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Essays on the Measurement and Implications of Trade Liberalisation

by

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Thesis submitted to Trinity College Dublin in fulfilment of the requirements for the degree of Doctor of Philosophy (Ph.D.)

September 2006

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Summary

This thesis is an empirical analysis of the measurement and implications of trade liberalisation. Four core chapters cover the following areas: (i) the modelling of agricultural trade policy instruments; (ii) the determinants of services trade; and the economic consequences of trade liberalisation for (iii) the Irish economy and (iv) developing countries in the context of the Doha Round of world trade negotiations. Chapter 1 introduces the context for the thesis, presents the motivation for the topics addressed and outlines the structure of the remaining chapters.

The primary methodology employed in this thesis is the Global Trade Analysis Project (GTAP) computable general equilibrium (CGE) model. Chapter 2 provides a detailed description of the standard GTAP model and its database. The structure of the model and database are presented, as are the assumptions that underpin the model framework and the construction of the database.

The contribution of this thesis is to improve the techniques and data available for modelling trade liberalisation and to better understand the potential outcomes of trade negotiations. This begins in chapter 3, which examines the implications of domestic support disciplines for agricultural trade liberalisation. Three issues in the modelling of the domestic support reductions are addressed: the measurement of the degree of domestic support overhang; the distinction of the "boxes" in GTAP and the representation of the market price support element of the amber box. The results show that the impact of an agreement to reduce domestic support will be limited and lower than conventionally estimated. Simulations combining domestic support cuts with market access and export competition disciplines show that the effects of import tariff reductions dominate the gains from domestic support cuts once full account is taken of the three issues addressed in this chapter.

In chapter 4 the focus switches to the services sector. The determinants of services trade are assessed using an econometrically estimated gravity model. Testing of a variety of different estimators indicates the Hausman-Taylor model to be the most appropriate estimator. The gravity model fits services trade flows in a similar manner to trade in

goods. Wealth of the importing and exporting countries and a common language are the most important determinants of services trade, distance is generally found to be insignificant. A variable measuring services trade barriers is introduced to enable a quantified set of tariff equivalents of those barriers to be estimated. It is only found to be weakly significant.

Chapter 5 analyses the effects of economy-wide trade liberalisation for Ireland. This incorporates liberalisation of agricultural, industrial and services trade and measures to improve trade facilitation. The scenario implemented is designed to illustrate the broad effects of trade liberalisation. The results indicate that Ireland's welfare will increase as a result of further trade liberalisation, with particularly strong gains from services liberalisation. Industrial liberalisation also generates positive gains to Ireland, while agricultural liberalisation has a slightly negative effect on the overall economy.

The final empirical chapter focuses on the differing outcomes for developing countries of agricultural trade liberalisation. The simulation incorporates further liberalisation in the areas of market access, export competition and domestic support in the context of the Doha Development Agenda trade negotiations. While most developing regions are found to experience strong positive results from this liberalisation, some suffer a decrease in welfare. The magnitude of the welfare benefits for these countries depends on measures to be taken by developing countries themselves. The results highlight the importance of the impact of further liberalisation of the erosion of preferential trading arrangements enjoyed by many developing regions.

Chapter 7 summarises the main findings of this thesis and discusses areas for further research.

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List of Abbreviations

ACP	African, Caribbean and Pacific
AMS	Aggregate Measure of Support
ATC	Agreement on Textiles and Clothing
CAP	Common Agricultural Policy
CDE	Constant Difference of Elasticities
CEEC	Central and Eastern European Country
CES	Constant Elasticity of Substitution
CGE	Computable General Equilibrium
c.i.f.	cost, insurance, freight
CPI	Consumer Price Index
DC	Developing Country
EBA	Everything But Arms
EC	European Commission
EFTA	European Free Trade Area
EU	European Union
FAO	Food and Agricultural Organisation
FDI	Foreign Direct Investment
FEM	Fixed Effects Model
f.o.b.	free on board
FTA	Free Trade Area
GATS	General Agreement on Trade in Services
GATT	General Agreement on Tariffs and Trade
GDP	Gross Domestic Product
GEMPACK	General Equilibrium Modelling Package
GNI	Gross National Income
GNP	Gross National Product
GTAP	Global Trade Analysis Project
HS	Harmonised System
HTM	Hausman-Taylor Model
IC	Industrialised Country
ICTSD	International Centre for Trade and Sustainable Development
IMF	International Monetary Fund
LDC	Least Developed Country
MAcMap	Market Access Map
MFA	Multi-Fibre Arrangement
MFN	Most Favoured Nation
MTR	Mid-Term Review
NTB	Non-tariff Barrier
NAFTA	North American Free Trade Agreement
ODS	Overall Distorting Support
OECD	Organisation for Economic Cooperation and Development
OLS	Ordinary Least Squares
PSE	Producer Support Estimate
PTA	Preferential Trade Agreement
REM	Random Effects Model

