2.9	-2.5
78	-1.8	-1.6	-0.3	-1.4	-6.4	-7.8	-0.5	-1.7	-2.0	-3.8
79	-3.0	-1.8	-1.3	-0.3	-6.1	-6.0	-2.4	-2.6	-3.0	-3.6
80	-2.7	-2.4	-1.0	-1.0	-6.9	-6.7	-0.4	-1.3	-2.7	-3.2
81	-3.5	-2.5	-0.8	-1.3	-6.0	-6.5	-0.9	-1.6	-3.2	-3.9
82	-3.0	-2.3	-0.7	-0.1	-5.1	-4.6	-1.3	-0.8	-2.7	-1.6
83	-2.9	-2.6	0.8	0.7	-7.6	-6.0	-0.4	-0.6	-1.9	-2.9
84	-3.1	-2.4	-0.6	-0.4	-5.4	-2.2	-0.8	-0.9	-2.6	-2.8
85	-3.0	-3.9	-0.4	-1.0	-6.6	-4.4	-1.7	-1.2	-2.7	-3.5
86	-4.6	-3.4	-2.0	-1.9	-5.4	-7.9	-1.2	-2.4	-3.7	-3.7
87	-3.0	-2.2	-1.0	1.5	-4.8	-6.3	-0.9	0.6	-2.5	-0.7
88	-3.0	-3.0	-0.9	0.1	-5.9	-6.7	-1.0	-1.8	-3.0	-2.4
89	-2.4	-3.9	0.7	-2.0	-5.1	-6.8	-0.3	-4.0	-2.0	-3.3
90 +	-2.9	-3.8	-0.8	-0.9	-5.9	-5.4	-1.0	0.2	-2.7	-3.2

Source: Calculated from disability volumes, Census of Population 2002 and 2006. Disability data aggregated at source for age 90 and over.

While a disability affecting speech is the greatest predictor of LTC residency, with 53% of people aged 65 and over with such a disability residing in long-stay care, this is a relatively small grouping of long-stay residents (and could be associated with end-of-life illness and multiple disability). The disabling conditions experienced by the greatest number of long-stay residents aged 65 and over in 2006 were those affecting "mobility and dexterity" (16,300) and "remembering and concentrating" (11,800), a finding consistent with the DOHC's Long-Stay Activity Statistics. These two categories contributed 48% of the 59,200 disabling conditions among long-stay residents aged 65 and over (many residents have multiple conditions) (Appendix C: Table C1). In the older population overall respectively 69,700 and 22,600 people aged 65 and over experienced a lot of difficulty in everyday activities or were unable to do them at all because of either such physical or cognitive impairments. In these groupings 20.9% of people with high levels of physical restriction and 40.3% with high levels of cognitive impairment resided in long-stay institutions. Although 30,100 people experienced pain as a disabling condition at these two highest levels of severity, only 6.6% of these people were resident in LTC.

10.7 Applying the evidence on the evolution of disability to forecasting

To forecast disability rates and LTC need, a common methodology is to employ a range of assumptions about the evolution of disability based on national and international evidence. In its forecasts, the Mercer Report (Department of Social and Family Affairs 2002) used UK data on disability prevalence, assuming centrally that healthy life expectancy would increase in line with total life expectancy. Other projections assumed static disability prevalence; reductions in disability rates exceeding the base projection; and increased disability rates. The Report of the Interdepartmental Working Group on Long Term Care, 2006 (Department of Health and Children 2008) updated these projections to take account of population change, without changing Mercer's disability prevalence projections.

In this chapter the Census data are employed to forecast disability rates. Since these disability forecasts are applied to the demographic forecasts of Morgenroth (2009), underpinned by Whelan's mortality rate forecasts (Whelan 2008), it is desirable that the methodological approaches should be compatible insofar as possible. (The application of the Whelan/Morgenroth methodology to disability rate forecasting in this thesis is explained in greater detail in Section 5 Appendix B.8.) In the Whelan methodology, mortality rates are forecast by estimating the rate of improvement by gender and age from

2002 to 2005. Whelan assumes that this rate of improvement will decline over the 25 years to 2031 to a 1.5% long-term average improvement rate assumed for all ages up to 90 years after 2031. No mortality improvements are assumed at ages of 100 years upwards. For each year between 2005 and 2031, the mortality declines are calculated by linear interpolation.

Since the 2002-2006 inter-censal period overlaps the 2002-2005 period, which provides the starting point for Whelan's forecasts, it is consistent to take the disability rate trend reduction over 2002-2006 as the starting point for the forecast disability rate in 2021. I employed the evidence from the two Censuses to construct a range of disability rate forecasts for 2007-2021 based on a range of assumptions about the evolution of disability. These assumptions are:

1) Static disability prevalence i.e. that the age and gender specific disability rates remain constant at 2006 levels.
2) The annual average rate of reduction in the disability rate maintains the age and gender specific rates of reduction observed for cognitive disabilities in the 2002-2006 period.
3) The annual average rate of reduction in the disability rate maintains the age and gender specific rates of reduction observed for physically limiting conditions in the 2002-2006 period.
4) The annual average rate of reduction in the disability rate maintains the age and gender specific rates of reduction observed for total disabilities in the 2002-2006 period.

While the first assumption is pessimistic, the following three assumptions are relatively optimistic, since they are entirely based on recent evidence of declining disability. It could be the case that, as assumed by Whelan, in relation to the steep decline in mortality over the 2002-2005 period, the observed decline in disability over the 2002-2006 period reflects a cohort effect (i.e. the ageing of a particularly healthy generation). Comparison of the forecast disability rate reduction scenarios in Department of Social and Family Affairs/Mercer (2002) for the years 2001-2031 with the annual average disability rate reductions in the years 2002-2006 (Table 10.5) reveals that the actual experience of declining disability has in most categories exceeded Mercer's most optimistic assumptions.

In the two categories of disability that contribute most to the population in need of residential long-term care - substantial physical limitation and cognitive impairment - the rate of reduction in disability for men has exceeded Mercer's optimistic scenario. For women the rate of reduction in the physical limitation category is close to Mercer's optimistic scenario and exceeds it in the case of cognitive impairment.

Table 10.5 Mercer's assumptions about disability rate evolution 2001-2031 compared to actual evolution 2002-2006

	Mercer's assumed annual average change in disability rates 2001-2031 %				Actual annual average change disability rates 2002-2006 %		
	Base	Static	Optimistic	Pessimistic	Total	Substantial limit basic physical activities	Difficulty learning, remember-ing, concentrat-ing
Male							
65-84	-0.67	0	-1.00	0.25	-0.44	-1.23	-6.07
85+	0	0	-0.67	0.25	-3.50	-0.80	-6.00
Female							
65-84	-0.90	0	-1.35	0.25	-1.41	-1.04	-6.69
85+	0	0	-0.90	0.25	-3.10	-0.80	-5.70

Source: Department of Social and Family Affairs (2002) and disability volumes, Census of Population, 2002 and 2006

Given the relatively pessimistic or optimistic nature of these first four assumptions, I adopted a further three assumptions employing a methodology designed to be compatible with the Whelan mortality forecasts. In the absence of long-run longitudinal evidence on Irish disability rates, these further scenarios assume that the rate of reduction in disability rates will by 2021 revert to the base rates assumed in Department of Social and Family Affairs/Mercer (2002). The disability rate declines for the years 2007-2021 are calculated by linear interpolation from the annual average rate in 2002-2006 to an assumed long-run rate in 2021 equivalent to the Mercer base rate assumption. This exercise is repeated for each of the three disability measures employed above, yielding three further forecast assumptions:

5) The annual age- and gender-specific rates of reduction in the disability rate are estimated by linear interpolation from the annual average rates of reduction

observed for cognitive disabilities for 2002-2006 to the Mercer base rate forecast (assumed to apply in 2021).

6)) The annual age- and gender-specific rates of reduction in the disability rate are estimated by linear interpolation from the annual average rates of reduction observed for physically limiting conditions for 2002-2006 to the Mercer base rate forecast (assumed to apply in 2021).

7) The annual age- and gender-specific rates of reduction in the disability rate are estimated by linear interpolation from the annual average rates of reduction observed for total disabilities for 2002-2006 to the Mercer base rate forecast (assumed to apply in 2021).

Having developed assumptions for the evolution of disability rates from 2006, it is necessary to determine which population with disabilities should provide a 2006 baseline for these forecasts. To relate the evolution of disability to the Whelan/Morgenroth mortality forecasts requires that the forecasting model should differentiate between disability rates by year of age and gender. However, due to issues of sample size, the NDS aggregates its data for severe disability by gender into two cohorts: ages 65-74 and 75 and over. This restriction presents a difficulty in forecasting disability at the same level of detail as the Whelan mortality rate forecasts. An alternative baseline for severe disability prevalence in 2006 is the prevalence of conditions that substantially limit one or more physical activities. This appears to be a valid alternative because the age and gender-specific prevalence rates of this category of disability closely mirror the NDS rates for severe disability (Table 10.6).

Table 10.6 Comparison NDS severe disability rate with Census 2006 substantial physical disability rates by age and gender

	NDS Severe Disability		Census 2006 Substantial Physical Limitation	
	Male	Female	Male	Female
	%	%	%	%
65-74 years	11.3	12.6	11.4	12.6
75 years & over	24.2	30.9	24.8	34.2

The advantage of using this measure as a forecasting baseline is that the Census does not share the restrictions of the NDS because it is a total population count providing disability

rates by year of age and gender. Starting from this baseline of disability prevalence, and forecasting under the seven assumptions above, a range of age and gender-specific disability rates is forecast for 2021 (Appendix C: Table C2). The preferred forecast is based on the sixth assumption i.e. that rates of reduction in the disability rate converge from the rates of reduction observed for physically limiting conditions for 2002-2006 to the Mercer base rate forecast in 2021. This forecast is preferred for a number of reasons:

i) The assumption of static disability prevalence is pessimistic given the recent evidence of declining disability prevalence for older people in Ireland;

ii) Assumptions 2-4 are based on the assumed continuation of recent disability trends and are optimistic. They are incompatible with the demographic and mortality rate forecasts in this model, which assume that a cohort effect of improved mortality in the 2002-2005 period will converge to the lower long-run mortality rate improvement;

iii) Of the remaining three forecasts 5-7, starting from the trend improvement in substantial physical limitation is preferred because it is the disability rate which is the greatest predictor of need for residential long-term care, as well as being the measure of disability used in the baseline population and closely approximating to the NDS severe disability rate;

iv) To use forecast 5 based on the sharp drop in cognitive disability rates would be to apply a rapid improvement in one sub-group of disabilities to the wider population with disabilities. Only 7.5% of the population aged 65 and over reported such disabilities in Census 2006, compared to 20.2% reporting substantial physical limitation and 19% recording severe levels of disability in the NDS.

A more complex forecasting model could conceivably be constructed which would combine the forecast disability rates for a range of conditions weighted by their prevalence. However the prevalence of multiple disabilities in the older population would make it a challenging exercise to reflect that reality. The trends in age-related substantial physical disability rates for men are illustrated at 5-year age intervals in Figures 10.6 and 10.7. Figure 10.5 shows the effect of continuing the annualised rate of reduction of the 2002-2006 period while Figure 10.6 shows the effect of converging from the same starting points to the Mercer base rate.

Figure 10.5 Evolution of male age-specific disability rates 2007-2021, if 2002-2006 trend in reduction of substantial physical limitation continues

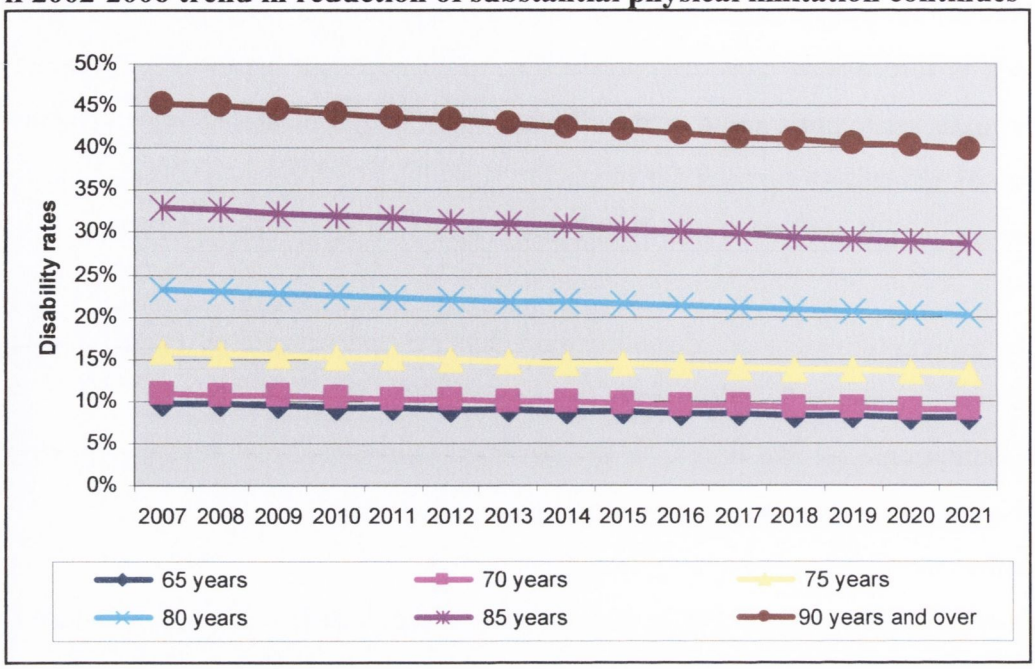
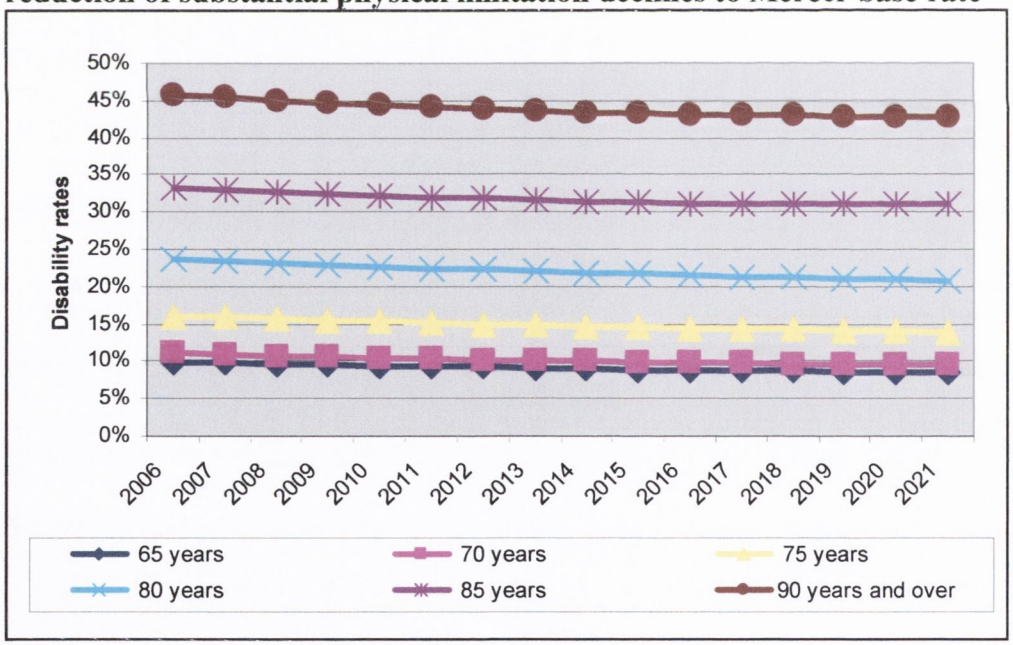


Figure 10.6 Evolution of male disability rates 2007-2021, if 2002-2006 trend in reduction of substantial physical limitation declines to Mercer base rate



Applying these forecast disability rates to the Morgenroth forecast population in 2021 generates a range of forecasts for the population with substantial physically limiting conditions, the proxy for severe disability in this model (Table 10.7; and Appendix C: Tables C3 and C4). As would be expected, the assumption of static disability prevalence yields the highest proportion of severely disabled in the over-65 age cohort in 2021. The

preferred disability rate forecast (6) yields the second highest proportion at 21.1% for women, 15.9% for men, and 18.6% of all people aged 65 and over (Appendix C: Tables C4 and C5). The growth at five-year intervals in the forecast population with severe disability based on this preferred forecast is shown in Appendix C, Table C5.

Table 10.7 Forecast populations with severe disabilities in 2021 based on alternative assumptions about evolution of disability

Assumption	Population aged 65 and over with substantial physical limitation/severe disability in 2021	
	Number	% of over 65s
1. Static disability prevalence	164,788	20.8
2. Cognitive disability trend reduction	62,879	7.9
3. Physical disability trend reduction	141,570	17.9
4. Total disability trend reduction	131,315	16.6
5. Cognitive disability trend reduces to Mercer base rate	101,263	12.8
6. Physical disability trend reduces to Mercer base rate	147,677	18.6
7. Total disability trend reduces to Mercer base rate	141,292	17.8

10.8 Projecting demand for residential long-term care

This forecast assumes initially that the relationship between the number of people aged 65 and over with severe disabilities and the number of LTC residents at the same age will remain constant over the forecast period. In 2006, an estimated 94,400 people aged 65 and over had substantial physical disabilities and 22,500 people aged 65 and over were LTC residents. This gives a ratio of population aged 65 and over with substantial physical disability to LTC residents aged 65 and over of 4.2:1. Applying this ratio to forecast population with severe disability, the preferred forecast demand for residential LTC for people aged 65 and over in 2021 would be 35,200 places or 4.4% of people aged 65 and over compared to 4.8% in 2006 (Table 10.8). Forecast demand for residential LTC should insofar as possible take into account current unmet demand, for which a potential indicator is the incidence of delayed discharge from acute care. Including a conservative estimate of such delayed discharges at 400 (Tussing and Wren 2006) increases preferred forecast

demand for residential LTC places in 2021 to 35,820 or 4.5% of the population aged 65 and over (Table 10.8). This suggests a requirement for an additional 13,324 LTC places or 888 places per annum from 2007-2021 for people aged 65 and over.

These forecasts compare with the forecast from the Interdepartmental Working Group on Long-Term Care of a requirement for between 600 and 1,200 additional residential LTC places per annum. The residential utilisation rate among over-65s was projected to rise to 5.4%, with a recommended target rate of 4% to be achieved by increasing community-based care (Department of Health and Children 2008). Were Morgenroth's higher population growth forecasts applied, the Working Group's projected 5.4% utilisation rate would suggest a need for nearly 43,000 residential LTC places for people aged 65 and over in 2021, an increase of 20,000 on the 2006 level, or 1,350 per annum over 15 years.

The lower forecast residential LTC demand is based on what might be regarded as an optimistic assumption of declining disability. Other studies have incorporated pessimistic assumptions about disability (Wanless 2002; Department of Social and Family Affairs 2002). Evidence of a rising obesity epidemic might support such pessimism. Additionally, if improvements in disability prevalence are related to increased investment in health care and improved access to care for older people, economic or political circumstances that reverse those improvements might be expected to reverse some of the improvement in disability prevalence. The forecast further assumes that factors determining demand for residential LTC remain unchanged. If high female labour force participation rates among younger women in Ireland persist as these women become older, the reduction in informal care supply may increase utilisation rates for residential LTC. An OECD study forecast greater growth in public LTC spending in countries such as Ireland, where female labour force participation rates are projected to increase significantly for the 50-64 year old cohort, whose parents are most likely to become disabled by ageing (OECD 2006).

The 2006 National Disability Survey recorded high numbers of people with severe disability in private households (e.g. 2,200 people aged 75 and over with the most severe level of disability in remembering and concentrating), suggesting an important role for informal or community care in keeping many people out of long-term residential care. First Irish evidence from the smaller sample SHARE study supports a picture of significant undermet and unmet care needs among older people in the community (Delaney et al. 2008).

Table 10.8 Forecast demand in 2021 for residential long-term care for population aged 65 and over, assuming factors leading to demand for residential care on 2006 basis and including 2006 estimated unmet demand

	Disability assumption	Pop. with severe disabilities	Resident in LTC facility	Ratio severe disability: res. LTC	Increase LTC residents	Extra places p.a.	Pop. 65+	% 65 Res. LTC
2006		94,400	22,500	4.20:1			467,926	4.8
2021 Forecasts of alternative trends in disability	1. Static disability	164,788	39,277	4.20:1	16,777	1,118	792,067	5.0
	2. Cognitive disability trend	62,879	14,987	4.20:1	-7,513	-501	792,067	1.9
	3. Physical disability trend	141,570	33,743	4.20:1	11,243	750	792,067	4.3
	4. Total disability trend	131,315	31,299	4.20:1	8,799	587	792,067	4.0
	5. Cognitive disability/Mercer	101,263	24,136	4.20:1	1,636	109	792,067	3.0
	6. Physical disability/Mercer	147,677	35,199	4.20:1	12,699	847	792,067	4.4
	7. Total disability/Mercer	141,292	33,677	4.20:1	11,177	745	792,067	4.3
2006	Unmet need of 400 added to LTC residents in 2006	94,400	22,900	4.12:1			467,926	4.9
2021 Forecasts of alternative trends in disability - plus provision for unmet demand	1. Static disability	164,788	39,975	4.12:1	17,475	1,165	792,067	5.0
	2. Cognitive disability trend	62,879	15,253	4.12:1	-7,247	-483	792,067	1.9
	3. Physical disability trend	141,570	34,343	4.12:1	11,843	790	792,067	4.3
	4. Total disability trend	131,315	31,855	4.12:1	9,355	624	792,067	4.0
	5. Cognitive disability/Mercer	101,263	24,565	4.12:1	2,065	138	792,067	3.1
	6. Physical disability/Mercer	147,677	35,824	4.12:1	13,324	888	792,067	4.5
	7. Total disability/Mercer	141,292	34,275	4.12:1	11,775	785	792,067	4.3

Although analysis of factors influencing the mix between residential and community care is important in planning services, there may be little difference in cost between care in one setting or the other for people with severe levels of disability. While there are good quality of life reasons to favour care in the community, if a policy of de-institutionalisation is driven by cost-cutting, the evidence is that this will not improve quality of life or care. A major European study of the outcomes and costs of de-institutionalisation and community living concluded:

> In a good care system, the costs of supporting people with substantial disabilities are usually high, wherever those people live. Policy makers must not expect costs to be low in community settings, even if the institutional services they are intended to replace appear to be inexpensive. (Mansell et al. 2007a: 7)

Changes in the eligibility framework for state supported residential care may change the mix between residential and community care, as it has in other countries. Under a new eligibility system for state support for residential long-term care, referred to as the "Fair Deal" and provided for in the Nursing Home Support Scheme Act 2009, state financial support for long-term care is contingent on a care needs assessment. This focuses primarily on the person's ability to carry out activities of daily living and also takes into account "the family and community support that is available to the person", "the medical, health and personal social services being provided to or available to the person both at the time of the carrying out of the assessment and generally" and "any other matter that affects the person's ability to care for himself or herself" (Department of Health and Children, 2008). At the time of writing it was unclear what degree of care need or severity of disability would be required for eligibility for state support for residential or community care.

10.9 Projecting Residential LTC Demand for HSE Regions

In this study, I do not model separately for the evolution of disability for the regions. I apportion national demand for residential LTC for people aged 65 and over proportionately to the forecast regional share of population aged 65 and over and 85 and over to generate regional residential LTC demand forecasts for the four HSE Regions in 2006 (Dublin/North-East, Dublin/Mid-Leinster, Southern and Western). I chose this

regional basis because the DOHC's Long-Stay Activity Statistics provide a profile of residents and facilities in these regions, in light of which the demand forecast can be assessed. This analysis employs Morgenroth's population forecasts for the regions (Table 10.9).

Table 10.9 Forecast population aged 65 & over and 85 & over, HSE Regions 2006 and 2021

		Dublin North-East	Dublin/Mid-Leinster	Southern	Western	Total
2006	Population aged 65 & over	94,516	120,340	128,545	124,525	467,926
	% national population aged 65 & over	20.2%	25.7%	27.5%	26.6%	100%
	Population aged 85 & over	9,472	11,770	12,823	13,963	48,028
	% national population aged 85 & over	19.7%	24.5%	26.7%	29.1%	100%
2021	Population aged 65 & over	169,314	207,028	213,401	202,322	792,067
	% national population aged 65 & over	21.4%	26.1%	26.9%	25.5%	100%
	Population aged 85 & over	222,20	26,278	29,237	28,122	105,858
	% national population aged 85 & over	21.0%	24.8%	27.6%	26.6%	100%

Source: Calculated from HSE Regional forecasts supplied by Morgenroth, compatible with M2F2 forecasts in Morgenroth (2009)

Table 10.10 Profile of residential long-term care utilisation by HSE region, 2006

	Dublin North-East	Dublin/Mid-Leinster	Southern	Western	Total
% of Patients	19.3	25.7	27	27.9	
% of Beds	18.2	24.3	27	30.4	
% Occupancy	93.8	93.5	88.6	81.1	
% residents 65+	93.7	83.5	95.6	96.3	
% share all residents 65+	19.6	23.2	28	29.1	
% share all residents 85+	19.4	23.5	28	29	
Number residents 65+*	4,414	5,229	6,302	6,555	22,500
Population aged 65+	94,516	120,340	128,545	124,525	467,926
Age utilisation rate	4.7	4.3	4.9	5.3	

*Source: Population share by age and region from DOHC's Long-Stay Activity Statistics 2006 applied to 22,500 estimated LTC residents aged 65 and over (Table 10.1) to generate estimated regional LTC residents aged 65 and over.

It is assumed in this forecast that the relationship between the population with severe disabilities and residential LTC demand is constant across the regions. However, the evidence from the Long-Stay Activity Statistics challenges this assumption. Although based on an incomplete survey, they provide the best available picture of regional variations (Table 10.10). Estimated regional utilisation rates for population aged 65 and over vary markedly: Western (5.3%); Southern (4.9%); Dublin/North-East (4.7%); Dublin/Mid-Leinster (4.3%). While the Western Region has the greatest proportion of the national population aged 85 and over at 29% and a proportionate share of all LTC residents aged 65 and over at 29%, this region also has the lowest bed occupancy at 81.1%, compared to bed occupancy levels in the Dublin regions of 94% (Tables 10.9 and 10.10). Although in Dublin/Mid-Leinster and the Southern regions the share of bed capacity corresponds closely to the share of population aged 85 and over, the Western region has a greater share of beds (30.4%) than of population aged 85 and over (29.1%) while the Dublin North-East region has a smaller share of beds (18.2%) than of population aged 85 and over (19.7%). This finding accords with anecdotal evidence that delayed discharge is particularly problematic in the East. Population ageing will exacerbate these pressures (Table 10.9).

When forecast national demand for residential LTC is apportioned in proportion to the regional share of population aged 65 and over, demand is forecast to be greatest in Dublin/Mid-Leinster and lowest in the Western Region (Table 10.11). Dublin/Mid-Leinster is forecast to have 4,135 additional LTC residents in 2021, a 79% increase over 15 years. If the basis for apportionment of forecast national demand for residential LTC is the regional share of population aged 85 and over, Dublin/Mid-Leinster remains the region with the greatest forecast increase in residents at 3,664 with the Southern Region close at 3,592. LTC demand can be further adjusted to take into account the wide regional variation in occupancy rates in 2006. These adjusted forecasts assume that LTC residential occupancy rates level up to the Dublin/North-East level of 93.8% before additional places are required. The effect of this adjustment is to emphasise the relatively greater forecast demand in the two Dublin-centred regions where occupancy is already high. Dublin/North-East's need for places overtakes the Southern Region in the occupancy-adjusted scenario where LTC demand is apportioned relative to share of population aged 65 and over (Table 10.11).

Table 10.11 Forecast demand for residential LTC, HSE Regions, 2021, applying preferred national LTC demand forecast

	Dublin North-East	Dublin/Mid-Leinster	Southern	Western	Total
	National LTC demand apportioned to regions proportionately to share of national population aged 65 and over				
2006 LTC residents aged 65+	4,414	5,229	6,302	6,555	22,500
2021 Forecast LTC residents aged 65+	7,658	9,364	9,652	9,151	35,824
Forecast increase residents aged 65+	3,244	4,134	3,350	2,596	13,324
% increase residents aged 65+	73%	79%	53%	40%	59%
LTC occupancy rate in 2006	93.8%	93.5%	88.6%	81.1%	88.5%
2021 LTC places required if regional 2006 occupancy at Dublin/NE level	3,244	4,118	2,980	1,569	11,911
Adjusted % increase in LTC places for residents aged 65+	73%	79%	47%	24%	53%
	National LTC demand apportioned to regions proportionately to share of national population aged 85 and over				
2021 Forecast LTC residents aged 65+	7,520	8,893	9,894	9,517	35,824
Forecast increase residents aged 65+	3,106	3,664	3,592	2,962	13,324
% increase residents aged 65+	70%	70%	57%	45%	59%
2021 LTC places required if regional 2006 occupancy at Dublin/NE level	3,106	3,647	3,223	1,936	11,911
Adjusted % increase in LTC places for residents aged 65+	70%	70%	51%	30%	53%

Source: National demand for residential LTC, incorporating a measure of unmet need (Table 10.8), apportioned regionally according to share of forecast population aged 65 and over, and 85 and over, and adjusted for relative rates of occupancy.

These forecasts are blind to the nature and quality of the accommodation on offer in the regions. A lower occupancy rate might reflect the inappropriateness of some accommodation to need, which appears feasible given the expressions of concern about standards of care discussed in Chapter 9. This comparison suggests that translating these demand forecasts into a basis for planned expansion would necessitate examination of existing capacity and the reasons underlying regional utilisation rates and more detailed examination of demographic forecasts for older age cohorts in each region. Given the

desirability that residential LTC should be close to the community and family of the resident, this analysis would need to be undertaken at the local level.

10.10 Effect of acute care developments on demand for long-term care

The continuum of care for people suffering the illnesses and disabilities of ageing stretches beyond residential, community, formal and informal care to care in acute hospital settings. Developments or deficiencies in one aspect of care will affect others. Comparison of care in Ireland with care in another country needs to take into account this wide spectrum of care, so that an apparent efficiency or reduction in one aspect of care is understood within the context of its effect on that country's wider health and social service provision. Developments in acute care may substantially increase LTC demand in either residential or community setting. An EU assessment of the budgetary challenges posed by ageing, reviewed in Chapter 2, found that considerable differences in LTC spending levels per head reflected radically different traditions in care for older people. Where care is largely formal and in an institutional rather than community setting, this leads to high levels of public spending on long-term care. Where care is more often informal and provided by family members, some long-term care is likely to be provided through the health system, and is included in data on health care expenditure (European Commission 2001).

The Irish Government has adopted an explicit policy of reducing resources in acute care and transferring resources to the community sector:

> "The whole purpose of health service reform is to take resources from the acute hospital sector and spend more resources in the community sector." -Taoiseach, Brian Cowen, Dáil Debates, Leaders' Questions, May 21st 2008 (Dáil Debates 2008)

This policy is informed by the detailed HSE-commissioned study of the potential for reducing acute care utilisation (PA Consulting Group 2007a), discussed in Chapter 2, which projected two alternative acute bed capacity requirements based on current practice or a preferred health system (PHS), which would reduce the role of the acute hospital. Continuing current practice is projected to require an increase in acute inpatient beds (in public and private hospitals) from 13,380 in 2007 to 21,563 in 2020. If the PHS were implemented, the acute inpatient bed requirement in 2020 is projected to reduce to 7,777,

while beds for day procedures would increase to 4,125 from 2,016 in 2007. PA Consulting Group (2007a) commented that the PHS "necessitates an increase of capacity in the community" and the need for additional LTC beds could be such that "it is fully possible that the net result is an increase in the total number of beds in the health system" (PA Consulting Group 2007a: 14, 17).

One method to assess the implications of the PHS is to place it in an international, comparative context. If the demographic assumptions of the PA report, which preceded and differed from Morgenroth's forecasts, are applied to the projected PHS bed requirement, Ireland's ratio of acute inpatient beds per 1,000 population reduces to 1.5 by 2020 (Table 10.12). The acute inpatient bed ratio per 1,000 people aged 65 and over would be 10.8 in 2020, based on the projection in PA Consulting Group (2007a) that approximately 14.3% of the population would then be aged 65 and over (compared to Morgenroth's forecast of 15% in 2020 and 15.4% in 2021). Table 10.12 compares these projected bed ratios with acute inpatient bed ratios for OECD countries, where people aged 65 and over comprised 14 per cent or more of the population in 2005 (OECD 2007b). The acute inpatient bed ratio per 1,000 population for these countries ranged from 8.2 in Japan to 2.2 in Sweden. The acute inpatient bed ratio per 1,000 people aged 65 and over ranged from 40.9 in Japan to 12.7 in Sweden, with the UK at 19.9, France at 22.4 and Germany at 33. The projected inpatient bed count in public and private hospitals under the PHS would place Ireland at the bottom of this international range. The table shows the effect on Irish bed ratios of including day beds (figures in brackets) but, since the OECD does not collect these data, no cross-country comparison can be made.

Although the PHS incorporates assumptions about reduced bed utilisation deriving from future changes in medical practice, which might reduce bed ratios in other countries, Ireland's placing in this comparison nonetheless suggests that the PHS implies moving to the Swedish model of health care provision. Table 10.12 further compares OECD data on LTC (OECD 2007c). Accompanying Sweden's relatively low acute bed complement is a developed LTC system, with 7.5 per cent of over 65s receiving LTC in institutions and 9.5 per cent receiving formal LTC at home. Even among countries with high levels of LTC provision, the ratios of acute care beds to population vary, suggesting a variable, country-specific relationship between acute and long-term care. Despite less aged populations than Sweden's and provision of formal LTC to higher proportions of older people, Norway and Denmark have 60 per cent more acute beds per 1,000 population aged 65 and over, at 20.6

and 20.7 beds per 1,000 respectively compared to Sweden's 12.7. (Norway's acute bed numbers are overstated due to the inclusion of rehabilitation beds.)

Table 10.12 Acute bed capacity, long-term care recipients and female labour force participation, in OECD countries with older age profiles, compared to proposed acute capacity for Ireland in 2020

	2005 Pop aged 65 and over %	2005 Acute inpat. beds/ 1000 pop.	2005 Acute Inpat. beds/ 1000 pop. aged 65+	1990 Female Labour Force Participation %	2004 Female Labour Force Participation %	2004 Pop. aged 65+ in res. LTC %	2004 Pop. 65+ formal LTC at home %	2004 Pop. aged 65+ any LTC %
Czech Rep	14.0	5.7	40.6	61	51	*4.9*	*8.2*	*13.1*
Luxembourg	14.3	5.2	36.2	34	45	3.9	4.5	8.4
Norway	14.7	3.0	20.6	57	62	*5.8*	*17.4*	*23.2*
Denmark	15.1	*3.1*	*20.7*	62	60	4.4	*21.5*	*25.9*
Hungary	15.7	5.5	35.1	47	43	8.0	15.1	23.1
Finland	15.9	2.9	18.3	59	56	*4.9*	*6.9*	*11.8*
UK	*16.0*	3.1	*19.9*	53	55	4.2	6.9	11.1
Switzerland	*16.2*	3.6	*23.4*	49	60	*6.6*	*9.4*	*16*
Austria	16.3	6.1	37.6	43	50	*3.6*	*19.3*	*22.9*
France	16.4	3.7	22.4	46	50	*6.3*	5.2	*11.5*
Spain	16.7	*2.6*	*15.3*	34	45	n.a.	n.a.	n.a.
Portugal	17.0	3.0	17.5	50	55	n.a.	n.a.	n.a.
Sweden	17.3	2.2	12.7	63	60	7.5	9.5	17
Germany	19.2	6.4	33.0	46	50	*3.4*	6.1	9.5
Italy	19.3	3.3	17.3	36	38	*1.5*	n.a.	n.a.
Japan	20.0	8.2	40.9	50	48	3.0	9.3	12.3
Ireland	11.2	2.8	24.9	36	50	4.8*	n.a.	n.a.
Ireland 2020: PHS* **	**14.3**	**1.5 (2.4)****	**10.8 (16.6)****					
Ireland 2020: current practice	**14.3**	**4.3 (5.0)****	**30.0 (34.9)****					

Sources: OECD HEALTH DATA October 2007 for bed, population and LTC data. Figures in italics are for preceding year. Countries vary in compliance with OECD definitions which can affect comparability. Germany's acute bed count includes psychiatric beds. If these were in proportion to the OECD average, Germany's true acute count would be 5.4:1,000 pop. World Bank WDI database for labour force figures, Ireland sourced from CSO. *Institutional LTC is this study's estimate for Ireland 2006 since these Irish OECD data include only residents in publicly funded institutions.** **Irish bed ratios in brackets for 2020 include day beds, not included in OECD data for other countries.*** Population data for 2020 as in PA(2007a), sourced from CSO Regional Population Projections, May 2005.

In effectively emulating Sweden's model of provision, the PHS emerges as a particularly ambitious target for Irish health care. Sweden developed its LTC facilities over a period of rapid population ageing, when public investment in health care facilities exceeded other OECD countries' from 1970 to 1990. Although reduced, Sweden's public investment in health care facilities remained above average and well above Ireland's public investment in the 1990s, when other countries began a process of catch-up. In the decade from 1995, Norway was the highest public investor in health care facilities in the OECD. In the 1990s, Sweden underwent a revolution in care delivery, analogous to the revolution implicit in the PHS. The 1992 ÄDEL Reform transferred responsibility for LTC provision from county councils to municipalities. From 1993 to 2003, hospital bed numbers reduced by over 40 per cent, numbers of LTC beds in nursing homes increased steeply initially then reduced somewhat in recent years, which may reflect re-definition of some LTC facilities as sheltered housing. The transfer of many ill, older people into their care placed great strains on municipalities, significantly changed the hitherto generous access to home help services and increased informal care demands (Trydegård 2004; Glenngård et al. 2005; Rauch 2007).

In OECD Health Data 2007, Swedish LTC bed capacity includes only those nursing home beds that provide medical as well as daily living services, whereas Ireland's data comprise an estimate of all nursing home beds. It is instructive nonetheless to calculate the LTC bed requirements for Ireland in 2021 to match Sweden's rate of provision by this relatively understated measure. In 2021 Ireland would require 48,738 LTC beds to match the Swedish ratio of LTC beds to population aged 80 and over, and 58,219 LTC beds to match Swedish capacity relative to population aged 65 and over (Table 10.13). Since in 2006 Ireland had 27,400 LTC beds, the requirement to match Swedish LTC bed count relative to population aged 80 and over would be an additional 21,300 LTC beds by 2021, a net addition of 1,423 beds per annum. To match Sweden's LTC bed count relative to population aged 65 and over would require 30,819 additional beds or 2,055 per annum. This compares with this chapter's previous preferred forecast residential LTC demand for population aged 65 and over of 13,324 additional beds over 15 years, equivalent to 888 additional beds per annum (Table 10.8).The 60% to 131% increase in the requirement for additional LTC beds in the years to 2021 to match Sweden's provision illustrates the impact that the reduction in acute capacity, envisaged in the PHS, could have on residential LTC demand.

Table 10.13 Irish LTC bed requirement to match Sweden's provision

	Population 1,000s	Aged 65+ 1,000s	Aged 80+ 1,000s	LTC beds	LTC beds/1,000 pop. 65+	LTC beds/1,000 pop. 80+	Residential LTC utilisation rate of pop. 65+
Sweden 2004	8,994	1,548	479	113,826	73.5	237.6	7.5%
Ireland 2021	5,132.6	792.1	205.1				
Irish population 2021 as % Swedish pop. 2004	57.1%	51.2%	42.8%				
Irish LTC beds in 2021 to match Swedish LTC beds in 2004 relative to pop aged 65+				58,219	73.5		6.7%
Irish LTC beds in 2021 to match Swedish LTC beds in 2004 relative to pop aged 80+				48,738		237.6	5.5%

Source: Calculated from LTC bed data in OECD Health Data 2007. Irish population projections from Morgenroth (2009). See text for discussion of data limitations. Irish utilisation rates in 2021 assume that all additional LTC beds accommodate residents aged 65 and over.

The PA report (PA Consulting Group 2007a) quotes the "HSE Assessment of Need for Residential Care for Older People" 2006 (unpublished) as estimating that Ireland will require an additional 10,021 LTC beds by 2021. The scope of the PA review excluded analysing LTC bed requirements. PA Consulting Group (2007a) projects a modest additional need for non-acute beds to transfer patients from the acute to the non-acute setting. The calculations above suggest that were the PHS to achieve the envisaged reduction of some 13,800 in the requirement for acute inpatient beds in Ireland in 2020, reducing Ireland's acute inpatient bed to population ratios to a level lower than Sweden's, the compensatory expansion to achieve a Swedish level of LTC provision relative to the population of older people would be between 21,300 and 30,800 additional LTC beds compared to the 13,300 of this chapter's initial preferred forecast. Since the majority of Irish LTC residents (65%) are aged 80 years and over, the lower forecast of 21,300 beds required to match Swedish LTC beds relative to population aged 80 and over is preferred in this scenario assuming reduced acute care provision. This would imply a residential LTC utilisation rate of 5.5% for over 65s in Ireland in 2021 (Table 10.13) which accords closely with the forecast 5.4% rate in Department of Health and Children (2008).

Sweden's demand for residential LTC is not solely influenced by its system of acute care. Its female labour force participation rate of 60% compared to Ireland's 50% in 2004

implies a relatively limited supply of informal carers. The steep increase in Irish participation rates suggests that in 2021 Ireland will face such pressures also. It would be helpful to policy-makers if there were a formula relating acute care need and provision to LTC need and provision at different points on the curve of population ageing. However, Table 10.12 illustrates great variability in the ratio of acute beds to older population and in LTC provision in institutions or the community in OECD countries. An examination of these international data indicates that there is no simple cross-country relationship between acute care and LTC. The analysis in this chapter and the cross-country analysis in Section 2 suggest that close interrogation of national data is necessary to reach a conclusion about the requisite LTC provision for a given acute capacity.

10.10 Cross-country comparison of residential and community LTC

Rauch (2007) assembled national data to analyse intensity of care provision for older people and illustrated that Sweden's LTC provision is not the most generous among Nordic countries' or other European states'. Rauch's indicator combines the proportion of population aged 65 and over in residential LTC with a measure of the intensity of home help services (calculated from percentage covered and average hours of service). Rauch's data and the OECD data in Table 10.12 are not directly comparable because of differences in the method of data collection - Rauch includes semi-residential care. In 2006, an annual average of 46,500 people were in receipt of home help services in Ireland, averaging 4.7 hours weekly, according to the HSE's database of home help hours and recipients. This would comprise 9.9% of the Irish population aged 65 and over but, since the HSE does not record recipients' ages, this is probably an over-statement of the coverage rate for people aged 65 and over. By Rauch's measure, Denmark offers the most generous services to older people, followed by Norway, the Netherlands, France and then Sweden. Ireland, on this calculation, offers more generous coverage than Germany, at the bottom of this ranking, attributed by Rauch to its targeting only the most severely impaired, with consequent heavy demands on informal care-givers (Table 10.14). Germany has relatively low female labour force participation at 50%, relatively generous acute care provision and is forecast to face heavily increased demand for formal care (Table 12.12, Source note; Schulz et al. 2004).

Table 10.14 Comparison of intensity of long-term care services in institutions and the community

		Covered per 100 population aged 65+			Intensity		FTE places/100
Care type		RC	HH	RC+HH	HH: h/week	RC+HH FTE value	RC + HH
Denmark	2004	8	20.8	28.8	5.9	0.7	20.3
Norway	2003	11.9	14.6	26.5	2.3	0.58	15.3
Netherlands	2003	8.5	13.9	22.4	3.5	0.6	13.4
France	2000-03	6.9	11.6	18.5	5.5	0.72	13.3
Sweden	2003	7.2	8.3	15.5	7.1	0.84	13.1
Ireland	2006	4.8	9.9	14.7	4.7	0.64	9.4
Germany	2000-03	4.9	2.8	7.7	9.6	0.99	7.6

Source: Adapted from Rauch (2007) RC= residential and semi-residential care services; HH= home help services; FTE= full-time equivalent. Irish data added.

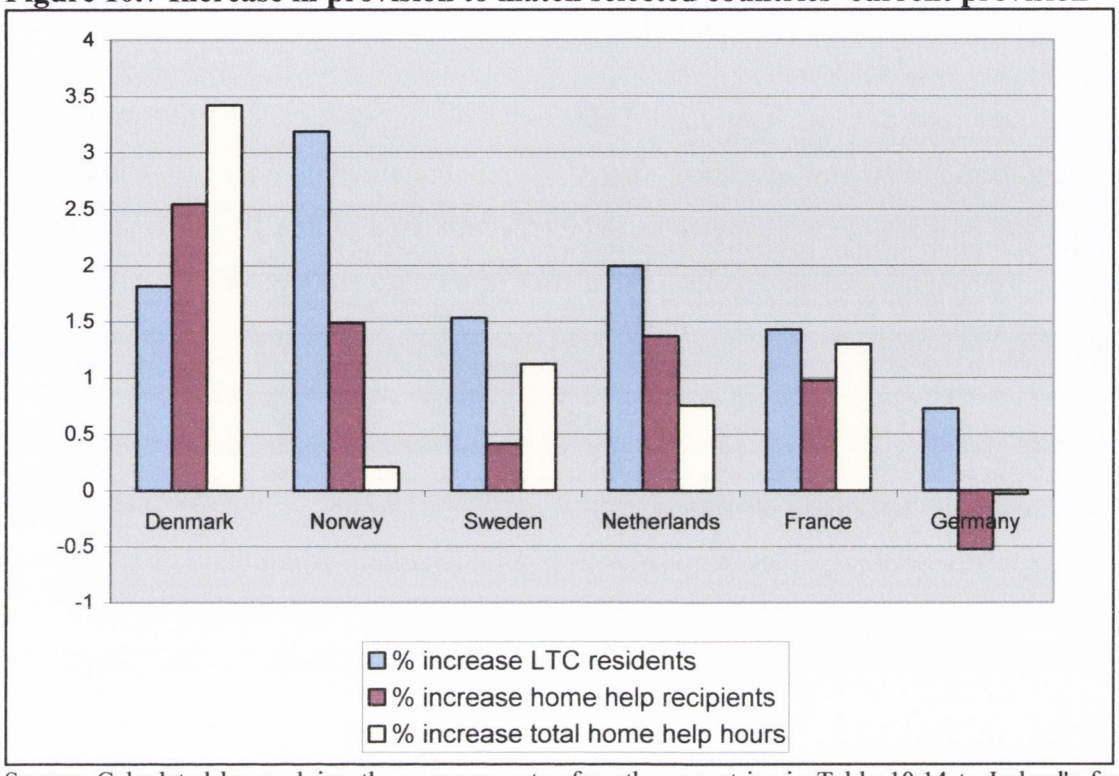
Table 10.15 Percentage increase in service provision for over- 65s required for Ireland in 2021 to match selected countries' provision

Care System Matched	LTC residents	% increase	Home help recipients	% increase	Weekly Home help hours	% increase
Denmark	63,368	182%	164,757	254%	972,065	342%
Norway	94,260	319%	115,647	149%	265,987	21%
Sweden	57,031	153%	65,744	41%	466,785	112%
Netherlands	67,329	199%	110,102	137%	385,357	75%
France	54,655	143%	91,884	98%	505,360	130%
Germany	38,813	73%	22,179	-52%	212,916	-3%
Ireland (2006)	22,500		46,500		219,819	

Rauch's methodology can be applied to calculate required residential LTC places and home help coverage in Ireland to match provision in other countries (Table 10.15 and Figure 10.7). To match Sweden's provision for people aged 65 and over, Ireland in 2021 would need to accommodate 57,000 people in LTC residences and supply an average 7 hours home help to 65,700 people - implying a doubling of home help hours. To match Norway's residential LTC provision would require residential LTC capacity to increase fourfold. To match Denmark's more community based system would require close to a threefold increase in residential LTC provision and a fourfold increase in home help hours. The share of population aged 80 and over in Denmark in 2004 (4.1%) was close to Ireland's forecast 4.0% share in 2021. While an approximation, Rauch's measure conveys

the commitment to services for older people in some other countries and the varying ways in which care is provided.

Figure 10.7 Increase in provision to match selected countries' current provision



Source: Calculated by applying the coverage rates for other countries in Table 10.14 to Ireland's forecast population in 2021. Calculated as increase required from Irish level of provision in 2006.

10.11 Conclusions

The forecast increase in numbers of people living to older ages in Ireland in 2021 and intervening years presents policy makers and Irish society with a challenge. Despite improvements in disability rates, despite older couples remaining together for longer years of life, there will be a substantial growth in the numbers of people requiring long-term care in residential facilities or the community. By 2021, capacity in care facilities will have to grow to meet this need as well as current unmet need. The initial projection models only the effects of population growth and the evolution of disability, with a conservative inclusion for unmet need. A comprehensive model would also take into account the effect of increased full- and part-time female labour force participation and changes in household composition. Most importantly, it should incorporate the consequences for LTC of the changes in the system of acute care delivery, envisaged by Government and the HSE. Based on other countries' experience, this would substantially increase requirements for

residential LTC and formal community carers. During this period of investment in capacity there is an opportunity to ensure that long-term care facilities are well-planned, close to communities in need of care, and as much as possible take the form of sheltered housing or so-called "extra care".

The initial preferred forecast suggests a requirement for an additional 13,324 residential LTC places from 2007-2021, or approximately 888 per annum, implying a residential LTC utilisation rate of 4.5% of people aged 65 and over (Forecast 1, Table 10.16). If acute care capacity is reduced and female labour force participation rates among younger women are substantially sustained as they become older, based on international experience, the additional capacity requirement in residential LTC will increase by at least two-thirds to over 21,000 places or in excess of an additional 1,400 per annum, increasing residential LTC utilisation to 5.5% of over 65s (Forecast 2, Table 10.16). To develop care in the community to the levels of other Western European states, the current level of home help provision will also have to increase substantially.

Table 10.16 Summary forecasts

Aged 65 and over	2006	2021
Population aged 65 and over	467,926	792,067
Severe Disability Rate %	20.2%	18.6%
Population aged 65+ with severe disabilities	94,400	147,677
Demand for residential LTC	22,500	35,824
Utilisation rate residential LTC %	4.8%	4.5%
Forecast 1: Additional residential LTC places		13,324
If Acute Care/LTC Care as in PHS/Sweden:		
Forecast 2 : Additional residential LTC places		21,300
Utilisation rate residential LTC %		5.5%

Note: This table summarises the forecast outcome on the preferred assumptions for the evolution of disability, assuming in Forecast 1 that the relationship between the population aged 65 and over with severe disabilities and numbers in residential LTC adjusts only marginally for unmet demand and is otherwise unchanged. Forecast 2 assumes that reduction in acute care capacity as in the PHS would require compensatory increase in LTC capacity to Sweden's level relative to population aged 80 and over.

SECTION FOUR: REFLECTIONS AND CONCLUSIONS

Chapter 11 Reflections and conclusions

11.1 Main findings of this thesis

The central motivation for the enquiry in this thesis is to understand the effect of ageing on the balance between acute and long-term care. In two related enquiries, one across countries, the other within Ireland, I have sought to understand how acute and long-term care provision and utilisation are related to one another. Although data inadequacy has prevented achievement of my objective of modelling the balance between acute and long-term care across countries, in separate analyses of the determinants of acute bed and long-term care utilisation, some illuminating findings have emerged on the path to that objective.

In Section 2, econometric, panel data analysis of the separate models of the drivers of acute and long-term care utilisation across OECD member countries has offered some new insights, demonstrating that:

- Proximity to death was an upward driver of acute bed utilisation across 17 OECD countries over the years 1985-2006. This is the first demonstration using macro cross-country measures that this finding in within-country studies holds true across developed countries;

- Cross-country variation in acute bed utilisation reflects the within-country evidence on alternative locations of death - the balance of care at the end of life. Deaths of people aged 35 to 74 are significant upward drivers of acute bed utilisation while deaths of people aged 75 to 84 are insignificant across countries where there is evidence that most deaths at older ages occur outside hospitals. Conversely, deaths at ages 75 to 84 are significant upward drivers of acute bed utilisation while deaths

of people aged 35 to 74 are insignificant across countries where there is evidence that most deaths at older ages occur within hospitals;

- Age, represented by the population share aged 65 and over, having been an upward driver of utilisation in the 1980s, when moderated by the effect of converging life expectancies becomes insignificant to or a downward driver of acute bed utilisation across 17 OECD countries for the years 1985-2006. When the analysis excludes three Southern European countries and the years before 1990, increased population age has had the effect of reducing acute bed utilisation. In contrast, age represented by share of population aged 65 and over is a significant upward driver of LTC utilisation across 7 OECD countries for the years 1997-2006. This effect is moderated and reduced by converging life expectancies; and is insignificant when the difference between male and female life expectancy is below 5 years. These findings add to the debate about the effect of ageing on health care, reinforcing a case for separating analysis of the effects of age on acute hospital care from analysis of its effects on long-term care;

- Convergence between male and female life expectancies due to greater improvement in male than female life expectancy has had a significantly reducing effect on acute bed utilisation. This effect is moderated by population age, is greater with increased population age share and is significant at most values for population age across 17 OECD countries over the years 1985-2006. Convergence between male and female life expectancies has also had a significantly reducing effect on long-term care utilisation across 7 OECD countries for the years 1997-2006. Due to the moderating effect of population age the effect of convergence on LTC utilisation is only significant when the percentage of population aged 65 and over exceeds 17% These findings introduce a new and potent factor into models of the determinants of utilisation, which may capture not only the availability of older people to care for one another but may proxy improvements in health status.