RTA	Regional Trade Agreement
SADC	Southern Africa Development Community
SDT	Special and Differential Treatment
TRI	Trade Restrictiveness Index
TRIPS	Trade Related Intellectual Property Rights
TRQ	Tariff Rate Quota
UNCTAD	United Nations Committee on Trade and Development
URAA	Uruguay Round Agreement on Agriculture
WTO	World Trade Organisation

Definition of Key Terms

Agenda 2000	A reform programme undertaken by the EU over the period 2000 to 2006.
Boxes	Domestic support measures are assigned to different categories, referred to as "boxes". The colour of a box indicates the fate of the subsidies allocated to it. Amber Box: measures that distort trade and production fall into the amber box. The monetary value of such support is referred to as the Aggregate Measure of Support. WTO members commit to bind and reduce their amber box support. Certain support measures are exempted from the amber box (and therefore exempt from reductions). Green Box: support that has little or no impact on trade and production and meets specific criteria qualifies for the green box. Blue Box: distorting payments may be placed in a separate blue box category if they are conditional on limiting production.
Doha Round	The current round of WTO trade negotiations begun in 2001.
EBA Agreement	The Everything But Arms Agreement between the EU and fifty of the world's least developed countries provides for the unilateral elimination of tariffs and quotas on imports from these countries into the EU, on all commodities except those related to the arms trade.
July 2004 Framework	An agreement reached in July 2004 providing a framework for negotiations towards an agreement on agriculture in the Doha Round.
Mid-term Review	A review of the EU's Common Agricultural Policy, agreed in June 2003. The key innovation of this review was the decision to decouple many direct support payments from production.
Tariffs	Tariffs are taxes on imports or exports of commodity. For most commodities, the applied tariff (the actual tariff in effect) is lower than the bound tariff (the legally binding ceiling). The difference is referred to as the degree of tariff overhang.
Uruguay Round	The most recently completed round of WTO trade negotiations, begun in 1986 and signed in 1994.

CHAPTER 1

INTRODUCTION

This thesis presents an empirical analysis of issues related to the measurement and implications of trade liberalisation. There are four core chapters covering the following areas: (i) the modelling of agricultural trade policy instruments; (ii) the determinants of services trade; and the economic consequences of trade liberalisation for (iii) the Irish economy and (iv) developing countries.

This chapter begins by introducing the context for the research. Section 1.2 presents the motivation for the four topics addressed and the contribution of the research in each of these areas. The following section presents the Global Trade Analysis Project (GTAP) computable general equilibrium (CGE) model and database employed in this research. Finally, section 1.4 outlines the structure of the thesis and an overview of the results.

1.1 Context

Global trade in goods and services were valued at $8.9 trillion and $2.1 trillion respectively in 2004 (WTO, 2005a). The growth in trade has been remarkably. Global trade in goods was valued at $3.6 trillion ten years previously. Exports of goods and services have grown on average by 9 per cent per annum in the period 2000 to 2004. This growth in trade continually exceeds the growth in production.

The expansion of trade in goods and services has led to an increased role for the international institutions that support and promote it. The most prominent of these is the World Trade Organisation (WTO). Established in 1995, there are currently one hundred and forty-nine member countries in the WTO and a further thirty countries with observer status or negotiating their accession. The primary role of the WTO is to administer and enforce agreements on trade signed by member countries. The most prominent of these are the General Agreement on Tariffs and Trade (GATT) and the General Agreement on Trade in Services (GATS).

A second key role of the WTO is to provide a forum for trade negotiations. There have been eight completed Rounds, as multilateral trade negotiations are known in the WTO, the most recently completed being the Uruguay Round (1986-1994). The current Doha Round was launched in the Qatari capital in November 2001. The topics under negotiation are wide-ranging. A successful outcome would have long-term effects on all countries involved. This Round is also referred to as the Doha Development Agenda. One of the principle ambitions set out in the Doha Declaration is that this Round should consider the needs of developing countries and that its outcome should be beneficial to them.

At the time of writing the Doha Round has stalled, with any resumption in negotiations not likely for at least several months. Preliminary research on the outcomes of the Doha Round, in this thesis and elsewhere, suggests that there will be losers as well as winners from further trade liberalisation (both within and between countries). However, the importance of trade as a driver of growth and development and the role of the world trading system in sustaining the global economy should not be underestimated.