Although inadequate long-term care data have prevented achievement of the original objective of this research of modelling the balance between acute and long-term care across countries and must qualify the LTC utilisation findings due to the limitations of the small dataset, these separate analyses of the drivers of acute and long-term care utilisation

suggest insights into the inter-relationship of care in alternative settings and support an understanding of the balance of care as a simultaneous relationship in which acute and long-term care utilisation and spending are inverse drivers of one another. Such an understanding of the balance of care derives from within-country studies finding evidence that acute and long-term care provision substitute for one another; and that the alternative forms of long-term care substitute for one another (Carr-Hill et al. 1994; Martin and Smith 1996; Portrait et al. 2000; European Commission 2001; Bolin et al. 2008; Werblow et al. 2007; Bonsang 2009; Forder 2009). Despite my inability to model the balance of care, a potential explanation for how the balance between acute and long-term care has developed in many OECD countries is suggested by the further findings:

- Female labour force participation has been inversely related to acute bed utilisation across 14 OECD countries over the years 1985-2006 and was a significant upward driver of long-term care utilisation across the 7 countries for which adequate LTC data are available for the years 1997-2006.

Combined with the significant, inverse relationship of population age to acute bed utilisation found for these 14 OECD countries from 1990 and the significant, positive relationship of age to LTC utilisation, these findings suggest that a long-term trend of rising female labour force participation may have played a pivotal role in the relationship of acute to long-term care, with higher participation and rising population age driving the development of formal LTC, which in turn reduces acute bed utilisation. This suggestion that FLFP is a pivotal variable for the balance of care is qualified, however, by the potential omitted variable bias caused by the absence of a variable for long-term care utilisation in the acute utilisation model. The significant, negative coefficient for FLFP could arise because it is also proxying this key omitted variable in the acute utilisation model. Given the evidence of an inverse association between acute and long-term care utilisation, the coefficient for LTC utilisation in an acute utilisation model would be expected to be negative. When, due to data deficiency, LTC utilisation is omitted from the acute utilisation model, variables such as FLFP and age with which LTC utilisation has a strong positive correlation are likely to have a negative bias.

Whether it is the case that FLFP and population age have had an inverse effect on acute utilisation across these countries outside Southern Europe since 1990 or whether these

apparently significant, negative associations are overstated due to omitted variable bias, the implications for the balance of care remain essentially the same. The variable whose omission is postulated to cause this bias is LTC utilisation. Either a negative bias exists which confirms an inverse association between acute and long-term care; or significant, negative coefficients are correctly attributed to FLFP and age in the acute utilisation model. In either scenario, the roles postulated for age and FLFP in the balance of care are as indirect downward drivers of acute utilisation via their role as upward drivers of LTC utilisation. Given the role of FLFP and age as positive drivers of LTC utilisation, this suggests that across the 14 developed countries in this analysis outside Southern Europe from the 1990s rising female labour force participation and an increased age share of population have caused formal LTC utilisation to increase and this has contributed to reduced acute bed utilisation.

My interest in the balance of care emerged initially from an interest in the validity of international comparisons of health care spending. In my investigation of these models of utilisation, it became apparent that the relationship of FLFP to GDP could complicate much analysis of the drivers of health care utilisation or expenditure. The challenge of estimating the effect of FLFP in an acute utilisation model that includes GDP as a co-variate led to an examination of the literature about alternatives theories of welfare, with particular reference to the arguments of Sen (1976) for a better welfare theory of real national income comparisons; and of Netten and Davies (1990) for a theory of the social production of welfare that recognises the welfare contribution of non-monetized transactions such as informal care. Application of these theories to the analysis of the relationship of FLFP to GDP leads to a potentially, far-reaching conclusion from this thesis:

- GDP is an over-stated measure of national welfare in models of health care utilisation or expenditure because it does not take into account the welfare loss when informal care supply diminishes as female labour participation increases.

This analysis has implications for international comparisons of health spending and GDP, both of which measures may be understated by the exclusion of informally delivered care. The observation that increased female labour force participation has the effect of formalising and causing the economic enumeration of a range of caring activities, which

then are included in both the GDP and health care expenditure functions also has implications for analysis of the relationship between health expenditure and national income. It appears to follow from this observation that the form of growth observed in developed economies in recent decades, which is associated with rising female labour force participation and increased formalisation of care, will cause these newly enumerated activities to comprise an increasing proportion of GDP. Since growth that derives from increased female labour force participation is by definition growth that brings with it a high proportion of newly formalised care, the apparent income elasticity of health spending evident in some studies may reflect a tautology. Furthermore, the role of national income as a driver of health expenditure may be questionable, if in the formulation of such a model, income is conceived as a measure of national welfare.

Such reflections support approaching international comparisons of health spending with caution if for no other reason than that spending on health in a country with under-developed formal LTC will appear excessive compared to spending or utilisation in a country with more developed LTC. If such spending comparisons aggregate health and LTC spending for some countries and not for others, it may be difficult to reach any useful conclusions about countries' relative spend. The widening of this analysis to encompass female labour force participation and its relationship to GDP suggests that truly enlightening international comparison of countries' resourcing of care requires including informally delivered care.

In Section 3, statistical analysis of the drivers of long-term care demand in Ireland has contributed further within-country findings that complement this international analysis:

- The first comprehensive, longitudinal data on Irish disability rates shows clear evidence of declining disability prevalence among older people in Ireland over the period 2002-2006;

- Demographic forecasts by Morgenroth (2009) reflecting recent improvements in male life expectancy suggest significant convergence will take place in male and female life expectancy in the years to 2021, which will reduce numbers of widowed, older women living alone. This development combined with the econometric, cross-country analysis suggests that age-specific demand for both

acute and formal long-term care in Ireland should therefore diminish, albeit subject to the caveat that trends in separation and divorce will moderate the effect of converging life expectancies on household composition;

- Despite converging life expectancies and reduced disability prevalence, there was a greater proportionate increase in the population residing in long-term care institutions than in the population aged 80 and over in the period 2003-2006, which suggests reduced supply of care in other settings;

- An explanation for this increase in demand for residential long-term care is supplied by rapid increases in female labour force participation rates, which have reduced the potential supply of informal carers in Ireland;

- Such sharply increasing female labour force participation combined with forecast rapid growth in the population at older ages and planned reductions in acute care capacity will require considerably increased formal LTC supply in all settings.

11.2 Conclusions and reflections

The possibility of applying insights from the econometric analysis in Section 2 to country-specific analysis for Ireland and other countries suggests a potentially fruitful avenue to advance the research in this thesis. Although each aspect of this thesis has been limited by data inadequacy, these complementary findings from cross-country and within-country analysis offer a route to overcoming these limitations. This thesis demonstrates that there is scope to develop understanding of the determinants of and inter-relationships between health and social care utilisation by informing cross-country analysis with insights from studies within countries as in Section 2, and by bringing experience across countries into the analysis within an individual country, as in Section 3.

My analysis has been informed by evidence from within-country studies of causal linkages between acute and long-term care utilisation, which support an understanding that both forms of utilisation are determined in a simultaneous relationship in which they are inverse

drivers of one another. In my examination of potential demand for long-term care services in Ireland, I attempted to assess the impact of planned reductions in acute care provision, implicitly modelling LTC as developing in response to contractions in acute care. This appears to have been the sequence of events in Sweden following the Adel Reform of 1992. Conversely, in my analysis of the drivers of acute bed utilisation across countries, I have hypothesised that reduced acute bed utilisation has been facilitated by increased formal LTC provision and utilisation, necessitated by the coincidence of increased female labour force participation and ageing of population. Neither proposition contradicts the other: reduced acute care provision can cause LTC provision to grow; and increased utilisation of LTC can reduce demands on the acute care sector. There is evidence for both patterns of causation in the literature and there seems little doubt that the balance of care has the characteristic of reverse causality and endogeneity with the methodological challenge that implies.

It is perhaps this methodological challenge, as well as the paucity of good international LTC data, that makes international analysts and forecasters separate the two sectors in their models, although within-country studies have accessed adequate data to implement methodologies that address this endogeneity and allow estimation of both sides of the balance of care equation. Both the cross-country and Irish analysis in this thesis support an argument for placing health systems analysis within a whole systems framework, that takes into account the inter-linked roles of health and social care, and of formally and informally delivered care, notwithstanding data inadequacies. The need for a cross-country, whole-systems model, to paraphrase Wanless, remains. Insofar as my analysis has not achieved a whole-systems model, I have not succeeded in my ultimate objective. But insofar as it has managed to cast some light on potential mechanisms that might explain the balance between these two sectors, it has exceeded my expectations of what the data could support.

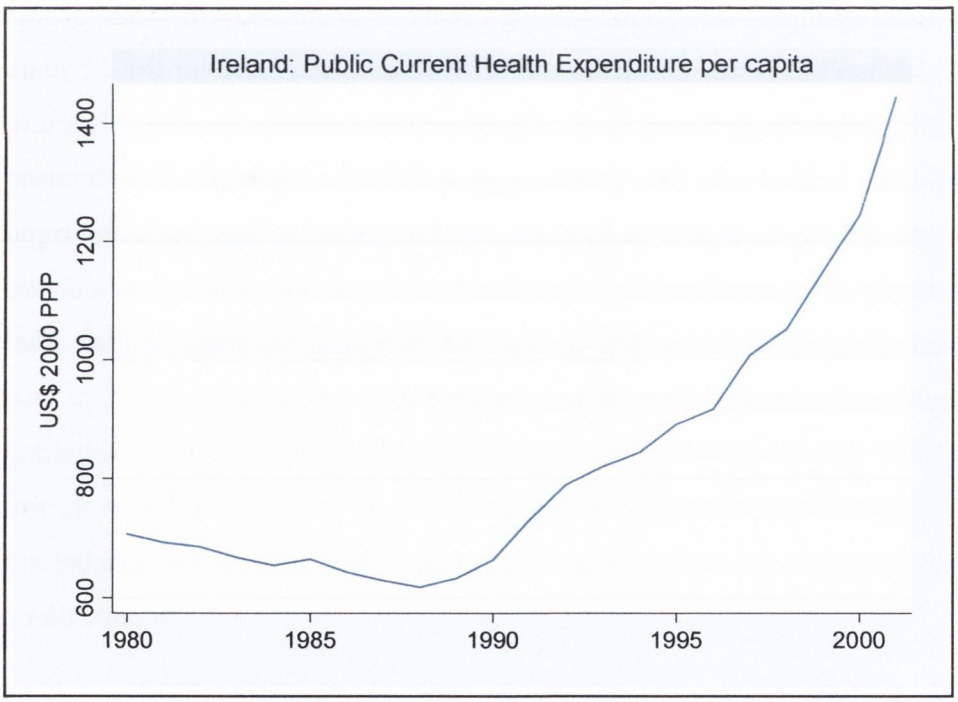
In assessing the implications of the findings of this thesis, I return to Ireland because it is the policy environment with which I am most familiar. The then Minister for Finance, Charlie McCreevy, expressed incomprehension at the rapid rise in health care spending in 2001: "Spending has been quadrupled since 1992, 1993. I don't think the Irish people are that much more ill in that period of time" (Wren 2003). A response to his implicit questioning of the drivers of Irish health expenditure might cite inflationary pressures, the

very low base of spending in 1992 following cutbacks in the 1980s, population growth or other possible contributory explanations. Before this analysis, I would not have considered the role of increased female labour force participation, subsequently accelerated by the Minister's policy initiative of tax individualisation. The steep rise in health spending in Ireland from the early 1990s had been preceded by a steep rise in FLFP (Figures 11.1 and 11.2). Subsequently, as this analysis has shown, in the years from 2003-2006 while the numbers of people aged 80 and over increased by 10% in Ireland, numbers of recipients of formal residential LTC increased by 12.4%.

Review of the Irish literature on ageing and health spending in Chapter 2 demonstrated a fairly wide consensus view of ageing as a key driver of health spending and utilisation. Although this does not accord with the international evidence or the findings of this thesis, in Ireland this view combined with an assumption of constant age-specific utilisation has become an argument for reducing current acute care capacity and utilisation because Ireland has a relatively low share of population aged 65 and over. Yet, as this analysis has demonstrated, the relationship of this population age share to acute bed utilisation across those countries, which tend to be the comparators for Irish analysts, has over the 22 years to 2006 been variable, increasingly inverse and closely related to the re-location of care to long-term settings. The analysis in this thesis suggests that to understand Irish acute utilisation rates, it is necessary to look to deficiencies in other care settings, including rapid diminution in the supply of informal carers. In particular, the centrality of death as a driver of acute bed utilisation makes understanding the care of the dying and those in their final year(s) of life a key to understanding rates of acute utilisation.

Figure 11.1

Figure 11.2



While this analysis may have contributed some insights to the understanding of drivers of acute and long-term care utilisation across countries, it remains constrained by inadequate data. Due to inadequate LTC data it is at present impossible to include variables for acute and long-term care utilisation within the same model and to employ either the two-stage

least squares (2SLS) or dynamic panel data methods that offer the best prospect of overcoming the endogeneity of the relationship of acute to long-term care. The limited panel for which LTC data were available also made it infeasible to include the full range of variables which could be included in the acute utilisation model. The OECD's development of its Health Data database and countries' co-operation in returning data that consistently separate health and LTC spending or utilisation may make such analysis more feasible in the future. The development of the longitudinal component of the SHARE dataset should also offer the prospect of combining data from this source with the OECD data and could supply a source of instrumental variables to enable the estimation of the effects of acute and long-term care utilisation on one another by 2SLS methodologies. While achieving greater coverage for the LTC variables that the OECD offers would enhance analysis of the balance of care, the development by Rauch using country-specific sources of an indicator of the intensity of long-term care provision, which I extended to Ireland in Chapter 10, demonstrates that macro variables such as numbers of LTC recipients that are supplied by the OECD may still fail to capture important cross-country differences in the nature and supply of care (Rauch 2007). A further development of this cross-country analysis which the available data would support would be to differentiate between the effects of full-and part-time female labour force participation on acute and long-term care utilisation. An additional feasible extension of this analysis is afforded by the recent publication of new sources of data for Ireland, reviewed in Appendix B, which should enable the further extension of the model of long-term care demand in Ireland, developed in this thesis.

In an analysis that has taken many paths that I had not envisaged, perhaps the most unexpected has been the possible consequences for international comparisons of health spending and GDP and for analysis of their relationship to one another, of my analysis of and reflections on the relationship of female labour force participation to GDP. It is not an original insight to recognise the deficiency of GDP as a measure of welfare when it excludes unremunerated work. Development economists like Deaton and Beneria have written on this topic (Beneria 1981; Deaton 1995). However, recognition of the importance of FLFP as a driver of health and long-term care spending (as well as the importance of FLFP to their inter-relationship), when combined with an appreciation of the shortcomings of GDP as a measure of national welfare, offers the possibility of re-casting the debates

about the role of national income as a driver of health spending and about the income elasticity of health expenditure.

The concept of elasticity of demand assumes some element of choice about how to spend income, whether at an individual or national level. If both increased national income and increased health expenditure are inevitable consequences of increased female labour force participation, of unremunerated activity becoming remunerated, there has not been an exercise of choice to devote a higher share of national income to health expenditure. In such circumstances both the increase in national income and the higher health expenditure are pre-determined consequences of increased FLFP. Re-visiting analysis of the impact of GDP on health expenditure in the light of this insight is a further inviting avenue for research that is beyond the scope of this thesis.

SECTION FIVE: APPENDICES A - C

Appendix A

Review of methodology

This appendix compares estimation results for most of the models discussed in this thesis, estimated by 11 alternative methodologies. Chapter 4 discusses the features of the data and the series of tests which determined the preferred methodological approaches adopted in this analysis. In this appendix estimations by the preferred methodologies are compared to estimations by alternative methodologies. The methodologies in the tables that follow in this appendix are: pooled ordinary least squares (POLS); "within groups" fixed effects (FE); "within groups" fixed effects with a cluster option for heteroscedasticity (FEC); least squares dummy variable estimation with dummy variables for countries only (LSDV1); least squares dummy variable estimation with dummy variables for countries and years (LSDV2); panel-corrected standards errors with country dummies only and no assumed autocorrelation (PCSE1): panel-corrected standard errors with dummies for both countries and years (PCSE2); panel-corrected standard errors with dummies for countries and years and with transformation for first-order autocorrelation (PCSE_AR); feasible generalized least squares with country dummies only and no assumed autocorrelation (FGLS1); feasible generalized least squares with dummies for both countries and years (FGLS2); feasible generalized least squares with dummies for countries and years and with transformation for first-order autocorrelation (FGLS2_AR).

The purpose of including this comparison is to observe to what degree the thesis findings are dependent on methodologies and the assumptions underlying them. It is striking that the all deaths decedent variable remains invariably positive and significant in its effect when estimated by each of these methodologies for all alternative models for the HMD17 panel (Tables A1-A3). The FLFP variable is always negative in effect and varies in significance; the converging life expectancy variable is always positive in effect and almost always significant (the exception being POLS regression). The differing age specifications (quadratic, two-cohort and two-cohort quadratic) have varying significance depending on the methodology adopted. When an alternative measure of welfare is substituted for GDP and FLFP, the chief notable effect is that the single age variable becomes negative and significant in all estimations (Tables A10-A14).

The most illuminating finding from these comparisons is the effect of methodology on the GDP variable. As noted earlier in this analysis, there is an inverse correlation between GDP and acute bed days per capita. GDP has increased in these OECD countries as acute bed utilisation has decreased. When time is not explicitly modeled by the inclusion of dummy variables for the years and there is no converging life expectancy variable, the effect is compatible with this correlation: GDP has a negative sign and varying significance, except in the POLS regression (Tables A1-A2). However, inclusion of the time dummy variables in the five alternative methodologies, where this applies, has the effect of making GDP positive and significant, the finding that has dominated interpretation of GDP in my analysis. Since the time dummies are negative and significant, it appears that they have removed a negative time trend attributed to GDP in models where they are absent. When the convergent life expectancy variable is included (Tables A3-A6), it has the effect of removing much of the negative time trend and GDP becomes positive and significant for all methodologies. This sequence of comparisons suggests that the apparent negative correlation between GDP and acute bed utilisation in models which do not take convergent life expectancies into account (or proxy them with a time trend) is suffering from the confounding factor, convergent life expectancies. Thus, the apparently inverse relationship between GDP and acute bed days reflects the fact that as national wealth has increased in these countries, so too has health status and the survival of older couples longer together, both factors which reduce age-specific acute bed utilisation. When the alternative measure of welfare is substituted for GDP, its effect is positive and significant in virtually all models and methodologies and the negative time trend is further reduced which suggests, as discussed in Chapter 7, that this measure is capturing the negative effect of increased female labour force participation on acute bed utilisation (Tables A8-A13).

Comparisons of models and methodologies for the HMD14 panel do not differ greatly although the degree of significance for some of the variables fluctuates somewhat more (Tables A14-A26). This panel shows the FLFP variable to be negative and to be significant much more frequently, although not invariably depending on method and model. The age variable is negative and generally significant. The convergent life expectancy variable is positive and generally significant. The all deaths decedent variable is always positive and significant when the convergent life expectancy variable is a co-variate except in the model when age is represented by two cohorts as quadratics, when it

loses some significance. The effect of the time trend and the convergent life expectancy variable on GDP is broadly the same for this panel as for HMD17. The differing age specifications have varying significance depending on methodology. The interaction effect for age and converging life expectancies in the preferred quadratic, interactive model for the HMD17 panel is significant in all but one methodology in the models with GDP as a measure of welfare and with the alternative welfare measure (Tables A5 and A11). The significance of the interaction effect in the linear, interactive model for the HMD14 panel is much more variable depending on methodology (Tables A17 and A23).

The final three tables in this appendix compare models and methodologies for the small HMD7 panel employed to investigate long-term care utilisation. The FLFP variable is always positive and significant. The significance levels of the age and converging life expectancies variables fluctuate. The variable interacting age and convergent life expectancies is positive and significant except for pooled OLS (Tables A27-A29).

SECTION 5 APPENDIX A: List of tables comparing estimation by alternative methodologies

Table	Model	Panel	Years	Co-Variates
A1	Acute utilisation	HMD17	1985-2006	GDPpc Percent65 PercentDecedents
A2	Acute utilisation	HMD17	1985-2006	GDPpc Percent65 PercentDecedents FLFP
A3	Acute utilisation	HMD17	1985-2006	GDPpc Percent65 PercentDecedents FLFP LEBdiff
A4	Acute utilisation	HMD17	1985-2006	GDPpc Percent65 Percent65-squ. PercentDecedents FLFP LEBdiff
A5	Acute utilisation	HMD17	1985-2006	GDPpc Percent65 Percent65-squ. PercentDecedents FLFP LEBdiff Age*LEBdiff
A6	Acute utilisation	HMD17	1985-2006	GDPpc Percent6579 Percent80 PercentDecedents FLFP LEBdiff
A7	Acute utilisation	HMD17	1985-2006	GDPpc Percent6579 Percent6579-squ. Percent80 Percent80-squ. PercentDecedents FLFP LEBdiff
A8	Acute utilisation	HMD17	1985-2006	GDPAVFCP Percent65 PercentDecedents
A9	Acute utilisation	HMD17	1985-2006	GDPAVFCP Percent65 PercentDecedents LEBdiff
A10	Acute utilisation	HMD17	1985-2006	GDPAVFCP Percent65 Percent65-squ. PercentDecedents LEBdiff
A11	Acute utilisation	HMD17	1985-2006	GDPAVFCP Percent65 Percent65-squ. PercentDecedents LEBdiff Age*LEBdiff
A12	Acute utilisation	HMD17	1985-2006	GDPAVFCP Percent6579 Percent80 PercentDecedents LEBdiff
A13	Acute utilisation	HMD17	1985-2006	GDPAVFCP Percent6579 Percent6579-squ. Percent80 Percent80-squ. PercentDecedents LEBdiff
A14	Acute utilisation	HMD14	1985-2006	GDPpc Percent65 PercentDecedents
A15	Acute utilisation	HMD14	1985-2006	GDPpc Percent65 PercentDecedents FLFP
A16	Acute utilisation	HMD14	1985-2006	GDPpc Percent65 PercentDecedents FLFP LEBdiff
A17	Acute utilisation	HMD14	1985-2006	GDPpc Percent65 PercentDecedents FLFP LEBdiff Age*LEBdiff
A18	Acute utilisation	HMD14	1985-2006	GDPpc Percent65 Percent65-squ. PercentDecedents FLFP LEBdiff
A19	Acute utilisation	HMD14	1985-2006	GDPpc Percent6579 Percent80 PercentDecedents FLFP LEBdiff
A20	Acute utilisation	HMD14	1985-2006	GDPpc Percent6579 Percent6579-squ. Percent80 Percent80-squ. PercentDecedents FLFP LEBdiff
A21	Acute utilisation	HMD14	1985-2006	GDPAVFCP Percent65 PercentDecedents
A22	Acute utilisation	HMD14	1985-2006	GDPAVFCP Percent65 PercentDecedents LEBdiff
A23	Acute utilisation	HMD14	1985-2006	GDPAVFCP Percent65 PercentDecedents LEBdiff Age*LEBdiff
A24	Acute utilisation	HMD14	1985-2006	GDPAVFCP Percent65 Percent65-squ. PercentDecedents LEBdiff
A25	Acute utilisation	HMD14	1985-2006	GDPAVFCP Percent6579 Percent80 PercentDecedents LEBdiff
A26	Acute utilisation	HMD14	1985-2006	GDPAVFCP Percent6579 Percent6579-squ. Percent80 Percent80-squ. PercentDecedents LEBdiff
A27	LTC utilisation	HMD7	1997-2006	Percent65 lnFLFP
A28	LTC utilisation	HMD7	1997-2006	Percent65 lnFLFP LEBdiff
A29	LTC utilisation	HMD7	1997-2006	Percent65 lnFLFP LEBdiff Age*LEBdiff

Appendix A. Table A1 Acute utilisation method comparison, HMD17, 1985-2006, Dependent variable: acute bed days per capita

	POLS	FE	FEC	LSDV1	LSDV2	PCSE1	PCSE2	PCSE2_AR	FGLS1	FGLS2	FGLS2_AR
GDPpc	0.006	-0.008**	-0.008	-0.008**	0.035***	-0.008***	0.035***	0.030***	-0.009***	0.033***	0.028***
	[0.109]	[0.004]	[0.442]	[0.004]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]
Percent65	-0.042***	-0.094***	-0.094***	-0.094***	0.016	-0.094***	0.016	0.017	-0.094***	0.007	0.016
	[0.001]	[0.000]	[0.001]	[0.000]	[0.092]	[0.000]	[0.096]	[0.214]	[0.000]	[0.425]	[0.218]
Percent Decedents	1.880***	1.494***	1.494*	1.494***	0.797***	1.494***	0.797***	0.432**	1.486***	0.863***	0.422**
	[0.000]	[0.000]	[0.010]	[0.000]	[0.000]	[0.000]	[0.000]	[0.005]	[0.000]	[0.000]	[0.003]
2006					-0.867***		-0.867***	-0.841***		-0.773***	-0.795***
					[0.000]		[0.000]	[0.000]		[0.000]	[0.000]
Observations	355	355	355	355	355	355	355	355	355	355	355
R^2	0.31	0.65	0.65	0.93	0.96	0.93	0.96	0.94			
AIC	277.3	-554.4	-556.4	-522.4	-679.3	.	.	.	.	.	.
BIC	292.8	-538.9	-544.8	-445.0	-520.5	.	.	.	.	.	.

p-values in brackets * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$ Source: HMD17 panel

Appendix A. Table A2 Acute utilisation method comparison, HMD17, 1985-2006, Dependent variable: acute bed days per capita

	POLS	FE	FEC	LSDV1	LSDV2	PCSE1	PCSE2	PCSE2_AR	FGLS1	FGLS2	FGLS2_AR
GDPpc	0.012**	-0.003	-0.003	-0.003	0.037***	-0.003	0.037***	0.031***	-0.006*	0.037***	0.030***
	[0.006]	[0.465]	[0.838]	[0.465]	[0.000]	[0.401]	[0.000]	[0.000]	[0.023]	[0.000]	[0.000]
percent65	-0.052***	-0.093***	-0.093***	-0.093***	0.015	-0.093***	0.015	0.017	-0.094***	0.004	0.015
	[0.000]	[0.000]	[0.001]	[0.000]	[0.115]	[0.000]	[0.116]	[0.215]	[0.000]	[0.608]	[0.240]
%Decedents	1.953***	1.567***	1.567**	1.567***	0.837***	1.567***	0.837***	0.457**	1.473***	0.906***	0.445**
	[0.000]	[0.000]	[0.009]	[0.000]	[0.000]	[0.000]	[0.000]	[0.003]	[0.000]	[0.000]	[0.002]
FLFP	-0.007**	-0.006*	-0.006	-0.006*	-0.003	-0.006**	-0.003	-0.002	-0.004	-0.006**	-0.002
	[0.008]	[0.024]	[0.520]	[0.024]	[0.232]	[0.003]	[0.064]	[0.491]	[0.081]	[0.002]	[0.419]
2006					-0.855***		-0.855***	-0.837***		-0.765***	-0.793***
					[0.000]		[0.000]	[0.000]		[0.000]	[0.000]
Observations	355	355	355	355	355	355	355	355	355	355	355
R^2	0.32	0.65	0.65	0.93	0.96	0.93	0.96	0.94			
AIC	272.2	-557.8	-559.8	-525.8	-678.9	.	.	.	.	.	.
BIC	291.5	-538.5	-544.3	-444.5	-516.3	.	.	.	.	.	.

p-values in brackets* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$ Source: HMD17 panel

Appendix A. Table A3 Acute utilisation method comparison, HMD17, 1985-2006, Dependent variable: acute bed days per capita

	POLS	FE	FEC	LSDV1	LSDV2	PCSE1	PCSE2	PCSE2_AR	FGLS1	FGLS2	FGLS2_AR
GDPpc	0.016**	0.013***	0.013*	0.013***	0.023***	0.013***	0.023***	0.027***	0.014***	0.025***	0.028***
	[0.001]	[0.000]	[0.026]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]
percent65	-0.053***	-0.070***	-0.070***	-0.070***	-0.041***	-0.070***	-0.041***	-0.008	-0.078***	-0.036***	-0.006
	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.524]	[0.000]	[0.000]	[0.612]
%Decedents	1.851***	0.952***	0.952**	0.952***	1.002***	0.952***	1.002***	0.624***	1.006***	1.103***	0.653***
	[0.000]	[0.000]	[0.006]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]
FLFP	-0.008**	-0.007***	-0.007	-0.007***	-0.005**	-0.007***	-0.005***	-0.003	-0.009***	-0.007***	-0.004
	[0.003]	[0.001]	[0.133]	[0.001]	[0.009]	[0.000]	[0.000]	[0.136]	[0.000]	[0.000]	[0.093]
LEBdiff	0.047	0.212***	0.212***	0.212***	0.189***	0.212***	0.189***	0.095***	0.185***	0.173***	0.076***
	[0.100]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]
2006					-0.242*		-0.242**	-0.564***		-0.273***	-0.576***
					[0.012]		[0.003]	[0.000]		[0.001]	[0.000]
Observations	355	355	355	355	355	355	355	355	355	355	355
R^2	0.33	0.79	0.79	0.96	0.97	0.96	0.97	0.95			
AIC	271.4	-740.7	-742.7	-708.7	-756.2	.	.	.	.	.	.
BIC	294.7	-717.4	-723.3	-623.5	-589.7	.	.	.	.	.	.

p-values in brackets * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$ Source: HMD17 panel

Appendix A. Table A4 Acute utilisation method comparison, HMD17, 1985-2006, age as quadratic
Dependent variable: acute bed days per capita

	POLS	FE	FEC	LSDV1	LSDV2"	PCSE1	PCSE2	PCSE2_AR	FGLS1	FGLS2"	FGLS2_AR
GDPpc	0.015**	0.014***	0.014*	0.014***	0.024***	0.014***	0.024***	0.028***	0.015***	0.027***	0.030***
	[0.003]	[0.000]	[0.026]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]
percent65	0.045	-0.120**	-0.120	-0.120**	0.128*	-0.120*	0.128*	0.207***	-0.165***	0.223***	0.295***
	[0.746]	[0.010]	[0.339]	[0.010]	[0.016]	[0.024]	[0.017]	[0.001]	[0.000]	[0.000]	[0.000]
Age-squared	-0.003	0.002	0.002	0.002	-0.005**	0.002	-0.005**	-0.007***	0.003*	-0.008***	-0.009***
	[0.476]	[0.277]	[0.696]	[0.277]	[0.001]	[0.331]	[0.001]	[0.000]	[0.047]	[0.000]	[0.000]
%Decedents	1.809***	0.984***	0.984**	0.984***	0.856***	0.984***	0.856***	0.498**	1.058***	0.876***	0.487***
	[0.000]	[0.000]	[0.005]	[0.000]	[0.000]	[0.000]	[0.000]	[0.001]	[0.000]	[0.000]	[0.001]
FLFP	-0.009**	-0.007***	-0.007	-0.007***	-0.004*	-0.007***	-0.004**	-0.003	-0.009***	-0.005**	-0.002
	[0.003]	[0.001]	[0.134]	[0.001]	[0.028]	[0.000]	[0.002]	[0.232]	[0.000]	[0.001]	[0.277]
LEBdiff	0.041	0.210***	0.210***	0.210***	0.185***	0.210***	0.185***	0.094***	0.185***	0.163***	0.072***
	[0.160]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]
2006					-0.341***		-0.341***	-0.665***		-0.426***	-0.722***
					[0.001]		[0.000]	[0.000]		[0.000]	[0.000]
Observations	355	355	355	355	355	355	355	355	355	355	355
R^2	0.33	0.80	0.80	0.96	0.97	0.96	0.97	0.96			
AIC	272.9	-739.9	-741.9	-707.9	-766.0	.	.	.	.	.	.
BIC	300.0	-712.8	-718.7	-618.9	-595.6	.	.	.	.	.	.

p-values in brackets * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$ Source: HMD17 panel

Appendix A. Table A5 Acute utilisation method comparison, HMD17, 1985-2006, quadratic, interactive model
Dependent variable: acute bed days

	POLS	FE	FEC	LSDV1	LSDV2	PCSE1	PCSE2	PCSE2_AR	FGLS1	FGLS2	FGLS2_AR
GDPpc	0.016**	0.010**	0.010	0.010**	0.021***	0.010***	0.021***	0.026***	0.010***	0.023***	0.026***
	[0.001]	[0.001]	[0.116]	[0.001]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]
percent65	0.717***	-0.364***	-0.364	-0.364***	-0.123	-0.364***	-0.123	-0.019	-0.414***	-0.058	0.073
	[0.000]	[0.000]	[0.111]	[0.000]	[0.174]	[0.000]	[0.143]	[0.860]	[0.000]	[0.435]	[0.432]
Age-squared	-0.010*	0.006**	0.006	0.006**	-0.001	0.006**	-0.001	-0.003	0.007***	-0.003	-0.006**
	[0.027]	[0.005]	[0.290]	[0.005]	[0.645]	[0.008]	[0.640]	[0.227]	[0.000]	[0.089]	[0.008]
%Decedents	1.671***	0.971***	0.971**	0.971***	0.833***	0.971***	0.833***	0.499***	0.938***	0.945***	0.546***
	[0.000]	[0.000]	[0.003]	[0.000]	[0.000]	[0.000]	[0.000]	[0.001]	[0.000]	[0.000]	[0.000]
FLFP	-0.012***	-0.005*	-0.005	-0.005*	-0.002	-0.005**	-0.002	-0.001	-0.005**	-0.004*	-0.001
	[0.000]	[0.028]	[0.355]	[0.028]	[0.328]	[0.006]	[0.185]	[0.740]	[0.007]	[0.022]	[0.647]
LEBdiff	1.107***	-0.064	-0.064	-0.064	-0.103	-0.064	-0.103	-0.162	-0.081	-0.107	-0.160
	[0.000]	[0.490]	[0.737]	[0.490]	[0.238]	[0.361]	[0.115]	[0.064]	[0.258]	[0.113]	[0.050]
Age*LEBdiff	-0.076***	0.019**	0.019	0.019**	0.019***	0.019***	0.019***	0.017**	0.019***	0.019***	0.016**
	[0.000]	[0.003]	[0.174]	[0.003]	[0.001]	[0.000]	[0.000]	[0.005]	[0.000]	[0.000]	[0.004]
2006					-0.356***		-0.356***	-0.670***		-0.367***	-0.666***
					[0.000]		[0.000]	[0.000]		[0.000]	[0.000]
Observations	355	355	355	355	355	355	355	355	355	355	355
R^2	0.38	0.80	0.80	0.96	0.97	0.96	0.97	0.96			
AIC	245.4	-747.5	-749.5	-715.5	-777.1	.	.	.	.	.	.
BIC	276.4	-716.5	-722.4	-622.6	-602.8	.	.	.	.	.	.

p-values in brackets * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$ Source: HMD17 panel

Appendix A. Table A6 Acute utilisation method comparison, HMD17, 1985-2006, two age cohorts
Dependent variable: acute bed days per capita

	POLS	FE	FEC	LSDV1	LSDV2	PCSE1	PCSE2	PCSE2_AR	FGLS1	FGLS2	FGLS2_AR
GDPpc	0.019**	0.014***	0.014*	0.014***	0.024***	0.014***	0.024***	0.027***	0.012***	0.024***	0.026***
	[0.003]	[0.000]	[0.026]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]
percent6579	-0.040	-0.068***	-0.068***	-0.068***	-0.040***	-0.068***	-0.040***	-0.010	-0.083***	-0.037***	-0.011
	[0.116]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.437]	[0.000]	[0.000]	[0.360]
percent80	-0.089	-0.077***	-0.077	-0.077***	-0.059	-0.077***	-0.059*	0.016	-0.057**	-0.001	0.074*
	[0.132]	[0.000]	[0.052]	[0.000]	[0.081]	[0.000]	[0.025]	[0.650]	[0.002]	[0.984]	[0.042]
%Decedents	1.842***	0.965***	0.965**	0.965***	1.056***	0.965***	1.056***	0.578***	0.970***	0.999***	0.501**
	[0.000]	[0.000]	[0.005]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.001]
FLFP	-0.009**	-0.007***	-0.007	-0.007***	-0.006**	-0.007***	-0.006**	-0.003	-0.008***	-0.006**	-0.003
	[0.003]	[0.001]	[0.128]	[0.001]	[0.008]	[0.000]	[0.001]	[0.198]	[0.000]	[0.001]	[0.208]
LEBdiff	0.050	0.211***	0.211***	0.211***	0.190***	0.211***	0.190***	0.095***	0.189***	0.169***	0.075***
	[0.086]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]
2006					-0.211		-0.211*	-0.599***		-0.337***	-0.693***
					[0.054]		[0.022]	[0.000]		[0.000]	[0.000]
Observations	355	355	355	355	355	355	355	355	355	355	355
R^2	0.33	0.79	0.79	0.96	0.97	0.96	0.97	0.95			
AIC	273.0	-738.8	-740.8	-706.8	-754.6	.	.	.	.	.	.
BIC	300.1	-711.7	-717.6	-617.7	-584.2	.	.	.	.	.	.

p-values in brackets * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$ Source: HMD17 panel

Appendix A. Table A7 Acute utilisation method comparison, HMD17, 1985-2006, 2 age cohorts, quadratics

Dependent variable: acute beddays p.c.

	POLS	FE	FEC	LSDV1	LSDV2	PCSE1	PCSE2	PCSE2_AR	FGLS1	FGLS2	FGLS2_AR
GDPpc	0.025***	0.006	0.006	0.006	0.013**	0.006	0.013**	0.018***	0.002	0.011**	0.015**
	[0.000]	[0.108]	[0.396]	[0.108]	[0.002]	[0.132]	[0.001]	[0.001]	[0.442]	[0.004]	[0.001]
percent6579	0.796**	-0.504***	-0.504*	-0.504***	-0.234**	-0.504***	-0.234**	-0.119	-0.515***	-0.228**	-0.129
	[0.002]	[0.000]	[0.013]	[0.000]	[0.008]	[0.000]	[0.002]	[0.216]	[0.000]	[0.001]	[0.163]
percent80	-0.873**	0.367***	0.367	0.367***	0.453***	0.367***	0.453***	0.488***	0.347***	0.564***	0.596***
	[0.007]	[0.000]	[0.058]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]
percent6579sq	-0.036***	0.018***	0.018*	0.018***	0.008*	0.018***	0.008**	0.004	0.019***	0.008**	0.005
	[0.001]	[0.000]	[0.035]	[0.000]	[0.027]	[0.000]	[0.008]	[0.274]	[0.000]	[0.009]	[0.241]
percent80sq	0.105*	-0.061***	-0.061*	-0.061***	-0.069***	-0.061***	-0.069***	-0.065***	-0.055***	-0.077***	-0.074***
	[0.020]	[0.000]	[0.024]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]
%Decedents	1.731***	0.772***	0.772*	0.772***	0.739***	0.772***	0.739***	0.407*	0.669***	0.654***	0.325*
	[0.000]	[0.000]	[0.022]	[0.000]	[0.000]	[0.000]	[0.000]	[0.010]	[0.000]	[0.000]	[0.028]
FLFP	-0.011***	-0.005*	-0.005	-0.005*	-0.003	-0.005**	-0.003	-0.001	-0.005**	-0.003	-0.001
	[0.000]	[0.022]	[0.330]	[0.022]	[0.170]	[0.004]	[0.099]	[0.617]	[0.008]	[0.087]	[0.684]
LEBdiff	0.038	0.203***	0.203***	0.203***	0.197***	0.203***	0.197***	0.110***	0.194***	0.171***	0.089***
	[0.196]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]
2006					-0.210		-0.210*	-0.567***		-0.292**	-0.611***
					[0.056]		[0.033]	[0.000]		[0.001]	[0.000]
Observations	355	355	355	355	355	355	355	355	355	355	355
R^2	0.35	0.81	0.81	0.96	0.97	0.96	0.97	0.96			
AIC	265.2	-765.2	-767.2	-733.2	-782.9	.	.	.	.	.	.
BIC	300.1	-730.4	-736.3	-636.4	-604.8	.	.	.	.	.	.

p-values in brackets * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$ Source: HMD17 panel

Appendix A. Table A8 Acute utilisation method comparison, HMD17, GDPAVFCP
Dependent variable: acute bed days per capita

	POLS	FE	FEC	LSDV1	LSDV2	PCSE1	PCSE2	PCSE2_AR	FGLS1	FGLS2	FGLS2_AR
GDPAVFCP	0.001***	0.001***	0.001	0.001***	0.001***	0.001***	0.001***	0.001***	0.000***	0.001***	0.001***
	[0.000]	[0.000]	[0.129]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]
Percent65	-0.084***	-0.120***	-0.120***	-0.120***	-0.037***	-0.120***	-0.037***	-0.024*	-0.118***	-0.051***	-0.032**
	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.015]	[0.000]	[0.000]	[0.002]
%Decedents	2.286***	2.137***	2.137***	2.137***	1.024***	2.137***	1.024***	0.582***	1.991***	1.068***	0.587***
	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]
2006					-0.432***		-0.432***	-0.476***		-0.397***	-0.445***
					[0.000]		[0.000]	[0.000]		[0.000]	[0.000]
Observations	355	355	355	355	355	355	355	355	355	355	355
R^2	0.38	0.66	0.66	0.94	0.96	0.94	0.96	0.94			
AIC	239.1	-565.3	-567.3	-533.3	-668.1	.	.	.	.	.	.
BIC	254.6	-549.8	-555.7	-455.9	-509.3	.	.	.	.	.	.

p-values in brackets * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$ Source: HMD17 panel

Appendix A. Table A9 Acute utilisation method comparison, HMD17, GDPAVFCP
Dependent variable: acute bed days per capita

	POLS	FE	FEC	LSDV1	LSDV2	PCSE1	PCSE2	PCSE2_AR	FGLS1	FGLS2	FGLS2_AR
GDPAVFCP	0.001***	0.001***	0.001**	0.001***	0.001***	0.001***	0.001***	0.001***	0.001***	0.001***	0.001***
	[0.000]	[0.000]	[0.002]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]
Percent65	-0.086***	-0.080***	-0.080***	-0.080***	-0.069***	-0.080***	-0.069***	-0.045***	-0.089***	-0.067***	-0.046***
	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]
%Decedents	2.074***	0.991***	0.991**	0.991***	1.070***	0.991***	1.070***	0.711***	1.072***	1.207***	0.789***
	[0.000]	[0.000]	[0.003]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]
LEBdiff	0.068**	0.193***	0.193***	0.193***	0.192***	0.193***	0.192***	0.108***	0.175***	0.171***	0.090***
	[0.007]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]
2006					-0.026		-0.026	-0.249***		-0.051	-0.249***
					[0.678]		[0.642]	[0.000]		[0.337]	[0.000]
Observations	355	355	355	355	355	355	355	355	355	355	355
R^2	0.39	0.80	0.80	0.96	0.97	0.96	0.97	0.95			
AIC	233.6	-757.4	-759.4	-725.4	-757.5	.	.	.	.	.	.
BIC	253.0	-738.1	-743.9	-644.1	-594.9	.	.	.	.	.	.

p-values in brackets * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$ Source: HMD17 panel

Appendix A. Table A10 Acute utilisation method comparison, HMD17, GDPAVFCP, age as quadratic
Dependent variable: acute bed days per capita

	POLS	FE	FEC	LSDV1	LSDV2	PCSE1	PCSE2	PCSE2_AR	FGLS1	FGLS2	FGLS2_AR
GDPAVFCP	0.001***	0.001***	0.001**	0.001***	0.001***	0.001***	0.001***	0.001***	0.001***	0.001***	0.001***
	[0.000]	[0.000]	[0.002]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]
Percent65	-0.032	-0.120**	-0.120	-0.120**	0.068	-0.120*	0.068	0.126*	-0.169***	0.143**	0.198***
	[0.791]	[0.007]	[0.321]	[0.007]	[0.184]	[0.021]	[0.192]	[0.046]	[0.000]	[0.002]	[0.001]
Percent65-squared	-0.002	0.001	0.001	0.001	-0.004**	0.001	-0.004**	-0.005**	0.003	-0.007***	-0.008***
	[0.660]	[0.362]	[0.744]	[0.362]	[0.007]	[0.429]	[0.008]	[0.007]	[0.058]	[0.000]	[0.000]
%Decedents	2.057***	1.010***	1.010**	1.010***	0.960***	1.010***	0.960***	0.617***	1.106***	1.037***	0.658***
	[0.000]	[0.000]	[0.002]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]
LEBdiff	0.066**	0.190***	0.190***	0.190***	0.193***	0.190***	0.193***	0.111***	0.171***	0.168***	0.090***
	[0.009]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]
2006					-0.076		-0.076	-0.303***		-0.126*	-0.326***
					[0.237]		[0.224]	[0.000]		[0.023]	[0.000]
Observations	355	355	355	355	355	355	355	355	355	355	355
R^2	0.39	0.80	0.80	0.96	0.97	0.96	0.97	0.95			
AIC	235.4	-756.3	-758.3	-724.3	-763.8	.	.	.	.	.	.
BIC	258.7	-733.1	-739.0	-639.1	-597.3	.	.	.	.	.	.

p-values in brackets * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$ Source: HMD17 panel

Appendix A Table A11 Acute utilisation method comparison, HMD17, GDPAVFCP, quadratic, interactive model
Dependent variable: acute bed days per capita

	POLS	FE	FEC	LSDV1	LSDV2	PCSE1	PCSE2	PCSE2_AR	FGLS1	FGLS2	FGLS2_AR
GDPAVFCP	0.001***	0.0005***	0.0005*	0.0005***	0.0005**	0.0005**	0.0005***	0.001***	0.001***	0.001***	0.001***
	[0.000]	[0.000]	[0.020]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]
Percent65	0.536***	-0.340***	-0.340	-0.340***	-0.161	-0.340***	-0.161	-0.082	-0.393***	-0.141	-0.034
	[0.001]	[0.000]	[0.111]	[0.000]	[0.070]	[0.000]	[0.057]	[0.425]	[0.000]	[0.053]	[0.709]
Age-squared	-0.007	0.005**	0.005	0.005**	-0.000	0.005*	-0.000	-0.002	0.006***	-0.001	-0.004
	[0.104]	[0.010]	[0.329]	[0.010]	[0.859]	[0.021]	[0.863]	[0.456]	[0.000]	[0.403]	[0.087]
%Decedents	1.976***	1.008***	1.008**	1.008***	0.957***	1.008***	0.957***	0.642***	1.021***	1.043***	0.684***
	[0.000]	[0.000]	[0.001]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]
LEBdiff	1.044***	-0.052	-0.052	-0.052	-0.060	-0.052	-0.060	-0.113	-0.069	-0.113	-0.151
	[0.000]	[0.543]	[0.755]	[0.543]	[0.472]	[0.420]	[0.375]	[0.192]	[0.277]	[0.079]	[0.062]
Age*LEBdiff	-0.070***	0.017**	0.017	0.017**	0.017**	0.017***	0.017***	0.015*	0.017***	0.019***	0.017**
	[0.000]	[0.005]	[0.176]	[0.005]	[0.002]	[0.000]	[0.000]	[0.010]	[0.000]	[0.000]	[0.002]
2006					-0.077		-0.077	-0.294***		-0.109*	-0.304***
					[0.225]		[0.203]	[0.000]		[0.041]	[0.000]
Observations	355	355	355	355	355	355	355	355	355	355	355
R^2	0.44	0.81	0.81	0.96	0.97	0.96	0.97	0.96			
AIC	208.7	-762.9	-764.9	-730.9	-772.9	.	.	.	.	.	.
BIC	235.8	-735.8	-741.6	-641.8	-602.5	.	.	.	.	.	.

p-values in brackets * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$ Source: HMD17 panel

Appendix A. Table A12 Acute utilisation method comparison, HMD17, GDPAVFCP, two age cohorts
Dependent variable: acute bed days per capita

	POLS	FE	FEC	LSDV1	LSDV2	PCSE1	PCSE2	PCSE2_AR	FGLS1	FGLS2	FGLS2_AR
GDPAVFCP	0.002***	0.001***	0.001**	0.001***	0.001***	0.001***	0.001***	0.001***	0.001***	0.001***	0.001***
	[0.000]	[0.000]	[0.001]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]
Percent6579	-0.060**	-0.079***	-0.079***	-0.079***	-0.069***	-0.079***	-0.069***	-0.047***	-0.093***	-0.068***	-0.051***
	[0.006]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]
Percent80	-0.152***	-0.083***	-0.083*	-0.083***	-0.072*	-0.083***	-0.072**	-0.011	-0.070***	-0.020	0.040
	[0.001]	[0.000]	[0.018]	[0.000]	[0.028]	[0.000]	[0.004]	[0.744]	[0.000]	[0.451]	[0.270]
%Decedents	2.025***	0.994***	0.994**	0.994***	1.077***	0.994***	1.077***	0.648***	1.054***	1.093***	0.640***
	[0.000]	[0.000]	[0.003]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]
LEBdiff	0.064*	0.192***	0.192***	0.192***	0.192***	0.192***	0.192***	0.108***	0.181***	0.167***	0.089***
	[0.010]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]
2006					-0.021		-0.021	-0.302***		-0.129	-0.377***
					[0.797]		[0.752]	[0.000]		[0.061]	[0.000]
Observations	355	355	355	355	355	355	355	355	355	355	355
R^2	0.40	0.80	0.80	0.96	0.97	0.96	0.97	0.95			
AIC	233.3	-755.5	-757.5	-723.5	-755.5	.	.	.	.	.	.
BIC	256.5	-732.2	-738.1	-638.3	-589.0	.	.	.	.	.	.

p-values in brackets * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$ Source: HMD17 panel

Appendix A. Table A13 Acute utilisation method comparison, HMD17, GDPAVFCP, 2 age cohort quadratics
Dependent variable: acute beddays pc

	POLS	FE	FEC	LSDV1	LSDV2	PCSE1	PCSE2	PCSE2_AR	FGLS1	FGLS2	FGLS2_AR
GDPAVFCP	0.002***	0.0004***	0.0004	0.0004***	0.0004***	0.0004***	0.0004***	0.0004**	0.0004***	0.0003***	0.0004**
	[0.000]	[0.000]	[0.130]	[0.000]	[0.001]	[0.000]	[0.001]	[0.003]	[0.000]	[0.001]	[0.002]
Percent6579	0.962***	-0.452***	-0.452*	-0.452***	-0.276***	-0.452***	-0.276***	-0.207*	-0.477***	-0.251***	-0.205*
	[0.000]	[0.000]	[0.019]	[0.000]	[0.001]	[0.000]	[0.000]	[0.024]	[0.000]	[0.000]	[0.015]
Percent6579-squared	-0.044***	0.016***	0.016	0.016***	0.009**	0.016***	0.009**	0.007	0.017***	0.008**	0.007
	[0.000]	[0.000]	[0.055]	[0.000]	[0.008]	[0.000]	[0.003]	[0.076]	[0.000]	[0.004]	[0.062]
Percent80	-1.256***	0.272**	0.272	0.272**	0.451***	0.272***	0.451***	0.492***	0.245***	0.551***	0.602***
	[0.000]	[0.003]	[0.127]	[0.003]	[0.000]	[0.001]	[0.000]	[0.000]	[0.001]	[0.000]	[0.000]
Percent80-squared	0.152***	-0.050***	-0.050*	-0.050***	-0.070***	-0.050***	-0.070***	-0.069***	-0.043***	-0.077***	-0.078***
	[0.000]	[0.000]	[0.047]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]
%Decedents	1.910***	0.887***	0.887**	0.887***	0.769***	0.887***	0.769***	0.483**	0.844***	0.713***	0.416**
	[0.000]	[0.000]	[0.008]	[0.000]	[0.000]	[0.000]	[0.000]	[0.002]	[0.000]	[0.000]	[0.005]
LEBdiff	0.045	0.195***	0.195***	0.195***	0.198***	0.195***	0.198***	0.122***	0.198***	0.168***	0.099***
	[0.076]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]
2006					-0.096		-0.096	-0.334***		-0.205**	-0.411***
					[0.235]		[0.143]	[0.000]		[0.001]	[0.000]
Observations	355	355	355	355	355	355	355	355	355	355	355
R^2	0.43	0.82	0.82	0.97	0.97	0.97	0.97	0.96			
AIC	215.2	-774.5	-776.5	-742.5	-786.7	.	.	.	.	.	.
BIC	246.2	-743.5	-749.4	-649.6	-612.5	.	.	.	.	.	.

p-values in brackets * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$ Source: HMD17 panel

Appendix A. Table A14 Acute utilisation method comparison, HMD14, 1985-2006, Dependent variable: acute bed days per capita

	POLS	FE	FEC	LSDV1	LSDV2	PCSE1	PCSE2	PCSE2_AR	FGLS1	FGLS2	FGLS2_AR
GDPpc	-0.024***	-0.012***	-0.012	-0.012***	0.032***	-0.012***	0.032***	0.028***	-0.016***	0.029***	0.025***
	[0.000]	[0.000]	[0.212]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]
percent65	0.048**	-0.135***	-0.135***	-0.135***	-0.000	-0.135***	-0.000	-0.005	-0.120***	-0.004	-0.016
	[0.004]	[0.000]	[0.001]	[0.000]	[0.997]	[0.000]	[0.997]	[0.776]	[0.000]	[0.658]	[0.275]
Percent Decedents	0.812***	0.829***	0.829	0.829***	0.314	0.829***	0.314*	0.237	0.659***	0.389**	0.273
	[0.000]	[0.000]	[0.172]	[0.000]	[0.055]	[0.000]	[0.013]	[0.154]	[0.000]	[0.003]	[0.081]
2006					-0.892***		-0.892***	-0.846***		-0.823***	-0.750***
					[0.000]		[0.000]	[0.000]		[0.000]	[0.000]
Observations	289	289	289	289	289	289	289	289	289	289	289
R^2	0.41	0.70	0.70	0.94	0.97	0.94	0.97	0.95			
AIC	193.4	-474.2	-476.2	-448.2	-615.4	.	.	.	.	.	.
BIC	208.1	-459.5	-465.2	-385.8	-476.1	.	.	.	.	.	.

p-values in brackets * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$ Source: HMD14 panel

Appendix A. Table A15 Acute utilisation method comparison, HMD14, 1985-2006, Dependent variable: acute bed days per capita

	POLS	FE	FEC	LSDV1	LSDV2	PCSE1	PCSE2	PCSE2_AR	FGLS1	FGLS2	FGLS2_AR
GDPpc	-0.021***	-0.003	-0.003	-0.003	0.038***	-0.003	0.038***	0.034***	-0.007**	0.037***	0.032***
	[0.000]	[0.362]	[0.805]	[0.362]	[0.000]	[0.211]	[0.000]	[0.000]	[0.010]	[0.000]	[0.000]
percent65	0.045**	-0.134***	-0.134**	-0.134***	-0.003	-0.134***	-0.003	-0.005	-0.121***	-0.018*	-0.018
	[0.007]	[0.000]	[0.001]	[0.000]	[0.768]	[0.000]	[0.755]	[0.716]	[0.000]	[0.046]	[0.179]
%Decedents	0.817***	0.950***	0.950	0.950***	0.405*	0.950***	0.405**	0.311	0.730***	0.567***	0.365*
	[0.000]	[0.000]	[0.110]	[0.000]	[0.011]	[0.000]	[0.001]	[0.052]	[0.000]	[0.000]	[0.016]
FLFP	-0.004	-0.012***	-0.012	-0.012***	-0.009***	-0.012***	-0.009***	-0.007**	-0.014***	-0.011***	-0.007**
	[0.201]	[0.000]	[0.158]	[0.000]	[0.000]	[0.000]	[0.000]	[0.010]	[0.000]	[0.000]	[0.003]
2006					-0.863***		-0.863***	-0.839***		-0.751***	-0.746***
					[0.000]		[0.000]	[0.000]		[0.000]	[0.000]
Observations	289	289	289	289	289	289	289	289	289	289	289
R^2	0.41	0.72	0.72	0.94	0.97	0.94	0.97	0.96			
AIC	193.7	-490.4	-492.4	-464.4	-632.9	.	.	.	.	.	.
BIC	212.1	-472.0	-477.7	-398.4	-489.9	.	.	.	.	.	.

p-values in brackets * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$ Source: HMD14 panel

Appendix A. Table A16 Acute utilisation method comparison, HMD14, 1985-2006, Dependent variable: acute bed days per capita

	POLS	FE	FEC	LSDV1	LSDV2	PCSE1	PCSE2	PCSE2_AR	FGLS1	FGLS2	FGLS2_AR
GDPpc	-0.019**	0.014***	0.014*	0.014***	0.031***	0.014***	0.031***	0.033***	0.012***	0.031***	0.031***
	[0.002]	[0.000]	[0.019]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]
percent65	0.044**	-0.084***	-0.084***	-0.084***	-0.025*	-0.084***	-0.025*	-0.012	-0.098***	-0.034***	-0.023
	[0.009]	[0.000]	[0.000]	[0.000]	[0.031]	[0.000]	[0.017]	[0.412]	[0.000]	[0.001]	[0.080]
%Decedents	0.791***	0.848***	0.848*	0.848***	0.651***	0.848***	0.651***	0.378*	0.790***	0.755***	0.432**
	[0.000]	[0.000]	[0.027]	[0.000]	[0.000]	[0.000]	[0.000]	[0.015]	[0.000]	[0.000]	[0.004]
FLFP	-0.005	-0.011***	-0.011*	-0.011***	-0.009***	-0.011***	-0.009***	-0.008**	-0.012***	-0.010***	-0.008***
	[0.177]	[0.000]	[0.011]	[0.000]	[0.000]	[0.000]	[0.000]	[0.003]	[0.000]	[0.000]	[0.001]
LEBdiff	0.013	0.199***	0.199***	0.199***	0.111***	0.199***	0.111***	0.041	0.159***	0.085***	0.026
	[0.653]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.086]	[0.000]	[0.000]	[0.213]
2006					-0.523***		-0.523***	-0.728***		-0.516***	-0.680***
					[0.000]		[0.000]	[0.000]		[0.000]	[0.000]
Observations	289	289	289	289	289	289	289	289	289	289	289
R^2	0.41	0.82	0.82	0.97	0.98	0.97	0.98	0.96			
AIC	195.5	-621.3	-623.3	-595.3	-653.2	.	.	.	.	.	.
BIC	217.5	-599.3	-605.0	-525.7	-506.5	.	.	.	.	.	.

p-values in brackets * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$ Source: HMD14 panel

Appendix A. Table A17 Acute utilisation method comparison, HMD14, 1985-2006, linear, interactive model,
Dependent variable: acute bed days per capita

	POLS	FE	FEC	LSDV1	LSDV2	PCSE1	PCSE2	PCSE2_AR	FGLS1	FGLS2	FGLS2_AR
GDPpc	-0.014*	0.014***	0.014	0.014***	0.029***	0.014***	0.029***	0.030***	0.013***	0.027***	0.027***
	[0.017]	[0.000]	[0.054]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]
percent65	0.523***	-0.076*	-0.076	-0.076*	-0.098**	-0.076**	-0.098***	-0.084*	-0.066*	-0.134***	-0.120***
	[0.000]	[0.039]	[0.393]	[0.039]	[0.003]	[0.006]	[0.000]	[0.029]	[0.037]	[0.000]	[0.001]
%Decedents	0.748***	0.857***	0.857*	0.857***	0.552**	0.857***	0.552***	0.325*	0.838***	0.650***	0.402**
	[0.000]	[0.000]	[0.037]	[0.000]	[0.001]	[0.000]	[0.000]	[0.041]	[0.000]	[0.000]	[0.007]
FLFP	-0.011**	-0.012***	-0.012*	-0.012***	-0.007**	-0.012***	-0.007***	-0.006*	-0.013***	-0.007***	-0.005*
	[0.002]	[0.000]	[0.022]	[0.000]	[0.003]	[0.000]	[0.000]	[0.036]	[0.000]	[0.000]	[0.026]
LEBdiff	1.121***	0.217**	0.217	0.217**	-0.061	0.217***	-0.061	-0.124	0.227***	-0.142*	-0.181*
	[0.000]	[0.006]	[0.255]	[0.006]	[0.428]	[0.000]	[0.298]	[0.085]	[0.001]	[0.020]	[0.015]
Age*LEBdiff	-0.079***	-0.001	-0.001	-0.001	0.012*	-0.001	0.012**	0.011*	-0.005	0.016***	0.015**
	[0.000]	[0.814]	[0.924]	[0.814]	[0.019]	[0.752]	[0.001]	[0.025]	[0.295]	[0.000]	[0.004]
2006					-0.557***		-0.557***	-0.744***		-0.545***	-0.672***
					[0.000]		[0.000]	[0.000]		[0.000]	[0.000]
Observations	289	289	289	289	289	289	289	289	289	289	289
R^2	0.46	0.82	0.82	0.97	0.98	0.97	0.98	0.96			
AIC	169.4	-619.4	-621.4	-593.4	-657.6	.	.	.	.	.	.
BIC	195.1	-593.7	-599.4	-520.0	-507.3	.	.	.	.	.	.

p-values in brackets * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$ Source: HMD14 panel

Appendix A. Table A18 Acute utilisation method comparison, HMD14, age as quadratic, 1985-2006
Dependent variable: acute bed days per capita

	POLS	FE	FEC	LSDV1	LSDV2	PCSE1	PCSE2	PCSE2_AR	FGLS1	FGLS2	FGLS2_AR
GDPpc	-0.020**	0.015***	0.015*	0.015***	0.031***	0.015***	0.031***	0.033***	0.013***	0.032***	0.032***
	[0.002]	[0.000]	[0.011]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]
percent65	0.178	-0.228***	-0.228	-0.228***	0.018	-0.228***	0.018	0.075	-0.294***	0.079	0.158*
	[0.317]	[0.000]	[0.199]	[0.000]	[0.768]	[0.000]	[0.719]	[0.216]	[0.000]	[0.175]	[0.029]
agesqu	-0.005	0.005*	0.005	0.005*	-0.001	0.005*	-0.001	-0.003	0.007***	-0.004	-0.006*
	[0.450]	[0.013]	[0.387]	[0.013]	[0.478]	[0.011]	[0.399]	[0.174]	[0.000]	[0.051]	[0.012]
%Decedents	0.737**	0.969***	0.969**	0.969***	0.607***	0.969***	0.607***	0.316	0.913***	0.667***	0.332*
	[0.002]	[0.000]	[0.008]	[0.000]	[0.001]	[0.000]	[0.000]	[0.056]	[0.000]	[0.000]	[0.031]
FLFP	-0.005	-0.012***	-0.012**	-0.012***	-0.009***	-0.012***	-0.009***	-0.007**	-0.011***	-0.009***	-0.007**
	[0.151]	[0.000]	[0.008]	[0.000]	[0.000]	[0.000]	[0.000]	[0.005]	[0.000]	[0.000]	[0.002]
LEBdiff	0.008	0.193***	0.193***	0.193***	0.111***	0.193***	0.111***	0.042	0.158***	0.084***	0.025
	[0.781]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.083]	[0.000]	[0.000]	[0.222]
2006					-0.540***		-0.540***	-0.759***		-0.567***	-0.753***
					[0.000]		[0.000]	[0.000]		[0.000]	[0.000]
Observations	289	289	289	289	289	289	289	289	289	289	289
R^2	0.41	0.83	0.83	0.97	0.98	0.97	0.98	0.96			
AIC	197.0	-625.9	-627.9	-599.9	-651.8	.	.	.	.	.	.
BIC	222.6	-600.2	-605.9	-526.6	-501.4	.	.	.	.	.	.

p-values in brackets * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$ Source: HMD14 panel

Appendix A. Table A19 Acute utilisation method comparison, HMD14, 1985-2006, 2 age cohorts, Dependent variable: acute bed days per capita

	POLS	FE	FEC	LSDV1	LSDV2	PCSE1	PCSE2	PCSE2_AR	FGLS1	FGLS2	FGLS2_AR
GDPpc	-0.024**	0.015***	0.015*	0.015***	0.031***	0.015***	0.031***	0.033***	0.011***	0.031***	0.031***
	[0.002]	[0.000]	[0.010]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]
percent6579	0.025	-0.082***	-0.082***	-0.082***	-0.025*	-0.082***	-0.025*	-0.011	-0.098***	-0.034***	-0.022
	[0.360]	[0.000]	[0.000]	[0.000]	[0.032]	[0.000]	[0.015]	[0.416]	[0.000]	[0.001]	[0.088]
percent80	0.101	-0.101***	-0.101	-0.101***	-0.030	-0.101***	-0.030	-0.003	-0.095***	-0.033	0.015
	[0.103]	[0.000]	[0.058]	[0.000]	[0.465]	[0.000]	[0.197]	[0.943]	[0.000]	[0.328]	[0.737]
%Decedents	0.792***	0.864***	0.864*	0.864***	0.662***	0.864***	0.662***	0.365*	0.782***	0.752***	0.377*
	[0.000]	[0.000]	[0.020]	[0.000]	[0.000]	[0.000]	[0.000]	[0.026]	[0.000]	[0.000]	[0.020]
FLFP	-0.004	-0.011***	-0.011**	-0.011***	-0.009***	-0.011***	-0.009***	-0.007**	-0.012***	-0.010***	-0.008**
	[0.232]	[0.000]	[0.008]	[0.000]	[0.000]	[0.000]	[0.000]	[0.004]	[0.000]	[0.000]	[0.001]
LEBdiff	0.008	0.194***	0.194***	0.194***	0.111***	0.194***	0.111***	0.042	0.160***	0.085***	0.027
	[0.783]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.085]	[0.000]	[0.000]	[0.188]
2006					-0.514***		-0.514***	-0.741***		-0.517***	-0.735***
					[0.000]		[0.000]	[0.000]		[0.000]	[0.000]
Observations	289	289	289	289	289	289	289	289	289	289	289
R^2	0.41	0.82	0.82	0.97	0.98	0.97	0.98	0.96			
AIC	196.6	-619.8	-621.8	-593.8	-651.2	.	.	.	.	.	.
BIC	222.3	-594.2	-599.8	-520.5	-500.9	.	.	.	.	.	.

p-values in brackets * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$ Source: HMD14 panel

Appendix A. Table A20 Acute utilisation method comparison, HMD14, 1985-2006, 2 age cohorts as quadratics
Dependent variable: acute bed days per capita

	POLS	FE	FEC	LSDV1	LSDV2	PCSE1	PCSE2	PCSE2_AR	FGLS1	FGLS2	FGLS2_AR
GDPpc	-0.021*	0.005	0.005	0.005	0.020***	0.005	0.020***	0.024***	0.003	0.018***	0.019***
	[0.016]	[0.117]	[0.371]	[0.117]	[0.000]	[0.127]	[0.000]	[0.000]	[0.358]	[0.000]	[0.000]
percent6579	0.430	-0.674***	-0.674***	-0.674***	-0.356***	-0.674***	-0.356***	-0.255*	-0.568***	-0.344***	-0.239*
	[0.151]	[0.000]	[0.001]	[0.000]	[0.000]	[0.000]	[0.000]	[0.013]	[0.000]	[0.000]	[0.016]
percent6579squ	-0.018	0.025***	0.025**	0.025***	0.014***	0.025***	0.014***	0.010*	0.021***	0.013***	0.009*
	[0.173]	[0.000]	[0.003]	[0.000]	[0.001]	[0.000]	[0.000]	[0.026]	[0.000]	[0.000]	[0.040]
percent80	-0.058	0.398***	0.398	0.398***	0.384***	0.398***	0.384***	0.371***	0.313***	0.493***	0.511***
	[0.870]	[0.000]	[0.100]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]
percent80squ	0.017	-0.068***	-0.068	-0.068***	-0.060***	-0.068***	-0.060***	-0.055***	-0.054***	-0.070***	-0.069***
	[0.729]	[0.000]	[0.055]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]
%Decedents	0.743**	0.679***	0.679*	0.679***	0.477*	0.679***	0.477**	0.256	0.637***	0.501***	0.219
	[0.001]	[0.000]	[0.050]	[0.000]	[0.011]	[0.000]	[0.002]	[0.120]	[0.000]	[0.000]	[0.163]
FLFP	-0.006	-0.009***	-0.009*	-0.009***	-0.007***	-0.009***	-0.007***	-0.006*	-0.007***	-0.006***	-0.005*
	[0.132]	[0.000]	[0.036]	[0.000]	[0.000]	[0.000]	[0.000]	[0.013]	[0.000]	[0.000]	[0.019]
LEBdiff	0.003	0.182***	0.182***	0.182***	0.118***	0.182***	0.118***	0.053*	0.182***	0.094***	0.041*
	[0.908]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.026]	[0.000]	[0.000]	[0.040]
2006					-0.425***		-0.425***	-0.647***		-0.470***	-0.651***
					[0.000]		[0.000]	[0.000]		[0.000]	[0.000]
Observations	289	289	289	289	289	289	289	289	289	289	289
R^2	0.42	0.85	0.85	0.97	0.98	0.97	0.98	0.96			
AIC	198.7	-662.1	-664.1	-636.1	-673.8	.	.	.	.	.	.
BIC	231.7	-629.1	-634.8	-555.5	-516.2	.	.	.	.	.	.

p-values in brackets * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$ Source: HMD14 panel

Appendix A. Table A21 Acute utilisation method comparison, HMD14 panel, GDPAVFCP, Dependent variable: acute bed days per capita

	POLS	FE	FEC	LSDV1	LSDV2	PCSE1	PCSE2	PCSE2_AR	FGLS1	FGLS2	FGLS2_AR
GDPAVFCP	0.000	0.000***	0.000	0.000***	0.001***	0.000***	0.001***	0.001***	0.000***	0.001***	0.001***
	[0.080]	[0.001]	[0.255]	[0.001]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]
Percent65	-0.022	-0.153***	-0.153***	-0.153***	-0.051***	-0.153***	-0.051***	-0.048***	-0.140***	-0.062***	-0.060***
	[0.197]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]
%Decedents	1.803***	1.810***	1.810**	1.810***	0.494**	1.810***	0.494***	0.357*	1.659***	0.697***	0.416**
	[0.000]	[0.000]	[0.009]	[0.000]	[0.003]	[0.000]	[0.000]	[0.025]	[0.000]	[0.000]	[0.007]
2006					-0.501***		-0.501***	-0.499***		-0.442***	-0.449***
					[0.000]		[0.000]	[0.000]		[0.000]	[0.000]
Observations	289	289	289	289	289	289	289	289	289	289	289
R^2	0.36	0.69	0.69	0.94	0.97	0.94	0.97	0.96			
AIC	214.3	-465.3	-467.3	-439.3	-615.7	.	.	.	.	.	.
BIC	228.9	-450.6	-456.3	-376.9	-476.4	.	.	.	.	.	.

p-values in brackets * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$ Source: HMD14 panel

Appendix A. Table A22 Acute utilisation method comparison, HMD14 panel, GDPAVFCP *, Dependent variable: acute bed days per capita

	POLS	FE	FEC	LSDV1	LSDV2	PCSE1	PCSE2	PCSE2_AR	FGLS1	FGLS2	FGLS2_AR
GDPAVFCP	0.001**	0.001***	0.001**	0.001***	0.001***	0.001***	0.001***	0.001***	0.001***	0.001***	0.001***
	[0.010]	[0.000]	[0.005]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]
Percent65	-0.023	-0.091***	-0.091***	-0.091***	-0.062***	-0.091***	-0.062***	-0.053***	-0.103***	-0.067***	-0.062***
	[0.178]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]
%Decedents	1.538***	0.968***	0.968*	0.968***	0.742***	0.968***	0.742***	0.439**	0.948***	0.824***	0.484**
	[0.000]	[0.000]	[0.011]	[0.000]	[0.000]	[0.000]	[0.000]	[0.006]	[0.000]	[0.000]	[0.002]
LEBdiff	0.078**	0.190***	0.190***	0.190***	0.123***	0.190***	0.123***	0.055*	0.169***	0.088***	0.031
	[0.004]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.021]	[0.000]	[0.000]	[0.137]
2006					-0.224**		-0.224**	-0.387***		-0.260***	-0.386***
					[0.002]		[0.001]	[0.000]		[0.000]	[0.000]
Observations	289	289	289	289	289	289	289	289	289	289	289
R^2	0.38	0.83	0.83	0.97	0.97	0.97	0.97	0.96			
AIC	207.8	-627.8	-629.8	-601.8	-642.2	.	.	.	.	.	.
BIC	226.1	-609.4	-615.1	-535.8	-499.2	.	.	.	.	.	.

p-values in brackets * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$ Source: HMD14 panel. *This estimation differs from chapter 7 because this is a slightly different panel with 289 observations compared to 280, a reduction caused by generating the productivity variable (GDPpew) in that chapter

Appendix A. Table A23 Acute utilisation method comparison, HMD14 panel, GDPAVFCP, linear interactive model
Dependent variable: acute bed days per capita

	POLS	FE	FEC	LSDV1	LSDV2	PCSE1	PCSE2	PCSE2_AR	FGLS1	FGLS2	FGLS2_AR
GDPAVFCP	0.001***	0.001***	0.001*	0.001***	0.001***	0.001***	0.001***	0.001***	0.001***	0.001***	0.001***
	[0.001]	[0.000]	[0.016]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]
Percent65	0.385***	-0.090**	-0.090	-0.090**	-0.132***	-0.090***	-0.132***	-0.122***	-0.092**	-0.169***	-0.157***
	[0.000]	[0.009]	[0.251]	[0.009]	[0.000]	[0.000]	[0.000]	[0.001]	[0.001]	[0.000]	[0.000]
%Decedents	1.594***	0.968***	0.968*	0.968***	0.654***	0.968***	0.654***	0.394*	0.959***	0.695***	0.431**
	[0.000]	[0.000]	[0.012]	[0.000]	[0.000]	[0.000]	[0.000]	[0.014]	[0.000]	[0.000]	[0.005]
LEBdiff	1.029***	0.190**	0.190	0.190**	-0.035	0.190***	-0.035	-0.100	0.190**	-0.143*	-0.177*
	[0.000]	[0.008]	[0.261]	[0.008]	[0.630]	[0.000]	[0.556]	[0.170]	[0.001]	[0.013]	[0.014]
Age*LEBdiff	-0.068***	-0.000	-0.000	-0.000	0.011*	-0.000	0.011**	0.011*	-0.002	0.016***	0.015**
	[0.000]	[0.997]	[0.999]	[0.997]	[0.022]	[0.996]	[0.003]	[0.033]	[0.718]	[0.000]	[0.003]
2006					-0.245***		-0.245***	-0.398***		-0.296***	-0.395***
					[0.001]		[0.000]	[0.000]		[0.000]	[0.000]
Observations	289	289	289	289	289	289	289	289	289	289	289
R^2	0.42	0.83	0.83	0.97	0.97	0.97	0.97	0.96			
AIC	188.0	-625.8	-627.8	-599.8	-646.3	.	.	.	.	.	.
BIC	210.0	-603.8	-609.4	-530.1	-499.7	.	.	.	.	.	.

p-values in brackets * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$ Source: HMD14 panel

Appendix A. Table A24 Acute utilisation method comparison, HMD14, GDPAVFCP, age as quadratic
Dependent variable: acute bed days per capita

	POLS	FE	FEC	LSDV1	LSDV2	PCSE1	PCSE2	PCSE2_AR	FGLS1	FGLS2	FGLS2_AR
GDPAVFCP	0.001**	0.001***	0.001**	0.001***	0.001***	0.001***	0.001***	0.001***	0.001***	0.001***	0.001***
	[0.007]	[0.000]	[0.002]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]
Percent65	-0.229	-0.237***	-0.237	-0.237***	-0.046	-0.237***	-0.046	-0.005	-0.319***	-0.009	0.052
	[0.177]	[0.000]	[0.155]	[0.000]	[0.456]	[0.000]	[0.379]	[0.940]	[0.000]	[0.877]	[0.467]
Percent65_squared	0.007	0.005*	0.005	0.005*	-0.001	0.005**	-0.001	-0.002	0.007***	-0.002	-0.004
	[0.222]	[0.010]	[0.347]	[0.010]	[0.785]	[0.008]	[0.749]	[0.477]	[0.000]	[0.306]	[0.111]
%Decedents	1.586***	1.068***	1.068**	1.068***	0.726***	1.068***	0.726***	0.405*	1.047***	0.778***	0.418**
	[0.000]	[0.000]	[0.003]	[0.000]	[0.000]	[0.000]	[0.000]	[0.019]	[0.000]	[0.000]	[0.009]
LEBdiff	0.083**	0.179***	0.179***	0.179***	0.124***	0.179***	0.124***	0.056*	0.157***	0.089***	0.032
	[0.002]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.019]	[0.000]	[0.000]	[0.132]
2006					-0.228**		-0.228**	-0.399***		-0.277***	-0.416***
					[0.002]		[0.002]	[0.000]		[0.000]	[0.000]
Observations	289	289	289	289	289	289	289	289	289	289	289
R^2	0.38	0.83	0.83	0.97	0.97	0.97	0.97	0.96			
AIC	208.3	-632.8	-634.8	-606.8	-640.3	.	.	.	.	.	.
BIC	230.3	-610.8	-616.5	-537.2	-493.6	.	.	.	.	.	.

p-values in brackets * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$ Source: HMD14 panel

Appendix A. Table A25 Acute utilisation method comparison, HMD14, GDPAVFCP, two age cohorts
Dependent variable: acute bed days per capita

	POLS	FE	FEC	LSDV1	LSDV2	PCSE1	PCSE2	PCSE2_AR	FGLS1	FGLS2	FGLS2_AR
GDPAVFCP	0.001**	0.001***	0.001**	0.001***	0.001***	0.001***	0.001***	0.001***	0.001***	0.001***	0.001***
	[0.001]	[0.000]	[0.003]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]
Percent6579	0.032	-0.089***	-0.089***	-0.089***	-0.061***	-0.089***	-0.061***	-0.052***	-0.103***	-0.066***	-0.061***
	[0.243]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]
Percent80	-0.143**	-0.102***	-0.102*	-0.102***	-0.029	-0.102***	-0.029	-0.016	-0.095***	-0.028	-0.007
	[0.004]	[0.000]	[0.044]	[0.000]	[0.468]	[0.000]	[0.193]	[0.652]	[0.000]	[0.365]	[0.861]
%Decedents	1.410***	0.967***	0.967*	0.967***	0.676***	0.967***	0.676***	0.384*	0.951***	0.773***	0.413*
	[0.000]	[0.000]	[0.011]	[0.000]	[0.000]	[0.000]	[0.000]	[0.019]	[0.000]	[0.000]	[0.013]
LEBdiff	0.073**	0.185***	0.185***	0.185***	0.125***	0.185***	0.125***	0.056*	0.172***	0.091***	0.034
	[0.006]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.021]	[0.000]	[0.000]	[0.109]
2006					-0.275**		-0.275***	-0.442***		-0.312***	-0.460***
					[0.003]		[0.000]	[0.000]		[0.000]	[0.000]
Observations	289	289	289	289	289	289	289	289	289	289	289
R^2	0.39	0.83	0.83	0.97	0.97	0.97	0.97	0.96			
AIC	203.0	-626.0	-628.0	-600.0	-641.1	.	.	.	.	.	.
BIC	225.0	-604.0	-609.7	-530.4	-494.4	.	.	.	.	.	.

p-values in brackets * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$ Source: HMD14 panel

Appendix A. Table A26 Acute utilisation method comparison, HMD14, GDPAVFCP, two age cohorts as quadratics
Dependent variable: acute bed days per capita

	POLS	FE	FEC	LSDV1	LSDV2	PCSE1	PCSE2	PCSE2_AR	FGLS1	FGLS2	FGLS2_AR
GDPAVFCP	0.001***	0.0004***	0.0004	0.0004***	0.0005***	0.0004***	0.0005***	0.001***	0.0004***	0.0004***	0.0004***
	[0.000]	[0.000]	[0.151]	[0.000]	[0.000]	[0.000]	[0.000]	[0.001]	[0.001]	[0.000]	[0.001]
Percent6579	0.780**	-0.602***	-0.602***	-0.602***	-0.425***	-0.602***	-0.425***	-0.364***	-0.565***	-0.401***	-0.319***
	[0.007]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.001]
Percent6579squ	-0.033**	0.022***	0.022**	0.022***	0.016***	0.022***	0.016***	0.013**	0.021***	0.015***	0.011**
	[0.009]	[0.000]	[0.001]	[0.000]	[0.000]	[0.000]	[0.000]	[0.002]	[0.000]	[0.000]	[0.006]
Percent80	-1.118**	0.250*	0.250	0.250*	0.418***	0.250**	0.418***	0.424***	0.193*	0.517***	0.549***
	[0.001]	[0.011]	[0.259]	[0.011]	[0.000]	[0.002]	[0.000]	[0.000]	[0.018]	[0.000]	[0.000]
Percent80squ	0.136**	-0.049***	-0.049	-0.049***	-0.062***	-0.049***	-0.062***	-0.063***	-0.037**	-0.072***	-0.076***
	[0.007]	[0.001]	[0.125]	[0.001]	[0.000]	[0.000]	[0.000]	[0.000]	[0.002]	[0.000]	[0.000]
%Decedents	1.403***	0.927***	0.927**	0.927***	0.458*	0.927***	0.458**	0.256	0.842***	0.488***	0.213
	[0.000]	[0.000]	[0.009]	[0.000]	[0.014]	[0.000]	[0.002]	[0.121]	[0.000]	[0.001]	[0.178]
LEBdiff	0.064*	0.188***	0.188***	0.188***	0.123***	0.188***	0.123***	0.062**	0.196***	0.100***	0.046*
	[0.019]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.007]	[0.000]	[0.000]	[0.022]
2006					-0.313***		-0.313***	-0.451***		-0.372***	-0.498***
					[0.000]		[0.000]	[0.000]		[0.000]	[0.000]
Observations	289	289	289	289	289	289	289	289	289	289	289
R^2	0.42	0.84	0.84	0.97	0.98	0.97	0.98	0.96			
AIC	196.3	-655.0	-657.0	-629.0	-670.3	.	.	.	.	.	.
BIC	225.6	-625.7	-631.4	-552.1	-516.3	.	.	.	.	.	.

p-values in brackets * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$ Source: HMD14 panel

Appendix A. Table A27 LTC utilisation method comparison, HMD7, 1997-2006, Dependent variable: LTC recipients as percentage population

	POLS	FE	FEC	LSDV1	LSDV2	PCSE1	PCSE2	PCSE2_AR	FGLS1	FGLS2	FGLS2_AR
Percent65	0.028	0.052	0.052	0.052	0.047	0.052***	0.047***	0.056***	0.063***	0.044*	0.052*
	[0.566]	[0.079]	[0.228]	[0.079]	[0.187]	[0.001]	[0.000]	[0.000]	[0.001]	[0.036]	[0.033]
lnFLFP	5.345***	5.731***	5.731**	5.731***	4.886**	5.731***	4.886***	3.199*	4.627***	3.219***	2.486***
	[0.000]	[0.000]	[0.008]	[0.000]	[0.001]	[0.000]	[0.001]	[0.021]	[0.000]	[0.000]	[0.001]
2006					0.046		0.046	0.122		0.173**	0.199**
					[0.689]		[0.550]	[0.115]		[0.005]	[0.001]
Observations	60	60	60	60	60	60	60	60	60	60	60
R^2	0.78	0.67	0.67	0.99	0.99	0.99	0.99	0.99			
AIC	92.2	-109.6	-111.6	-97.6	-82.7	.	.	.	.	.	.
BIC	98.5	-103.4	-107.5	-78.8	-45.0	.	.	.	.	.	.

p-values in brackets * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$ Source: HMD7 panel

Appendix A. Table A28 LTC utilisation method comparison, HMD7, 1997-2006, Dependent variable: LTC recipients as percentage population

	POLS	FE	FEC	LSDV1	LSDV2	PCSE1	PCSE2	PCSE2_AR	FGLS1	FGLS2	FGLS2_AR
Percent65	-0.340***	0.062	0.062	0.062	0.066	0.062***	0.066***	0.066***	0.069***	0.060**	0.060**
	[0.000]	[0.058]	[0.170]	[0.058]	[0.062]	[0.001]	[0.000]	[0.000]	[0.001]	[0.004]	[0.005]
LEBdiff	-0.519***	0.051	0.051	0.051	0.224*	0.051	0.224**	0.212**	0.027	0.162***	0.151***
	[0.000]	[0.448]	[0.452]	[0.448]	[0.027]	[0.452]	[0.002]	[0.003]	[0.535]	[0.000]	[0.001]
lnFLFP	2.152***	6.016***	6.016**	6.016***	4.083**	6.016***	4.083**	3.879**	4.764***	2.738***	2.678***
	[0.001]	[0.000]	[0.003]	[0.000]	[0.005]	[0.000]	[0.001]	[0.002]	[0.000]	[0.000]	[0.001]
2006					0.223		0.223**	0.227**		0.256***	0.254***
					[0.102]		[0.003]	[0.002]		[0.000]	[0.000]
Observations	60	60	60	60	60	60	60	60	60	60	60
R^2	0.87	0.67	0.67	0.99	0.99	0.99	0.99	0.99			
AIC	61.9	-108.3	-110.3	-96.3	-88.0	.	.	.	.	.	.
BIC	70.2	-100.0	-104.1	-75.4	-48.2	.	.	.	.	.	.

p-values in brackets * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$ Source: HMD7 panel

Appendix A. Table A29 LTC utilisation method comparison, HMD7, 1997-2006, Dependent variable: LTC recipients as percentage population

	POLS	FE	FEC	LSDV1	LSDV2	PCSE1	PCSE2	PCSE2_AR	FGLS1	FGLS2	FGLS2_AR
Percent65	-0.564	-0.376***	-0.376*	-0.376***	-0.331**	-0.376***	-0.331**	-0.302**	-0.332***	-0.283**	-0.268**
	[0.053]	[0.001]	[0.011]	[0.001]	[0.009]	[0.000]	[0.003]	[0.009]	[0.000]	[0.001]	[0.003]
LEBdiff	-1.155	-1.266***	-1.266**	-1.266***	-1.069**	-1.266***	-1.069**	-0.995**	-1.125***	-0.980***	-0.944**
	[0.148]	[0.000]	[0.007]	[0.000]	[0.009]	[0.000]	[0.004]	[0.010]	[0.000]	[0.001]	[0.001]
Age*LEBdiff	0.042	0.081***	0.081**	0.081***	0.073**	0.081***	0.073***	0.068**	0.071***	0.063***	0.061***
	[0.421]	[0.000]	[0.006]	[0.000]	[0.001]	[0.000]	[0.000]	[0.001]	[0.000]	[0.000]	[0.000]
lnFLFP	2.300***	4.066***	4.066***	4.066***	3.479**	4.066***	3.479**	2.904*	4.079***	3.103***	2.756**
	[0.001]	[0.000]	[0.000]	[0.000]	[0.008]	[0.000]	[0.003]	[0.015]	[0.000]	[0.000]	[0.002]
2006					0.082		0.082	0.113		0.085	0.095
					[0.521]		[0.401]	[0.237]		[0.267]	[0.209]
Observations	60	60	60	60	60	60	60	60	60	60	60
R^2	0.87	0.77	0.77	0.99	0.99	0.99	0.99	0.99			
AIC	63.1	-126.9	-128.9	-114.9	-101.4	.	.	.	.	.	.
BIC	73.6	-116.4	-120.5	-91.8	-59.6	.	.	.	.	.	.

p-values in brackets * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$ Source: HMD7 panel

Appendix B

Review of approaches to modelling long-term care need, demand and expenditure

B.1 Introduction

The alternative approaches to modelling LTC need, demand and expenditure have been characterised as micro-simulation or macro-simulation models (Wittenberg et al. 1998). Micro-simulation models are based on representative samples, which are employed to simulate changes in individuals' disability status and long-term care utilisation and expenditure. Such models require regular surveys of the same large sample of individuals and have been employed in the US (Wiener et al. 1994) and in the UK (Forder and Fernández 2009). Macro-simulation models group the population into sub-groups or cells. In a cell-based model the units of analysis are aggregates of individuals grouped by characteristics such as age and gender. Cell-based, macro-simulation models have been employed in the UK (Nuttall et al. 1994; Richards et al. 1996; Wittenberg et al. 1998; 2006; Malley et al. 2006; Wanless 2006); Ireland (Department of Social and Family Affairs 2002; Department of Health and Children 2008); and in other EU countries (Comas-Herrera and Wittenberg 2003). These models vary in their complexity largely reflecting data availability. This appendix reviews the methodologies of a number of models (B.2 - B.6); the data requirements to develop such models for Ireland and the data limitations which restrict their application in this thesis (B.7); and elaborates on the methodology employed to project long-term care demand in Chapter 10 (B.8).

B.2 Methodology of Personal Social Services Research Unit (PSSRU) model

The model developed by the Personal Social Services Research Unit (PSSRU) to project demand for and expenditure on long-term care for older people in England has evolved through a number of iterations (Wittenberg et al. 1998; 2006; 2008; Malley et al. 2006). The PSSRU undertakes social and health care research supported mainly by the Department of Health in England and has branches at the Universities of Kent and Manchester and the London School of Economics. The PSSRU model is a cell-based

macro-simulation which takes the form of an Excel spreadsheet and has five main parts. The first part estimates numbers of older people with different levels of disability by age, gender, household type/informal care and housing tenure; and creates up to 1,000 population sub-groups or cells. The second part attaches a probability of receiving health and social care services and disability benefits to each cell. The third part estimates total health and social services expenditure, which in the fourth part is allocated to the various sources of funding. A fifth part projects the numbers of social care staff required to deliver the projected services (Wittenberg et al. 2006). The base case assumes unchanged age-specific dependency and unchanged relationships between receipt of care and age, dependency and household type. Alternative scenarios are modeled according to alternative sensitivity assumptions.

A key aspect of the PSSRU methodology is that the probability of receipt of domiciliary services is estimated by multi-variate analysis of the determinants of utilisation using data from the General Household Survey, a nationally representative population survey of individuals. The model analyses predictors of present use of formal domiciliary care to model future use. The estimated percentages receiving formal domiciliary services are fitted values from multi-variate logistic regression analysis. These fitted values are multiplied by the projected numbers of older people within each cell to produce numbers of services recipients. Estimated numbers of service recipients are multiplied by estimates of the average intensity of service receipt. Institutional residence is treated as another dependency category. Numbers of people in residential care are estimated from national statistics. Their proportionate breakdown by age, gender, previous household type and housing tenure is derived from PRSSU surveys of residential care and applied to the totals. From these estimates, the proportion of older disabled people in residential long-term care is estimated for the base year for subgroups of population and these proportions are used to make projections for future years (Wittenberg et al. 2006).

B.3 PSSRU model as applied to the Wanless Review

The Wanless Social Care Review was commissioned by the King's Fund to determine how much should be spent on social care for older people in England over the 20 years to 2026 and to consider appropriate funding arrangements (Wanless 2006). This Review based its projections on a combination of models employing micro-simulation and macro-

simulation methods. An adaptation of the PSSRU macro-simulation model projected likely future costs of care under a range of scenarios (Malley et al. 2006). A micro-simulation model projected the relationship between population ageing and onset of disability and need (Jagger et al. 2006). The Review team also developed a static micro-simulation model of future funding options (Wanless 2006).

The approach to projecting service receipt in the Wanless Review differed from the standard PRSSU model, in adopting a normative basis for service use, related to desired outcomes. The Wanless Review Group modeled the relationship between need and demand for services and identified a cost-effective package of care by sub-group. This exercise was supported by research on quantitative, preference-based outcome measurement by Professor Ann Netten and colleagues at the PSSRU, University of Kent, who provided data to estimate how far services could improve outcomes for older people. Such outcome measures derived from the Older People's Utility Scale (OPUS) project which develops and values social outcomes found to be important to older people (Netten et al. 2002; 2005; 2006); the Relative Needs Formula project that measures the impact of services on these outcomes (Darton et al. 2006); and the home care user experience extension project. In the Wanless Review, the PSSRU cell-based macro-simulation model was linked to the University of Essex CARESIM model (Malley et al. 2006). CARESIM used British Family Resources Survey data to simulate what people would have to pay for care and supplied to the PSSRU model projections of the proportion of dependent older people eligible for local authority support and the proportion of gross costs met by users.

B.4 Macro-simulation models for Germany, Spain and Italy

Comas-Herrera and Wittenberg (2003) investigated the sensitivity of projections of future long-term care expenditure in Germany, Spain, Italy and the United Kingdom to changes in assumptions about demography, dependency, informal care, formal care and unit costs. This European Commission-funded study adjusted pre-existing LTC forecasting models for the UK, Germany and Spain and developed a model for Italy (with three regional variants) to enable comparable projections and sensitivity analyses.

All of these models are cell-based macro-simulations. Their level of complexity and sophistication varies depending on data availability. In all the models population is

projected by age, gender and dependency level; and demand for LTC services is projected under the headings of informal services, formal home care and residential long-term care. A further step projects expenditure on LTC. The UK model is the PSSRU model described above and is the most complex. Whereas in the UK model, future utilisation is forecast based on multi-variate analysis of the determinants of current utilisation, in the Italian model the proportion of each sub-group of the older population by region, age, gender and dependency, who receive each service, is estimated and this proportion is held constant over time. In the Spanish model, utilisation patterns by dependency are held constant over time. In the German model, estimated age and gender-specific utilisation patterns are held constant over time. The degree of estimation required to establish the base case utilisation patterns in each country is highly variable. Only in the PSSRU model for the UK is there adequate data to employ multi-variate regression analysis to estimate functions for utilisation of domiciliary services.

B.5 Forder and Fernandez PSSRU micro-simulation model

The PSSRU dynamic micro-simulation (DMS) model takes an actual (sampled) population and simulates how people would respond to different social care systems (Forder and Fernández 2009). This DMS model developed from the static micro-simulation model developed by Wanless (2006). The Forder and Fernandez (2009) report was commissioned by the Department of Health to inform a Green Paper examining long-term care funding reform. The DMS model is designed primarily to consider the effects of changing the financial system. Whereas the Wanless model used data from the first wave of the English Longitudinal Study of Ageing (ELSA), due to limitations in the ELSA sample size the Forder and Fernandez model uses the British Household Panel Survey (BHPS). The BHPS is an annual survey consisting of a nationally representative sample of households recruited in 1991. This longitudinal survey provides details of wealth, levels of need, disability rates, health status, marital status, informal care-giving within the home, housing tenure, household composition and socio-economic characteristics. In this model care-giving outside the home is imputed from ELSA.

The DMS model determines people's needs and wealth/income and combines this with individual characteristics data for each person in the BHPS sample. Potential use of care and support is then calculated based on need and other characteristics. The model

simulates the existing budget-constrained, needs-eligibility criteria applied by local councils in allocating financial support. Individuals that are eligible on needs grounds are assigned a potential level of support (the 'normative' level). Taking into account the means-tested funding system and the effect on behaviour of the imposition of charges, the model produces estimates of recipient numbers by type of care and calculates the level of public and private expenditure on care.

B.6 Long-term care models in Ireland

Prior to the analysis in this thesis, published in Layte et al (2009a; 2009b), the most comprehensive forecasts of long-term care demand in Ireland had been published in the Mercer report (Department of Social and Family Affairs 2002). The modelling methodology of Mercer falls within the category of macro-simulation. In the absence of Irish data on the prevalence of disability, Mercer applied UK data on disability prevalence, assuming centrally that healthy life expectancy would increase in line with total life expectancy. Other projections assumed static disability prevalence; reductions in disability rates exceeding the base projection; and increased disability rates. Mercer projected numbers of people aged 65 and over who would need long-term care from 2001-2051 by applying this range of projected levels of disability to population projections. While estimating current numbers in receipt of residential and community-based long-term care, the Mercer methodology made no specific forecasts of future utilisation patterns or numbers receiving alternative forms of care. The Mercer methodology is highly aggregated, with forecasts reported at the single-cell level of all people aged 65 and over. The Report of the Interdepartmental Working Group on Long Term Care, 2006 (Department of Health and Children 2008) updated these projections to take account of population change, without changing Mercer's disability prevalence projections or further developing the Mercer methodology.

B.7 Data requirements for long-term care models

Data availability determines the nature and complexity of the models that can be applied to projecting long-term care demand and expenditure. Micro-simulation models require individual-level longitudinal surveys of the variables of interest. Examples of such surveys

are ELSA, which supplied data for the Wanless (2006) micro-simulation; the BHPS, which supplied data to the Forder and Fernandez (2009) PSSRU micro-simulation model; and the Medical Research Council Cognitive Function and Ageing Study (MRC CFAS), a large-scale multi-centre longitudinal epidemiological study of ageing, which informed the micro-simulation model of population ageing and onset of disability developed by Jagger et al (2006) for the Wanless Review (2006).

No such longitudinal survey for Ireland has been available for the analysis in this thesis. The HESSOP (Health and Social Services for Older People) longitudinal study of community-dwelling older people was designed to identify their health and social needs, service use, and challenges to service delivery and take-up (Garavan et al. 2001; O'Hanlon et al. 2005). Its very small sample size (1,000 people aged 65 and over, with only 314 of the original participants providing full responses to the follow-up longitudinal study) limits its usefulness. Remedying this deficiency in the Irish data has become possible with the publication of the first wave results of The Irish LongituDinal Study on Ageing (TILDA) in 2011 (Barrett et al. 2011). This is the most detailed study on ageing ever undertaken in Ireland with a sample size of over 8,000 people aged 50 and over. While static micro-simulation modelling has become feasible with the publication of the TILDA first wave and dynamic micro-simulation modelling will be feasible with the publication of subsequent waves, such data were not available to the analysis in this thesis.

Cell-based, macro-simulation models can be more readily adapted to available data sources, as the range of models reviewed in this Appendix demonstrates. Depending on their complexity, the data requirements for such models are:

- Population projections by age and gender;
- Disability prevalence or trends by age and gender;
- Household composition;
- Receipt of informal care by household type;
- Housing tenure/socio-economic status/income and assets;
- Utilisation patterns of formal care

Whereas the PSSRU model for the UK has access to data from the General Household Survey which enables multi-variate analysis of the probability of receiving domiciliary

care, the models for other European countries reviewed and adapted in Comas-Herrera and Wittenberg (2003) estimate current utilisation patterns and hold these patterns constant over time in projecting future demand for services.

In contrast to the Mercer model, the model developed in Chapter 10 of this thesis and published in Layte et al (2009a; 2009b) benefits from the publication of the first comprehensive longitudinal data on the prevalence of disability in Ireland in the Census of Population for 2002 and 2006. The model applies disability rate trends from evidence from the Census of Population for 2002 and 2006 to forecast disability rates to 2021 and applies these rates to forecast population aged 65 and over. In a further step, the model employs estimates of current utilisation rates of residential long-term care, to project future demand for residential care, holding current utilisation patterns constant over time. A further forecast models the effect of including estimated unmet need for residential LTC based on delayed discharges from acute hospitals. A final scenario models the requirement if Irish LTC utilisation were equivalent to the utilisation rate in Sweden. Sweden is the comparator because proposed reductions in acute hospital capacity in Ireland by 2020 would re-configure care to resemble most closely the acute care supply in Sweden.

Due to data limitations, the model does not predict formal home care utilisation or informal care utilisation. The data available to this analysis on utilisation of formal home care was limited to numbers of recipients of publicly-provided home help and hours of home help and there were no available sources for private care provision or linking formal domiciliary care or informal carers to the recipients of care, such as the General Household Survey or British Household Panel Survey, which supply data to the PSSRU models. Furthermore, the absence of provision for a unique personal identifier in Irish health and social care datasets is a serious obstacle to researchers in Ireland who wish to analyse patterns or predictors of utilisation by linking existing datasets (Staines et al. 2010). Such linkages between datasets have enabled analysis of predictors of care home utilisation in Northern Ireland (Connolly and O'Reilly 2009). In the analysis in this thesis, it was not possible to link receipt of formal or informal home care to population subgroups, whether defined by age and gender solely, or by age, gender, dependency and other individual/household attributes.

A number of new data sources, published subsequent to the development of this model, will enable its future extension. These new sources are: the report of the first wave of The Irish Longitudinal Study on Ageing (Barrett et al. 2011); a module of the Quarterly National Household Survey with data about carers and for whom they care (Central Statistics Office Ireland 2010a); and the second volume of the National Disability Survey, which published data on utilisation of formal and informal care and unmet need for care by age and disability status (Central Statistics Office Ireland 2010b). In forthcoming versions of the model, these new data sources will allow the estimation of utilisation of informal and formal home care by age, gender and dependency status, as well as more comprehensive estimation of unmet need. The publication of the first wave results from TILDA will enable multi-variate analysis of the predictors of utilisation of care in the community to derive fitted values for predictors of utilisation in the same manner as the PSSRU methodology estimates the probability of receipt of services by multi-variate analysis of the determinants of utilisation using data from the General Household Survey. It will therefore be possible in future versions of the model to divide estimated population by age, gender and disability status into a number of sub-cells; and to assign to these cells current utilisation patterns (Wren, forthcoming).

B.8 Modelling approach in this thesis

The model of long-term care need and demand in Ireland in this thesis is a cell-based macro-simulation. It is an advance on the Mercer model in its application of new longitudinal Irish data on disability prevalence and evolution; and in its forecasts for residential long-term care demand at national and regional level. Although providing disaggregated forecasts of numbers of people with disabilities by single year of age and gender under a range of assumptions about the evolution of disability, in projecting residential long-term care demand, this model forecasts at a highly aggregated, single-cell level for all people aged 65 and over.

The approach to modelling long-term care demand in this thesis is statistical rather than econometric because, for the reasons outlined above, the available data were inadequate to support multi-variate econometric analysis of predictors of utilisation and because a statistical approach to disability rate forecasting is compatible with the methodology underlying the demographic forecasts employed in the model. The analysis advances Irish

modelling of long-term care need and demand by applying the longitudinal disability rate trend evidence from the Census of Population for 2002 and 2006 to forecast disability rates to 2021. The model applies these rates to forecast population aged 65 and over by single year of age and gender to give the forecast population with severe disabilities in any year. The model develops a number of assumptions about how disability rates might evolve, which are employed in alternative forecasts of the population with severe disabilities. The development of alternative assumptions about the evolution of disability and the justification for the preferred forecast assumptions are described in detail in Chapter 10, Section 10.7 with supplementary tables in Appendix C.

Since these disability forecasts are applied to the demographic forecasts of Morgenroth (2009), underpinned by Whelan's work on mortality rates (Whelan 2008), the statistical approach adopted to the evolution of disability rates is designed to be compatible insofar as possible with the Whelan/Morgenroth methodology. Whelan (2008) applies the 'targeting approach' used by the Government Actuary's Department (GAD) in making population projections in the UK. The three components of this approach as applied by Whelan are: to estimate short-term mortality trends by age and sex; to judge the long-term rate of improvement in the mortality rate for a target future year; and to interpolate between the observed short-term trend and the longer term trend assumed for the target year.

Whelan (2008) therefore forecasts mortality rates by estimating the rate of improvement for each gender at each age over the period 2002 to 2005. Centrally, Whelan assumes that there is a cohort effect in this mortality rate improvement, i.e. that this rate of improvement in mortality will not be sustained and will decline over the twenty-five year period to 2031 to a long-term average improvement rate. Whelan found that the current rate of decline of mortality for males averaged 5% per annum across most ages, with little variation. For females, the current rate of decline oscillated with age about an averaged rate of 3.5% per annum. In Whelan's forecast a long term rate of decline of 1.5% per annum was assumed for all ages up to 90 years after calendar year 2031. It was assumed, because of the paucity of data, that there would be no mortality improvements at ages of 100 years upwards. For each year between 2005 and 2031, the mortality declines for that year were calculated by linear interpolation.

The methodology applied in this thesis to forecasting disability rates follows the targeting approach to forecasting mortality rates in Whelan (2008). The preferred forecast follows Whelan in assuming a cohort effect in the improvement in disability. This forecast assumes that the rates of reduction in disability rates converge from the rates of reduction observed for physically limiting conditions over the 2002-2006 period to the Mercer base rate forecast in 2021. These forecasts are generated in an Excel spreadsheet. The first step of the targeting approach, estimating short-term disability trends by age and sex, is implemented by an initial calculation of the annual average disability rate reduction by single year of age and gender over the years 2002-2006, given by the formula:

$$\Delta DR_{02-06} = (DR_{2006}/DR_{2002})^{1/4} - 1$$

Where DR = Census of Population Disability Rate

The second required step of the targeting approach is to judge the long-term rate of improvement in the disability rate for a target future year. In the absence of long-run longitudinal evidence on the evolution of disability rates, the annual average reduction in the final forecast year, 2021, is assumed to be the base rate reduction in Mercer (Department of Social and Family Affairs 2002 : 71). Mercer's base rate combines the assumptions: that disability prevalence would remain unchanged at ages from 85 and over; that the rate of decline in disability rates for women aged 65-84 would be 0.9% p.a., which is not much lower than the 1.04% observed annual average rate of decline over the years 2002-2006; and that the rate of decline for men aged 65 to 84 would be 0.67%, approximately half the observed 1.23% annual average rate of decline over the years 2002-2006 (Chapter 10 Table 10.5).

Although these assumptions derive from an earlier study with differing demographic and disability prevalence data, the justification for applying them in this analysis is that they represent the previous, central forecast in the Irish literature, which represents a more pessimistic view of the probable evolution of disability than the observed 2002-2006 trends. Interestingly, the adoption of the Mercer base rates as long-term rates in the target year, 2021, does not greatly alter the forecasting outcome compared to an assumption of a continuation in the observed trend improvement in physical disability. The net effect of assuming that the rate of improvement in physical disability rates declines over this period

to converge to the Mercer base rate, as opposed to assuming that the rates of improvement in physical disability rates continue at their 2002-2006 trend rate, is to increase the proportion of population aged 65 and over with forecast substantial physical limitation from 17.9% to 18.6% (Chapter 10 Table 10.7).

The third and final step in the targeting approach is to interpolate between the observed short-term trend and the longer term trend assumed for the target year. In this analysis the rates of reduction in disability rates in the years between 2006 and 2021 are calculated by the formula:

$$\Delta DR_t = \Delta DR_{t-1} + (\Delta DR_{2021} - \Delta DR_{02-06})/\Delta T$$

Where ΔDR_{2021} = Mercer base rate reduction
And $\Delta T = 2021 - 2006 = 15$

Finally the disability rate forecast by single year of age, gender and disabling condition is given by the formula:

$$DR_t = (DR_{t-1} \times \Delta DR_t) + DR_{t-1}$$

Where DR_t = Forecast disability rate in year t

In this macro-simulation, when forecasting residential LTC demand, the population aged 65 and over with severe disability is aggregated in a single cell. An initial assumption of a constant residential LTC utilisation rate for the population aged 65 and over with severe disability is applied to forecast demand for residential LTC to 2021. Further forecasts are generated for alternative utilisation scenarios: the effect of including estimated unmet need for residential LTC; and the effect of applying Swedish utilisation rates of residential long-term care by population aged 65 and over and 80 and over to the projected Irish population. The rationale for and approaches to these alternative utilisation scenarios are discussed in Chapter 10.

SECTION 5 APPENDIX C: List of tables relating to Irish disability rate forecasts

Table	Title
C1	Distribution of specified disabling conditions in the older population overall and among older people residing in nursing homes or long-stay hospitals
C2	Forecast severe disability rates by age and gender in 2021 under a range of assumptions about the evolution of disability
C3	Forecast population by year of age and gender with substantial physical limitation in 2021 under a range of assumptions about the evolution of disability
C4	Forecast female and male populations aged 65 and over with substantial physical limitation in 2021 under a range of assumptions about the evolution of disability
C5	Forecast population aged 65 and over with severe disabilities at five year intervals, preferred disability evolution assumption

Appendix C. Table C1 Distribution of specified disabling conditions in the older population overall and among older people residing in nursing homes or long-stay hospitals

	Seeing	Hearing	Speech	Mobility	Remembering	Intellectual	Emotional	Pain	Breathing	Total disabilities
Number with this disability in total population aged 65 and over	26,600	31,400	9,500	91,500	40,500	6,900	26,000	61,400	30,100	323,900
Numbers in LTC with this disability aged 65 and over	4,100	3,700	5,000	16,300	11,800	2,300	7,300	5,900	2,800	59,200
Percentage of all people aged 65 and over with this disability, residing in nursing home/hospital	15.4%	11.8%	52.6%	17.8%	29.1%	33.3%	28.1%	9.6%	9.3%	
Percentage of disabling conditions in LTC comprised by this disability	6.9%	6.3%	8.4%	27.5%	19.9%	3.9%	12.3%	10.0%	4.7%	
Numbers in total population aged 65 and over with specified disability at severe level i.e. lot of difficulty in everyday activities or cannot do at all (1000s)	12,300	13,100	5,300	69,700	22,600	3,600	9,100	30,100	12,800	178,600
Percentage of people aged 65 and over with specified disability at this level of severity residing in nursing home/hospital	15.4%	11.5%	56.6%	20.9%	40.3%	38.9%	38.5%	6.6%	7.0%	

Source: Calculated from National Disability Survey CSO special tabulation from main NDS sample i.e. those who reported a disability in Census 2006. Individuals experience multiple disabilities and appear under multiple categories of disability.

Appendix C. Table C2 Forecast severe disability rates by age and gender in 2021 under a range of assumptions about the evolution of disability

Assumption	1	2	3	4	5	6	7	1	2	3	4	5	6	7
Age	Female %							Male %						
65 years	9.7	3.2	7.9	13.6	5.6	8.3	10.8	9.9	5.0	8.0	13.9	6.9	8.5	11.0
66 years	9.8	3.8	7.3	12.7	6.0	8.1	10.5	9.8	3.5	7.3	12.1	5.8	8.1	10.3
67 years	10.5	3.6	9.9	15.7	6.1	9.7	12.0	10.0	4.9	7.2	11.5	6.8	8.1	10.1
68 years	10.8	3.4	7.7	11.5	6.0	8.8	10.6	10.4	4.3	7.2	11.7	6.5	8.3	10.4
69 years	12.2	4.5	9.1	13.1	7.3	10.1	11.9	11.4	4.0	10.6	15.1	6.7	10.4	12.3
70 years	12.4	4.1	9.2	12.2	7.0	10.2	11.6	11.0	3.1	8.9	12.1	5.8	9.5	10.9
71 years	14.0	4.1	11.8	12.8	7.6	12.2	12.7	12.0	6.9	8.9	14.2	8.8	9.9	12.3
72 years	15.1	4.0	11.8	12.9	7.8	12.7	13.3	13.4	6.2	11.0	13.0	8.9	11.6	12.5
73 years	17.0	6.0	13.6	13.5	10.0	14.5	14.5	14.0	5.1	9.6	11.9	8.3	11.1	12.3
74 years	17.3	6.9	12.8	12.7	10.7	14.2	14.2	14.4	4.4	9.5	11.8	7.9	11.2	12.4
75 years	19.5	4.6	14.7	14.4	9.5	16.2	16.1	16.0	3.9	13.3	13.6	7.9	13.9	14.1
76 years	21.5	6.3	18.3	16.0	11.6	18.9	17.7	17.6	7.5	15.0	16.1	11.2	15.5	16.0
77 years	22.9	5.5	18.8	16.5	11.3	19.8	18.6	19.1	5.6	19.6	15.2	10.3	18.3	16.3
78 years	25.7	9.4	24.6	19.5	15.3	23.9	21.4	20.5	6.1	16.5	16.1	11.1	17.5	17.3
79 years	28.2	11.0	23.2	17.8	17.3	24.4	21.6	22.0	8.7	21.2	16.8	13.5	20.5	18.4
80 years	29.5	10.2	25.5	19.5	17.1	26.2	23.1	23.6	8.4	20.2	16.5	13.9	20.8	18.9
81 years	32.6	12.9	28.9	19.2	20.1	29.2	24.1	24.9	9.1	20.5	16.9	14.8	21.5	19.7
82 years	34.6	15.8	31.0	22.0	22.8	31.1	26.6	26.2	13.0	25.6	18.6	17.9	24.6	21.2
83 years	39.1	12.0	44.0	25.3	21.5	39.2	30.3	29.0	11.5	32.4	19.7	18.0	29.0	23.0
84 years	39.4	17.2	36.1	24.4	25.5	35.8	29.9	30.0	21.4	28.0	20.7	24.3	27.5	23.9
85 years	43.0	15.3	40.6	27.2	26.7	41.9	34.8	33.3	17.1	28.6	18.3	24.5	31.0	25.2
86 years	43.3	18.7	31.7	21.4	29.4	37.5	31.2	33.6	9.7	25.0	20.0	19.0	29.3	26.4
87 years	48.6	23.4	41.6	30.9	34.6	45.2	39.3	37.3	14.1	46.8	26.7	23.8	41.5	31.9
88 years	50.7	20.2	44.5	32.1	33.2	47.7	41.0	40.1	14.1	40.8	25.2	24.8	40.4	32.3
89 years	53.2	24.3	59.3	36.9	37.0	56.0	44.9	40.5	14.1	30.1	22.1	24.9	35.3	30.6
90 years +	59.2	23.7	52.2	38.2	38.8	55.9	48.3	45.8	19.9	39.8	25.7	31.1	42.9	35.0

Table C2 Assumptions:

1) Static disability prevalence i.e. that the age- and gender-specific disability rates remain constant at 2006 levels.

2) The annual average rate of reduction in the disability rate maintains the age- and gender-specific rates of reduction observed for cognitive disabilities in the 2002-2006 period.

3) The annual average rate of reduction in the disability rate maintains the age- and gender-specific rates of reduction observed for physically limiting conditions in the 2002-2006 period.

4) The annual average rate of reduction in the disability rate maintains the age- and gender-specific rates of reduction observed for total disabilities in the 2002-2006 period.

5) The annual age- and gender-specific rates of reduction in the disability rate are estimated by linear interpolation from the annual average rates of reduction observed for cognitive disabilities for 2002-2006 (assumed to apply in 2006) to the Mercer base rate forecast (assumed to apply in 2021).

6) The annual age- and gender-specific rates of reduction in the disability rate are estimated by linear interpolation from the annual average rates of reduction observed for physically limiting conditions for 2002-2006 (assumed to apply in 2006) to the Mercer base rate forecast (assumed to apply in 2021).

7) The annual age- and gender-specific rates of reduction in the disability rate are estimated by linear interpolation from the annual average rates of reduction observed for total disabilities for 2002-2006 (assumed to apply in 2006) to the Mercer base rate forecast (assumed to apply in 2021).

Appendix C Table C3 Forecast population by year of age and gender with substantial physical limitation in 2021 under a range of assumptions about the evolution of disability

Assumption	1	2	3	4	5	6	7	1	2	3	4	5	6	7
Age				Female							Male			
65 years	2,402	804	1,949	3,363	1,373	2,065	2,666	2,443	1,235	1,958	3,432	1,687	2,088	2,716
66 years	2,392	941	1,797	3,111	1,472	1,984	2,564	2,394	853	1,790	2,945	1,408	1,981	2,500
67 years	2,443	842	2,323	3,675	1,415	2,261	2,805	2,324	1,146	1,666	2,662	1,586	1,886	2,347
68 years	2,523	787	1,804	2,684	1,397	2,045	2,461	2,423	988	1,675	2,708	1,516	1,934	2,419
69 years	2,681	995	2,014	2,881	1,606	2,223	2,628	2,492	884	2,311	3,311	1,463	2,280	2,699
70 years	2,664	883	1,977	2,623	1,516	2,197	2,507	2,363	663	1,904	2,599	1,247	2,025	2,342
71 years	3,005	892	2,543	2,751	1,627	2,634	2,733	2,480	1,426	1,835	2,932	1,818	2,043	2,542
72 years	3,117	837	2,435	2,674	1,613	2,633	2,750	2,696	1,250	2,214	2,616	1,790	2,331	2,519
73 years	3,386	1,194	2,699	2,678	1,982	2,887	2,876	2,721	1,002	1,879	2,323	1,625	2,170	2,395
74 years	3,286	1,318	2,426	2,413	2,041	2,704	2,697	2,666	820	1,763	2,196	1,466	2,084	2,308
75 years	3,539	838	2,664	2,607	1,729	2,938	2,909	2,773	676	2,305	2,360	1,373	2,411	2,437
76 years	3,537	1,046	3,015	2,637	1,912	3,111	2,923	2,716	1,160	2,323	2,485	1,736	2,393	2,469
77 years	3,538	852	2,894	2,545	1,742	3,053	2,876	2,747	809	2,808	2,187	1,482	2,630	2,340
78 years	3,730	1,372	3,578	2,837	2,227	3,467	3,111	2,676	791	2,155	2,103	1,446	2,292	2,266
79 years	3,545	1,383	2,917	2,234	2,174	3,068	2,710	2,547	1,006	2,453	1,949	1,571	2,372	2,131
80 years	3,542	1,218	3,064	2,340	2,050	3,137	2,767	2,531	900	2,164	1,771	1,488	2,229	2,031
81 years	3,812	1,508	3,385	2,248	2,352	3,418	2,826	2,502	918	2,066	1,706	1,492	2,169	1,984
82 years	3,756	1,713	3,357	2,390	2,474	3,378	2,885	2,381	1,183	2,328	1,692	1,631	2,233	1,924
83 years	3,863	1,181	4,344	2,496	2,119	3,868	2,988	2,351	935	2,627	1,595	1,454	2,347	1,860
84 years	3,687	1,615	3,377	2,284	2,383	3,354	2,796	2,231	1,591	2,085	1,541	1,806	2,049	1,779
85 years	3,902	1,390	3,682	2,463	2,425	3,798	3,152	2,320	1,189	1,988	1,272	1,703	2,159	1,756
86 years	3,585	1,549	2,630	1,773	2,433	3,104	2,588	2,085	603	1,552	1,244	1,179	1,817	1,641
87 years	3,633	1,750	3,113	2,309	2,592	3,381	2,944	2,066	782	2,595	1,481	1,320	2,299	1,770
88 years	3,358	1,341	2,947	2,128	2,198	3,160	2,717	1,913	675	1,950	1,206	1,183	1,931	1,544
89 years	3,105	1,417	3,463	2,155	2,160	3,267	2,621	1,639	569	1,217	896	1,007	1,427	1,239
90 years +	15,395	6,168	13,576	9,940	10,093	14,519	12,566	6,881	2,992	5,983	3,864	4,683	6,447	5,266

Appendix C. Table C4 Forecast female and male populations aged 65 and over with substantial physical limitation in 2021 under a range of assumptions about the evolution of disability

Gender	FEMALE							MALE						
Assumption	1	2	3	4	5	6	7	1	2	3	4	5	6	7
TOTAL	97,428	35,833	83,975	74,241	59,106	87,654	82,067	67,360	27,046	57,595	57,075	42,157	60,024	59,225
% OVER 65s	23.5	8.6	20.2	17.9	14.3	21.1	19.8	17.9	7.2	15.3	15.1	11.2	15.9	15.7

Appendix C. Table C5 Forecast population aged 65 and over with severe disabilities at five year intervals, preferred disability evolution assumption

	2006				2011				2016				2021			
	FEMALE		MALE		FEMALE		MALE		FEMALE		MALE		FEMALE		MALE	
Age	Rate	Nos.	Rate	Nos.	Rate	Nos.	Rate	Nos.	Rate	Nos.	Rate	Nos.	Rate	Nos.	Rate	Nos.
65	9.7%	1,468	9.9%	1,516	9.1%	1,830	9.3%	1,882	8.7%	1,935	8.8%	1,990	8.3%	2,065	8.5%	2,088
66	9.8%	1,485	9.8%	1,472	9.0%	1,660	9.0%	1,667	8.4%	1,891	8.5%	1,859	8.1%	1,984	8.1%	1,981
67	10.5%	1,528	10.0%	1,421	10.3%	1,799	9.1%	1,591	10.0%	2,161	8.5%	1,824	9.7%	2,261	8.1%	1,886
68	10.8%	1,499	10.4%	1,396	9.8%	1,655	9.4%	1,535	9.2%	1,917	8.7%	1,833	8.8%	2,045	8.3%	1,934
69	12.2%	1,669	11.4%	1,488	11.2%	1,658	11.1%	1,648	10.5%	2,108	10.8%	2,171	10.1%	2,223	10.4%	2,280
70	12.4%	1,662	11.0%	1,378	11.4%	1,643	10.3%	1,470	10.7%	2,053	9.8%	1,871	10.2%	2,197	9.5%	2,025
71	14.0%	1,816	12.0%	1,421	13.3%	1,921	11.0%	1,518	12.7%	2,243	10.3%	1,776	12.2%	2,634	9.9%	2,043
72	15.1%	1,895	13.4%	1,528	14.0%	1,936	12.6%	1,634	13.2%	2,212	12.0%	1,947	12.7%	2,633	11.6%	2,331
73	17.0%	2,045	14.0%	1,503	15.9%	2,071	12.6%	1,510	15.1%	2,402	11.7%	1,740	14.5%	2,887	11.1%	2,170
74	17.3%	2,004	14.4%	1,445	15.9%	2,032	12.8%	1,483	14.9%	2,072	11.8%	1,587	14.2%	2,704	11.2%	2,084
75	19.5%	2,218	16.0%	1,529	18.0%	2,232	15.2%	1,651	16.9%	2,282	14.5%	1,836	16.2%	2,938	13.9%	2,411
76	21.5%	2,369	17.6%	1,538	20.4%	2,429	16.7%	1,698	19.6%	2,620	16.0%	1,949	18.9%	3,111	15.5%	2,393
77	22.9%	2,375	19.1%	1,530	21.6%	2,451	19.1%	1,834	20.6%	2,597	18.8%	2,115	19.8%	3,053	18.3%	2,630
78	25.7%	2,521	20.5%	1,451	25.2%	2,692	19.2%	1,703	24.6%	2,889	18.2%	1,870	23.9%	3,467	17.5%	2,292
79	28.2%	2,757	22.0%	1,480	26.6%	2,690	21.6%	1,747	25.3%	2,886	21.1%	2,047	24.4%	3,068	20.5%	2,372
80	29.5%	2,746	23.6%	1,462	28.2%	2,744	22.5%	1,678	27.1%	2,939	21.5%	1,921	26.2%	3,137	20.8%	2,229
81	32.6%	2,844	24.9%	1,388	31.3%	2,900	23.5%	1,560	30.2%	3,085	22.4%	1,815	29.2%	3,418	21.5%	2,169
82	34.6%	2,757	26.2%	1,265	33.4%	2,828	25.9%	1,517	32.2%	3,074	25.3%	1,888	31.1%	3,378	24.6%	2,233
83	39.1%	2,967	29.0%	1,277	40.1%	3,134	29.7%	1,488	40.1%	3,517	29.7%	1,986	39.2%	3,868	29.0%	2,347
84	39.4%	2,605	30.0%	1,103	38.2%	2,881	29.2%	1,332	37.0%	2,994	28.4%	1,674	35.8%	3,354	27.5%	2,049
85	43.0%	2,625	33.3%	1,102	42.4%	2,946	32.0%	1,305	42.0%	3,228	31.2%	1,687	41.9%	3,798	31.0%	2,159
86	43.3%	2,337	33.6%	926	39.9%	2,496	31.1%	1,106	38.0%	2,683	29.7%	1,393	37.5%	3,104	29.3%	1,817
87	48.6%	2,114	37.3%	782	46.6%	2,542	39.6%	1,168	45.5%	2,829	41.1%	1,641	45.2%	3,381	41.5%	2,299
88	50.7%	1,696	40.1%	634	48.9%	2,421	40.3%	1,019	48.0%	2,636	40.4%	1,313	47.7%	3,160	40.4%	1,931
89	53.2%	1,638	40.5%	518	54.8%	2,223	37.4%	748	55.7%	2,800	35.8%	1,009	56.0%	3,267	35.3%	1,427
90+	59.2%	6,457	45.8%	1,750	57.3%	8,275	44.1%	2,542	56.2%	11,315	43.1%	4,142	55.9%	14,519	42.9%	6,447
65+	23.0%	60,097	16.6%	34,303	22.2%	66,088	16.0%	40,033	21.4%	75,365	15.7%	48,885	21.1%	87,654	15.9%	60,024
Female & Male	20.2%	94,400			19.4%	106,121			18.7%	124,250			18.6%	147,677		

SECTION SIX: REFERENCES

DATABASES

CSO Database Direct. Central Statistics Office Ireland. Available at http://www.cso.ie

Eurostat. Statistical Office of the European Union, Luxembourg. Available at http://epp.eurostat.ec.europa.eu/ (data downloaded November 2009)

Human Mortality Database. University of California, Berkeley (USA), and Max Planck Institute for Demographic Research (Germany). Available at www.mortality.org or www.humanmortality.de (data downloaded January 2010).

OECD 2009. OECD Health Data, Statistics and Indicators for 30 countries, Paris: OECD. Available at www.oecd.org

US Census Bureau. International Data Base. US Census Bureau, Population Division. Available at http://www.census.gov/ipc/www/idb (data downloaded August 2009)

World Development Indicators (WDI). Available at http://databank.worldbank.org (data downloaded 2010)

REFERENCES

Ahmad, S., and M. S. O'Mahony. 2005. "Where older people die: a retrospective population-based study." *Quarterly Journal of Medicine* 98 (12):865-70.

Ahn, N., R. Genova, J. A. Herce, and J. Pereira. 2004. "Bio-demographic aspects of population ageing." *ENEPRI Research Report No. 1*, Brussels. ENEPRI.

Alecxih, L. 2006. Nursing home use by 'oldest old' sharply declines. Paper read at *National Press Club*, 2006, USA.

ANCIEN. 2009. "Assessing needs of care in European nations." European Network of Economic Policy Research Institutes (ENEPRI) www.ancien-longtermcare.eu.

Antonovsky, A. 1979. *Health, stress and coping.* San Francisco; London: Jossey-Bass.

Arellano, M., and S. Bond. 1991. "Some Tests of Specification for Panel Data: Monte Carlo Evidence and an Application to Employment Equations." *The Review of Economic Studies* 58 (2):277-97.

Baltagi, B. H. 2008. *Econometric analysis of panel data.* 4th ed. Chichester: Wiley.

Baltagi, B. H., and D. Li. 2001. "LM Tests for Functional Form and Spatial Error Correlation." *International Regional Science Review* 24 (2):194–225.

Barrett, A., and A. Bergin. 2005. "Assessing Age-related Pressures on the Public Finances 2005 to 2050." In *Budget Perspectives 2006*, ed. T. Callan and A. Doris. Dublin: ESRI.

Barrett, A., G. Savva, V. Timonen, and R. A. Kenny, eds. 2011. *Fifty Plus in Ireland 2011: First results from the Irish Longitudinal Study on Ageing (TILDA).* The Irish Longitudinal Study on Ageing, Trinity College Dublin.

Barros, P. P. 1998. "The black box of health care expenditure growth determinants." *Health Economics* 7 (6):533-44.

Bartolini, S., and L. Bonatti. 2008. "Endogenous growth, decline in social capital and expansion of market activities." *Journal of Economic Behavior and Organization* 67:917–26.

Batljan, I., and M. Lagergren. 2005. "Future demand for formal long-term care in Sweden." *European Journal of Ageing* 2:216-24.

Baum, C. F. 2001. "Residual diagnostics for cross-section time series regression models." *The Stata Journal* 1 (1):101–4.

———. 2006. *Introduction to modern econometrics using Stata.* College Station, Tex: Stata.

Baumol, W. J. 1993. "Health Care, Education and the Cost Disease: A Looming Crisis for Public Choice " *Public Choice* 77 (1):17-28.

Beaudry, P., and F. Collard. 2002. "Why has the employment-productivity trade-off among industrialized countries been so strong?" *NBER Working Paper Series, 8754*. Cambridge, MA. National Bureau of Economic Research.

Beccaro, M., M. Costantini, P. Giorgi Rossi, G. Miccinesi, M. Grimaldi, and P. Bruzzi. 2006. "Actual and preferred place of death of cancer patients. Results from the Italian survey of the dying of cancer (ISDOC)." *Journal of Epidemiology and Community Health* 60 (5):412-6.

Beck, N., and J. N. Katz. 1995. "What to do (and not to do) with Time-Series Cross-Section Data." *The American Political Science Review* 89 (3):634-47.

Beech, R., and J. Larkinson. 1990. "Estimating the financial savings from maintaining the level of acute services with fewer hospital beds." *The International Journal of Health Planning and Management* 5:89-103.

Beneria, L. 1981. "Conceptualizing the labor force: The underestimation of women's economic activities " *Journal of Development Studies* 17 (3):10 - 28.

Bennett, M., D. Fadden, D. Harney, P. O'Malley, C. Regan, and L. Sloyan. 2003. "Population ageing in Ireland and its impact on pension and healthcare costs: Report of Society of Actuaries Working Party on Population Studies." Society of Actuaries in Ireland.

Blundell, R., S. Bond, M. Devereux, and F. Schiantarelli. 1992. "Investment and Tobin's Q: Evidence from company panel data." *Journal of Econometrics* 51 (1-2):233-57.

Boeri, T., D. D. Boca, and C. Pissarides, eds. 2005. *Women at work : an economic perspective.* Oxford University Press.

Bolin, K., B. Lindgren, and P. Lundborg. 2008. "Informal and formal care among single-living elderly in Europe." *Health Economics* 17 (3):393-409.

Bonsang, E. 2009. "Does informal care from children to their elderly parents substitute for formal care in Europe?" *Journal of Health Economics* 28:143-54.

Brambor, T., W. R. Clark, and M. Golder. 2006. "Understanding Interaction Models: Improving Empirical Analyses." *Political Analysis* 14:63-82.

Busse, R., C. Krauth, and F. W. Schwartz. 2002. "Use of acute hospital beds does not increase as the population ages: results from a seven year cohort study in Germany." *Journal of Epidemiology and Community Health* 56 (4):289-93.

Campos, J., N. R. Ericsson, and D. F. Hendry. 2005. *General-to-specific modelling.* 2 vols. Cheltenham: Edward Elgar.

Canadian Institute for Health Information. 2005. "Provincial and Territorial Government Health Expenditure by Age Group, Sex and Major Category: Recent and Future Growth Rates." Ontario. Canadian Institute for Health Information.

Cárdenas-Turanzas, M., T. M. Carrillo, H. Tovalín-Ahumada, and L. Elting. 2007. "Factors associated with place of death of cancer patients in the Mexico City Metropolitan area." *Supportive Care International* 15:243-9.

Carr-Hill, R., G. Hardman, S. Martin, S. Peacock, T. Sheldon, and P. Smith. 1994. "A formula for distributing NHS revenues based on small area use of hospital beds." *CHE Occasional Paper, 22*. Centre for Health Economics, The University of York.

Carter, S. B. 1986. "Comment." In *Long-Term Factors in American Economic Growth*, ed. S. L. Engerman and R. E. Gallman: University of Chicago Press.

Central Statistics Office Ireland. 2002. "Census of Population." Central Statistics Office.

———. 2006. "Census of Population." Central Statistics Office.

———. 2008. "National Disability Survey 2006 - First Results." Dublin: Stationery Office.

———. 2010a. "Quarterly National Household Survey: Carers, Quarter 3 2009."

———. 2010b. "National Disability Survey 2006: Report 2." Stationery Office, Dublin.

Christiansen, T., M. Bech, J. Lauridsen, and P. Nielsen. 2006. "Demographic changes and aggregate health-care expenditure in Europe." *ENEPRI Research Report, 32*. Brussels. ENEPRI.

Clifford, C. A., D. J. Jolley, and G. G. Giles. 1991. "Where people die in Victoria." *The Medical Journal of Australia* 155 (7):446-51, 56.

Cohen, J., J. Bilsen, J. Addington-Hall, R. Lofmark, G. Miccinesi, S. Kaasa, B. Onwuteaka-Philipsen, and L. Deliens. 2008. "Population-based study of dying in hospital in six European countries." *Palliative Medicine* 22 (6):702-10.

Cohen, J., J. Bilsen, P. Hooft, P. Deboosere, G. van der Wal, and L. Deliens. 2006. "Dying at home or in an institution using death certificates to explore the factors associated with place of death." *Health Policy* 78 (2-3):319-29.

Comas-Herrera, A., and R. Wittenberg. 2003. "European Study of Long-Term Care Expenditure. Report to the European Commission, Employment and Social Affairs DG." *PSSRU Discussion Paper 1840*. PSSRU, LSE Health and Social Care, London School of Economics.

Connolly, S., and D. O'Reilly. 2009. "Variation in care home admission across areas of Northern Ireland." *Age and Ageing* 38:461–5.

Convery, J. 2001. "Ireland." In *Social Care and Social Exclusion: A Comparative Study of Older People's Care in Europe*, ed. T. Blackman, S. Brodhurst and J. Convery. Basingstoke and New York: Palgrave.

Costa, D. L. 2000. "Understanding the twentieth-century decline in chronic conditions among older men." *Demography* 37 (1):53-72.

Crespo, L., and P. Mira. 2008. "Caring for parents and employment of European middle-aged women." In *First Results from the Survey of Health, Ageing and Retirement in Europe (2004-2007)*, ed. A. Borsch-Supan: Mannheim Research Institute for the Economics of Aging (MEA).

CSO. "CSO Database Direct." Central Statistics Office Ireland.

Cutler, D. M. 2001. "The reduction in disability among the elderly." *Proceedings of the National Academy of Sciences of the USA* 98 (12):6546-7.

Dáil Debates. 2008. "Leaders' Questions, Dáil Eireann, 21st May 2008." *Dáil Debates Volume 655*, Dublin. Dáil Eireann.

Darton, R., J. Forder, A. Bebbington, A. Netten, A.-M. Towers, and J. Williams. 2006. "Analysis to Support the Development of the Relative Needs Formula for Older People: Final report." *PSSRU Discussion Paper 2265*, PSSRU University of Kent and London School of Economics.

Davidson, R., and J. G. Mackinnon. 2004. *Econometric theory and methods.* New York; Oxford: Oxford University Press.

Davison, D., G. Johnston, P. Reilly, and M. Stevenson. 2001. "Where do patients with cancer die in Belfast?" *Irish Journal of Medical Science* 170 (1):18-23.

De Buitleir, D., and P. McArdle. 2003. Tax and Spend: A Look to the Future with an Eye on the Past. Paper read at *Kenmare Economics Conference*, 2003, Kenmare.

De Hoyos, R. E., and V. Sarafidis. 2006. "Testing for cross-sectional dependence in panel-data models." *The Stata Journal* 6 (4):482–96.

Deaton, A. 1995. "Data and Econometric Tools for Development Analysis." In *Handbook of Development Economics*, ed. J. Behrman and T. N. Srinivasan. Amsterdam: Elsevier Science B.V.

Delaney, L., C. Harmon, C. Kelleher, J. Kennedy, B. Gannon, and E. O'Shea. 2008. "Survey of Health, Ageing and Retirement in Europe (SHARE): Irish first wave results." Dublin and Galway. UCD Geary Institute & Irish Centre for Social Gerontology, NUIG.

Department of Health and Children. 1997-2006. "Longstay Activity Statistics volumes." Dublin: Department of Health and Children.
———. 2006. "A Fair Deal: The Nursing Home Support Scheme 2008 - Frequently Asked Questions." Dublin: Department of Health and Children.
———. 2006b. "A Fair Deal on Long-Term Nursing Home Care - Speech by Mary Harney, T.D., Minister for Health, 12 December 2006." Dublin: Department of Health and Children.
———. 2006c. "Longstay Activity Statistics 2006." Dublin: Department of Health and Children.
———. 2008. "Report of the Interdepartmental Working Group on Long Term Care, 2006." Dublin: Department of Health and Children.
Department of Social and Family Affairs. 2002. "Study to Examine the Future Financing of Long-Term Care in Ireland." Dublin. undertaken by Mercer Ltd on behalf of the Department.
Department of the Taoiseach. 2006. "Towards 2016: Ten-Year Framework Social Partnership Agreement 2006-2015." Dublin: Stationery Office.
Dew-Becker, I., and R. J. Gordon. 2008. "The Role of Labour Market Changes in the Slowdown of European Productivity Growth " *CEPR Discussion Paper 6722*. Centre for Economic Policy Research.
Dougherty, C. 2007. *Introduction to econometrics*. 3rd ed. Oxford ; New York: Oxford University Press.
Drukker, D. M. 2003. "Testing for serial correlation in linear panel-data models." *The Stata Journal* 3 (2):168–77.
Dubos, R. J. 1965. *Man adapting*. Yale U.P.
Esmail, N., and M. Walker. 2002. "How Much Does Canada Spend on Health Care Compared to Other Countries?" In *Fraser Forum, 8*. Vancouver: The Fraser Institute.
EU-SILC. "European Union Statistics on Income and Living Conditions." Eurostat.
European Commission. 2001. "The Budgetary Challenges faced by Ageing Populations." Brussels. European Commission Directorate-General for Economic and Financial Affairs.
Eurostat. Statistical Office of the European Union, Luxembourg.
Fahey, T. 1995. "Health and social care implications of population ageing in Ireland, 1991-2011." In *Planning health and social care services for the elderly: implications of the projected increase in our elderly population (1991-2011)*. Publication No. 43. Dublin: National Council for the Elderly
Felder, S., M. Meier, and H. Schmitt. 2000. "Health care expenditure in the last months of life." *Journal of Health Economics* 19 (5):679-95.
Fischer, S., G. Bosshard, U. Zellweger, and K. Faisst. 2004. "Place of death: Where do people die in Switzerland nowadays?" *Zeitschrift fur Gerontologie und Geriatrie* 37 (6):467-74.
Flory, J., Y. Young-Xu, I. Gurol, N. Levinsky, A. Ash, and E. Emanuel. 2004. "Place Of Death: U.S. Trends Since 1980." *Health Affairs* 23 (3):194-200.
Fogel, R. W., and D. L. Costa. 1997. "A Theory of Technophysio Evolution, with Some Implications for Forecasting Population, Health Care Costs and Pension Costs." *Demography* 34 (1):49-66.
Forder, J. 2009. "Long-term care and hospital utilisation by older people: an analysis of substitution rates." *Health Economics* 18:1322-38.
Forder, J., and J.-L. Fernández. 2009. "Analysing the costs and benefits of social care funding arrangements in England: technical report " *PSSRU Discussion Paper 2644*, Personal Social Services Research Unit.

Frech III, H. E., and R. D. Miller. 1999. *The Productivity of Health Care and Pharmaceuticals: An International Comparison* Washington D.C: The AEI Press.

Fries, J. H. 1980. "Ageing, Natural Death and the Compression of Morbidity." *The New England Journal of Medicine* 303 (3).

Garavan, R., R. Winder, and H. McGee. 2001. "Health and Social Services for Older People (HeSSOP): Consulting Older People on Health and Social Services: A Study of Service Use, Experience and Needs." Dublin. National Council on Ageing and Older People.

Gerdtham, U. 1993. "The Impact of Ageing on Health Care Expenditure in Sweden." *Health Policy* 24:1-8.

Gerdtham, U., and B. Jonsson. 2000. "International comparisons of health expenditure: theory, data and econometric analysis." In *Handbook of Health Economics*, ed. A. J. Culyer and J. P. Newhouse. Amsterdam: Oxford: Elsevier.

Gerdtham, U., J. Sogaard, B. Jonsson, and F. Andersson. 1992b. "A pooled cross-section analysis of the health care expenditures of the OECD countries." In *Health Economics Worldwide*, ed. P. Zweifel and H. E. Frech III. Dordrecht: Kluwer Academic Publishers.

Gerdtham, U. G., J. Sogaard, F. Andersson, and B. Jonsson. 1992a. "An econometric analysis of health care expenditure: a cross-section study of the OECD countries." *Journal of Health Economics* 11 (1):63-84.

Glenngård, A. H., F. Hjalte, M. Svensson, A. Anell, and V. Bankauskaite. 2005. "Health Systems in Transition: Sweden." *Health Systems in Transition*, Copenhagen. WHO Regional Office for Europe on behalf of the European Observatory on Health Systems and Policies.

Goldin, C. 1986. "The Female Labor Force and American Economic Growth,1890-1980." In *Long-Term Factors in American Economic Growth*, ed. S. L. Engerman and R. E. Gallman: University of Chicago Press.

Gomes, B., and I. J. Higginson. 2008. "Where people die (1974-2030): past trends, future projections and implications for care." *Palliative Medicine* 22:33-41.

Greene, W. H. 2008. *Econometric Analysis.* 6th, Pearson International Edition ed. New Jersey: Pearson Prentice Hall.

Gronau, R. 1973. "The intrafamily allocation of time: the value of the housewives' time." *The American Economic Review* 63 (4):634-51.

Gruenberg, E. M. 1977. "The Failures of Success." *Milbank Memorial Fund quarterly* 55:3-24.

Gruneir, A., V. Mor, S. Weitzen, R. Truchil, J. Teno, and J. Roy. 2007. "Where people die: a multilevel approach to understanding influences on site of death in America." *Medical Care Research and Review* 64 (4):351-78.

Gu, D., G. Liu, D. A. Vlosky, and Z. Yi. 2007. "Factors Associated With Place of Death Among the Chinese Oldest Old." *Journal of Applied Gerontology* 26 (1):34-57.

Hansen, P., and A. King. 1996. "The determinants of health care expenditure: a cointegration approach." *Journal of Health Economics* 15 (1):127-37.

Hansen, S. M., S. W. Tolle, and D. P. Martin. 2002. "Factors associated with lower rates of in-hospital death." *Journal of Palliative Medicine* 5 (5):677-85.

Health Service Executive. 2005. "National Service Plan 2006." Health Service Executive.

———. 2007. Home Help Hours and Clients Data for 2006 and 2007, supplied directly for the purpose of this study.

Hitiris, T., and J. Posnett. 1992. "The determinants and effects of health expenditure in developed countries." *Journal of Health Economics* 11 (2):173-81.

HMD. "Human Mortality Database ": University of California, Berkeley, USA and Max Planck Institute for Demographic Research, Germany.

Huber, M., R. Rodrigues, F. Hoffmann, K. Gasior, and B. Marin. 2009. *Facts and Figures on Long-Term Care - Europe and North America.* Vienna: European Centre for Social Welfare Policy and Research.

Hughes, G., J. Williams, and S. Blackwell. 2004. "Demand and Cost of Long-Term Care Services, Country Report: Ireland." Dublin. ESRI.

Hunt, R. W., B. S. Fazekas, C. G. Luke, and D. M. Roder. 2001. "Where patients with cancer die in South Australia, 1990-1999: a population-based review." *The Medical Journal of Australia* 175 (10):526-9.

International Labour Organization. 2011. "Key Indicators of the Labour Market (KILM) database: Table 5 - part-time workers. Table information." ILO.

International Observatory on End of Life Care. 2003. "Country Report Poland." http://www.eolc-observatory.net.

Irish Hospice Foundation. 2010. Estimated place of death statistics for Ireland based on 2004, 2006 and 2007 data from various sources.

Irish Nursing Homes Organisation. 2003-2007. "Annual Private Nursing Home Surveys " Irish Nursing Homes Organisation in association with Horwath Bastow Charleton (Limerick).

Jacobzone, S., E. Cambois, E. Chaplain, and J. M. Robine. 1999. "The health of older persons in OECD countries: Is it improving fast enough to compensate for population ageing?" *OECD Labour Market and Social Policy Occasional Papers No. 37*, Paris. OECD.

Jagger, C., R. Matthews, N. Spiers, C. Brayne, A. Comas-Herrera, T. Robinson, J. Lindesay, and P. Croft. 2006. "Compression or Expansion of Disability? Forecasting future disability levels under changing patterns of diseases." *Wanless Social Care Review Research Report*, Leicester Nuffield Research Unit, University of Leicester.

Jakobsson, E., T. Johnsson, L.-O. Persson, and F. Gaston-Johansson. 2006. "End-of-life in a Swedish population: demographics, social conditions and characteristics of places of death." *Scandinavian Journal of Caring Science* 20:10-7.

Jarvis, C., and A. Tinker. 1999. "Trends in old age morbidity and disability in Britain." *Ageing and Society* 19: 603 - 27.

Jaumotte, F. 2004. "Labour force participation of women: empirical evidence on the role of policy and other determinants in OECD countries." *OECD Economic Studies, 37*. Paris. OECD.

Jerome, J. K. 1889. *Three men in a boat : to say nothing of the dog.* Bristol: J.W. Arrowsmith.

Jimeno, A. A., R. Catalan, M. Garcia Ruiz, E. Benedi, A. Fernandez Pico, and R. Usoz. 1993. "Where does the terminal patient die?" *Aten Primaria* 11 (3):120-2.

Jürges, H. 2008. "Health, Bequests, and Social Support in the Last Year of Life: First Results from the SHARE End-of-Life Interviews." In *First Results from the Survey of Health, Ageing and Retirement in Europe (2004-2007): Starting the Longitudinal Dimension*, ed. A. Börsch-Supan, A. Brugiavini, H. Jürges, A. Kapteyn, J. Mackenbach, J. Siegrist and G. Weber. Mannheim: Mannheim Research Institute for the Economics of Aging (MEA).

Kam, C. D., and R. J. Franzese, Jr. 2007. *Modeling and interpreting interactive hypotheses in regression analysis.* The University of Michigan Press.

Karlsson, M., L. Mayhew, R. Plumb, and B. Rickayzen. 2006. "Future costs for long-term care: cost projections for long-term care for older people in the United Kingdom." *Health Policy* 75 (1):87-213.

Keehan, S., H. Lazenby, M. Zezza, and A.Catlin. 2004. "Age Estimates in the National Health Accounts." *Health Care Financing Review* 1 (1):1-16.

Kinsella, K., and V. A. Velkoff. 2001. "An Aging World: 2001." Series P95/01-1 Washington, DC. U.S. Census Bureau.

Klasen, S., and F. Lamanna. 2009. "The Impact of Gender Inequality in Education and Employment on Economic Growth: New Evidence for a Panel of Countries." *Feminist Economics* 15 (3):91-132.

Klein, T. 1996. "Determinants of institutionalisation in old age." In *Long-term care: Economic issues and policy solutions*, ed. R. Eisen and F. A. Sloan. Washington: Kluwer Academic Publishers.

Klinkenberg, M., G. Visser, M. I. van Groenou, G. van der Wal, D. J. Deeg, and D. L. Willems. 2005. "The last 3 months of life: care, transitions and the place of death of older people." *Health and Social Care in the Community* 13 (5):420-30.

Kmenta, J. 1986. *Elements of Econometrics.* 2nd ed. New York: MacMillan Publishing Company.

Laing and Buisson. 2007. "Care of Elderly People UK Market Survey 2007." London. Laing & Buisson.

Larragy, J. 1995. "A National Economic and Social Council Perspective." In *Planning health and social care services for the elderly: implications of the projected increase in our elderly population (1991-2011).* Publication No 43. Dublin: National Council for the Elderly.

Larsson, K., I. Kareholt, and M. Thorslund. 2008. "Care utilisation in the last years of life in relation to age and time to death: results from a Swedish urban population of the oldest old." *European Journal of Ageing* 5:349-57.

Layte, R. 2007. "An Analysis of the Impact of Age and Proximity of Death on Health Care Costs in Ireland." In *Working Paper No. 193.* Dublin: ESRI.

Layte, R., M. Barry, K. Bennett, A. Brick, E. Morgenroth, C. Normand, J. O'Reilly, S. Thomas, L. Tilson, M. M. Wiley, and M.-A. Wren. 2009b. "Projecting the Impact of Demographic Change on the Demand for and Delivery of Health Care in Ireland." *ESRI Research Series, 13.* Dublin. Economic and Social Research Institute.

Layte, R., E. Morgenroth, and C. Normand. 2009c. "The Complex Task of Projecting the Demand for and Delivery of Health Care." In *Projecting the Impact of Demographic Change on the Demand for and Delivery of Health Care in Ireland, ESRI Research Series No 13*, ed. R. Layte. Dublin: ESRI.

Layte, R., A. Nolan, B. Nolan, and T. v. Ourti. 2005. "Health and Morbidity by Age and Socio-Economic Characteristics." *ENEPRI Research Report, 15.* Brussels. ENEPRI.

Layte, R., M. Wiley, J. O'Reilly, P. Holmes, E. Morgenroth, M. Barry, M.-A. Wren, S. Thomas, C. Normand, S. Smith, and T. Fahey. 2009a. "The Impact of Demographic Change on Demand for and Delivery of Health Services in Ireland 2006-2021, Report 1: Recent Demographic Trends and their Impact on the Delivery of Health Care in Ireland,." Dublin. ESRI/TCD/UCD.

Lind, D. A., W. G. Marchal, and S. A. Wathen. 2005. *Basic statistics for business & economics.* 5th ed. Boston; London: McGraw-Hill Irwin.

Lubitz, J. D., and G. F. Riley. 1993. "Trends in Medicare payments in the last year of life." *The New England Journal of Medicine* 328 (15):1092-6.

Lynch, T., D. Clark, C. Centeno, J. Rocafort, L. A. Flores, A. Greenwood, D. Praill, S. Brasch, A. Giordano, L. De Lima, and M. Wright. 2009. "Barriers to the development of palliative care in the countries of Central and Eastern Europe and the Commonwealth of Independent States." *Journal of pain and symptom management* 37 (3):305-15.

Malley, J., A. Comas-Herrera, R. Hancock, A. Juarez-Garcia, D. King, and L. Pickard. 2006. "Expenditure on social care for older people to 2026: projected financial implications of the Wanless Report." *PSSRU Discussion Paper, 2332*. LSE Health and Social Care, London School of Economics.

Mansell, J., M. Knapp, J. Beadle-Brown, and J. Beecham. 2007a. "Deinstitutionalisation and Community Living - Outcomes and Costs: a Report of a European Study: Volume 1 Executive Summary." Canterbury. Tizard Centre, University of Kent,.

Manton, K. G., and X. Gu. 2001. "Changes in the prevalence of chronic disability in the United States black and nonblack population above age 65 from 1982 to 1999." *Proceedings of the National Academy of Sciences of the USA* 98 (11):6354-9.

Martin, S., and P. Smith. 1996. "Explaining variations in inpatient length of stay in the National Health Service." *Journal of Health Economics* 15 (3):279-304.

McCoskey, S. K., and T. M. Selden. 1998. "Health care expenditures and GDP: panel data unit root test results." *Journal of Health Economics* 17 (3):369-76.

McEnery, B. 2007. "Nursing Home Care: A Fair Price – Ireland." Horwath Bastow Charleton (Limerick), for Age Action Ireland.

McGee, H., A. O'Hanlon, M. Barker, R. Stout, D. O'Neill, R. Conory, A. Hickey, E. Shelley, and R. Layte. 2005. *One island - two systems : a comparison of health status and health and social service use by community-dwelling older people in the Republic of Ireland and Northern Ireland.* Dublin; Belfast: Institute of Public Health in Ireland.

McGrail, K., B. Green, M. L. Barer, R. G. Evans, C. Hertzman, and C. Normand. 2000. "Age, costs of acute and long-term care and proximity to death: evidence for 1987/88 and 1994/95 in British Columbia." *Age and Ageing* 29:249-53.

McKee, M. 2004. "Reducing hospital beds: what are the lessons to be learned?" *Policy Brief, 6*. European Observatory on Health Systems and Policies.

McNamara, B., and L. Rosenwax. 2007. "Factors affecting place of death in Western Australia." *Health and Place* 13 (2):356-67.

Menec, V. H., S. Nowicki, and A. Kalischuk. 2010. "Transfers to acute care hospitals at the end of life: do rural/remote regions differ from urban regions?" *Rural Remote Health* 10 (1):1281.

Miller, R. D., and H. E. Frech III. 2004. *Health Care Matters: Pharmaceuticals, Obesity, and the Quality of Life.* Washington D.C.: AEI Press.

Morgenroth, E. 2009. "The Impact of Demographic Change on Demand for and Delivery of Health Services in Ireland 2006-2021. Report 2: Demographic Projections for the period until 2021." Dublin. Economic and Social Research Institute.

Mortensen, J. 2005. "Ageing, health and retirement in Europe, the AGIR project: final report on scientific achievements." *ENEPRI Research Report No 11*, Brussels. ENEPRI.

Mortensen, J., C. K. Spiess, T. Schneider, J. Costa-Font, and C. Patxot. 2004. "Health Care and Female Employment: A Potential Conflict?" *Occasional Paper, 6*. European Network of Economic Policy Research Institutes (ENEPRI).

Motiwala, S. S., R. Croxford, D. N. Guerriere, and P. C. Coyte. 2006. "Predictors of place of death for seniors in Ontario: a population-based cohort analysis." *Canadian Journal on Aging* 25 (4):363-71.

Mpinga, E. K., S. Pennec, B. Gomes, and J. Cohen. 2006. "First International Symposium on Places of Death: an Agenda for the 21st Century." *Journal of Palliative Care* 22 (4):293-6.

Mystakidou, K., E. Parpa, E. Tsilika, I. Panagiotou, A. Galanos, M. Tsiatas, and P. Theodorakis. 2009. "The incidence of place of death in Greek patients with cancer

in 1995 and 2005." *The American Journal of Hospice and Palliative Care* 26 (5):347-53.
National Economic and Social Council. 2005. "The Developmental Welfare State." Dublin. The National Economic and Social Council.
National Economic and Social Forum. 2005. "Care For Older People." *NESF Report 32*. Dublin. National Economic and Social Forum.
Netten, A., and B. Davies. 1990. "The Social Production of Welfare and Consumption of Social Services." *Journal of Public Policy* 10 (3):331-47.
Netten, A., J. Forder, and J. Shapiro. 2006. "Measuring PSS Outputs for National Accounts: Services for Older People." *Discussion Paper 2267/3*, Personal Social Services Research Unit, University of Kent.
Netten, A., M. Hirst, and C. Glendinning. 2005. "Developing a Measure of PSS Outputs: interim report." *Discussion Paper 2234*, Personal Social Services Research Unit, University of Kent.
Netten, A., M. Ryan, P. Smith, D. Skatun, A. Healey, M. Knapp, and T. Wykes. 2002. "The Development of a Measure of Social Care Outcome for Older People." *Discussion Paper 1690/2*, Personal Social Services Research Unit, University of Kent.
New Zealand Ministry of Health. 2001. "New Zealand Palliative Care Strategy." Wellington.
Newhouse, J. P. 1977. "Medical-care expenditure: a cross-national survey." *The Journal of Human Resources* 12 (1):115-25.
Nuttall, S. R., R. J. L. Blackwood, B. M. H. Bussell, J. P. Cliff, M. J. Cornall, A. Cowley, P. L. Gatenby, and J. M. Webber. 1994. "Financing long-term care in Great Britain." *Journal of the Institute of Actuaries* 121:1-68.
O'Connell, J. M. 1996. "The relationship between health expenditures and the age structure of the population in OECD countries." *Health Economics* 5 (6):573-8.
O'Neill, D. 2006. "A review of the deaths at Leas Cross Nursing Home 2002-2005." Health Service Executive.
O'Hanlon, A., H. McGee, B. M., R. Garavan, A. Hickey, R. Conroy, and D. O'Neill. 2005. "Health and Social Services for Older People II (HeSSOP II): Changing Profiles from 2000 to 2004." *Report No. 91*, Dublin. National Council on Ageing and Older People.
OECD. 2000. "A System of Health Accounts: Version 1.0." Paris. OECD.
———. 2002. "The state of implementation of the OECD manual, A System of Health Accounts (SHA)." Paris. Working Party on Social Policy, Health Policy Statistics, OECD.
———. 2005. "Long-Term Care for Older People." Paris. The OECD Health Project, OECD.
———. 2005a. "Guidelines for estimating long-term care expenditure in the Joint 2006 SHA Data Questionnaire."
———. 2005b. "Draft guidelines for improving long-term care expenditure in OECD Health Data 2006/2007." Paris. Directorate for Employment, Labour and Social Affairs, Group on Health, OECD.
———. 2006. "Projecting OECD health and long-term care expenditures: what are the main drivers? ." *Economics Department Working Papers, 477*. Paris. OECD.
———. 2006b. "OECD Health Data 2006: statistics and indicators for 30 countries." Paris: OECD/Irdes.
———. 2007a. "Trends in severe disability among elderly people: assessing the evidence in 12 OECD countries and the future implications." *Health Working Papers, 26*. Paris. OECD.

———. 2007b. "OECD Health Data 2007, statistics and indicators for 30 countries." Paris: OECD/Irdes.
———. 2007c. "OECD Health Data 2007, additional information." Paris: OECD/Irdes.
———. 2007d. "OECD Health Data 2007: definitions, sources and methods." Paris: OECD/Irdes.
———. 2008. "OECD Health Data 2008, statistics and indicators for 30 countries." Paris: OECD/Irdes.
———. 2009. "OECD Health Data 2009, statistics and Indicators for 30 countries." Paris: OECD/Irdes.
———. 2009b. "OECD Health Data 2009: definitions, sources and methods." Paris: OECD/Irdes.
———. 2010. *Revision of the System of Health Accounts Website*. OECD 2010 [cited July 24th 2010].
Oguz, N. Y., S. H. Miles, N. Buken, and M. Civaner. 2003. "End-of-Life Care in Turkey." *Cambridge Quarterly of Healthcare Ethics* 12:279-84.
Okunade, A. A., M. C. Karakus, and C. Okeke. 2004. "Determinants of health expenditure growth of the OECD countries: jackknife resampling plan estimates." *Health Care Management Science* 7 (3):173-83.
Omran, A. 1971. "The Epidemiologic Transition." *Milbank Memorial Fund quarterly* 29:509-38.
PA Consulting Group. 2007a. "Health Service Executive Acute Hospital Bed Capacity Review: A Preferred Health System in Ireland to 2020. Detailed Report." PA Consulting Group.
Parkin, D., A. McGuire, and B. Yule. 1987. "Aggregate health care expenditures and national income. Is health care a luxury good?" *Journal of Health Economics* 6 (2):109-27.
Pellikaan, F., and E. Westerhout. 2005. "Alternative scenarios for health, life expectancy and social expenditure: the influence of living longer in better health on health care and pension expenditures and government finances in the EU." *ENEPRI Research Report, 8*. Brussels. ENEPRI.
Pesaran, M. H. 2004. "General diagnostic tests for cross section dependence in panels." *Cambridge Working Papers in Economics* 0435.
Phillips, P. C. B., and H. R. Moon. 1999. "Linear regression limit theory for nonstationery panel data." *Econometrica* 67 (5):1057-111.
———. 2000. "Nonstationary panel data analysis: an overview of some recent developments." *Econometric Reviews* 19 (3):263 - 86.
Pickard, L. 2002. "The decline of intensive intergenerational care of older people in Great Britain, 1985–1995." *Population trends*, Office for National Statistics.
———. 2008. "Informal care for older people provided by their adult children: projections of supply and demand to 2041 in England." *PSSRU Discussion Paper 2515*, Personal Social Services Research Unit.
Plumper, T., and V. E. Troeger. 2007. "Efficient Estimation of Time-Invariant and Rarely Changing Variables in Finite Sample Panel Analyses with Unit Fixed Effects." *Political Analysis* 15:124-39.
Plumper, T., V. E. Troeger, and P. Manow. 2005. "Panel data analysis in comparative politics: Linking method to theory." *European Journal of Political Research* 44:327-54.
Portrait, F., M. Lindeboom, and D. Deeg. 2000. "The use of long-term care services by the Dutch elderly." *Health Economics* 9:513-31
Pritchard, R. S., E. S. Fisher, J. M. Teno, S. M. Sharp, D. J. Reding, W. A. Knaus, J. E. Wennberg, and J. Lynn. 1998. "Influence of patient preferences and local health

Wiggins, V. 2009. "FAQ: How does xtgls differ from regression clustered with robust standard errors?" In *STATA Data Analysis and Statistical Software Resources and Support*: StataCorp.

Wilson, D. M., and C. D. Truman. 2001. "Does the availability of hospital beds affect utilization patterns? The case of end-of-life care." *Health Services Management Research* 14 (4):229-39.

———. 2002. "Addressing myths about end-of-life care: research into the use of acute care hospitals over the last five years of life." *Journal of Palliative Care* 18 (1):29-38.

Wilson, D. M., C. D. Truman, R. Thomas, R. Fainsinger, K. Kovacs-Burns, K. Froggatt, and C. Justice. 2009. "The rapidly changing location of death in Canada, 1994-2004." *Social Science and Medicine* 68 (10):1752-8.

Wittenberg, R., A. Comas-Herrera, D. King, J. Malley, L. Pickard, and R. Darton. 2006. "Future demand for long-term care, 2002 to 2041: projections of demand for long-term care for older people in England." *PSSRU Discussion Paper, 2330*, London.

Wittenberg, R., L. Pickard, A. Comas-Herrera, B. Davies, and R. Darton. 1998. "Demand for long-term care: projections of long-term care finance for elderly people." PSSRU:University of Kent.

Wittenberg, R., L. Pickard, J. Malley, D. King, A. Comas-Herrera, and R. Darton. 2008. "Future Demand for Social Care, 2005 to 2041: Projections of Demand for Social Care for Older People in England." *PSSRU Discussion Paper 2514*, PSSRU.

Wooldridge, J. M. 2002. *Econometric Analysis of Cross-Section and Panel Data.* Cambridge, Massachusetts: The MIT Press.

Working Party on Services for the Elderly. 1988. "The Years Ahead: A Policy for the Elderly." Dublin: Stationery Office.

Wren, M.-A. 2003. *Unhealthy state : anatomy of a sick society.* Dublin: New Island.

———. 2004. "Health spending and the black hole." In *Quarterly Economic Commentary, September 2004*. Dublin: Economic and Social Research Institute.

Yang, L., N. Sakamoto, and E. Marui. 2006. "A study of home deaths in Japan from 1951 to 2002." *BMC Palliative Care* 5 (2).

Yoo, B.-K., J. Bhattacharya, K. M. McDonald, and A. M. Garber. 2004. "Impacts of informal caregiver availability on long-term care expenditures in OECD countries " *Health Services Research* 39 (6):1971-92.

Zweifel, P., S. Felder, and A.Werblow. 2004. "Population Ageing and Health Care Expenditure: New Evidence on the ''Red Herring''." *The Geneva Papers on Risk and Insurance* 29 (4):652-66.

Zweifel, P., S. Felder, and M. Meiers. 1999. "Ageing of population and health care expenditure: A red herring?" *Health Economics* 8 (6):485-96.

Zweifel, P., L. Steinmann, and P. Eugster. 2005. "The Sisyphus syndrome in health revisited." *International Journal of Health Care Finance and Economics* 5 (2):127-45.