Ireland provides a good example of the role that trade can play in the development of an economy. As one the most open economies in the Organisation for Economic Cooperation and Development (OECD), this facilitated the exceptional performance of the Irish economy over the last fifteen years. As a small, export-oriented economy, Ireland has benefited from the increased opening up of the world economy and the system of world trade regulated by the WTO.

A stable and open international economy has provided increased opportunities for Irish-based exporters to access new markets and has promoted efficiency and consumer gains in the domestic market through the increased availability of imported products. The resulting economic prosperity depends on the smooth functioning of the world trading system and a continued acceptance of the legitimacy of the WTO.

1.2 Motivation

The contribution of this thesis to the international literature is to improve the techniques and data available for modelling trade liberalisation and to better understand the potential outcomes of trade negotiations.

The first topic addressed in chapter 3 of this thesis is the role of domestic support disciplines in agricultural trade liberalisation.[1] The chapter focuses on the extension of the standard GTAP computable general equilibrium model and database to improve the representation of agricultural trade policy instruments and the understanding of the implications of the further liberalisation of agricultural trade. In particular, this research

[1] This research is joint work with Martina Brockmeier and Alan Matthews. A paper based on this chapter was presented at the 8th Annual Conference on Global Economic Analysis in June 2005 and published as an Institute for International Integration Studies Discussion Paper in 2006 (Walsh *et al.*, 2006).

concentrates on the domestic support pillar of agricultural trade, although the interaction between domestic support and the other two pillars (market access and export competition) is also considered.

Through the construction of an extensive domestic support dataset and extending the standard GTAP model, three specific issues are addressed in this chapter. First, the impact of overhang in domestic support is considered. Differences between bound and applied rates of domestic support can be significant and failure to consider this "overhang" may distort simulation results. Second, the accurate distinction of the different categories of domestic support instruments (known as "boxes") is necessary if liberalisation is to be correctly modelling in GTAP. Finally, the market price support component of the amber box is not explicitly represented in the standard GTAP model.

In the next chapter the focus switches to trade in services.[2] Unlike the other topics in the thesis, this research does not employ the GTAP model. The determinants of trade in services are assessed using an econometrically estimated gravity model based on a panel dataset on trade in services assembled by the OECD. A variety of econometric estimators are tested to find the most appropriate. The gravity mode is augmented to better capture the determinants of services trade at a sectoral level through the addition of sector specific variables.

Of particular interest is the role of barriers to services trade. Such barriers tend to be qualitative in nature, making an assessment of their influence on services trade flows

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[2] A paper based on this chapter was presented at the 8th Annual Conference of the European Trade Study Group (ETSG) in September 2006 and published as an Institute for International Integration Studies Discussion Paper in 2006 (Walsh, 2006).

difficult. The introduction to the gravity equation of a new variable measuring services trade barriers enables a quantified set of tariff equivalents of those barriers to be estimated. This variable is based on a trade restrictiveness index assembled by the Australian Productivity Commission.

As opposed to the sectoral focus of the first two topics, the final two topics examine the implications of economy-wide trade liberalisation in the context of the Doha Round negotiations on Ireland and developing countries respectively.[3] The same methodology is employed in both. The GTAP model and database are used to implement a number of scenarios that simulate the impacts of trade liberalisation on the world economy against a baseline experiment in which no further liberalisation occurs.

In the analysis of the economic consequences of economy-wide trade liberalisation for Ireland a stylised liberalisation scenario is implemented.[4] This simulation does not to reflect a set of modalities that have emerged from the current negotiations, rather it is designed to illustrate the broad effects of trade liberalisation.

The approach to the final topic is narrower in two ways. It focuses on the differing outcomes for developing countries and only considers agricultural trade liberalisation.[5] Agriculture is a key sector for many developing countries and will play a large role in determining whether they will benefit from the Doha Development Agenda. The

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[3] These chapters are joint work with Alan Matthews. They are based on a research report commissioned by Forfás that was published in September 2005 (Matthews and Walsh, 2005).

[4] A paper based on this chapter, co-authored with Alan Matthews was presented to the 19th Annual Conference of the Irish Economic Association in May 2005 and published in *The Economic and Social Review* in April 2006 (Matthews and Walsh, 2006a).

[5] A paper based on this chapter, co-authored with Alan Matthews, was presented to the 20th Annual Conference of the Irish Economic Association in May 2006 and published in the Institute for International Integration Studies Discussion Paper series in June 2006 (Matthews and Walsh, 2006b).

simulation incorporates further liberalisation in the areas of market access, export competition and domestic support.

1.3 Methodology

As noted in the previous section, the primary methodology employed in this thesis is the GTAP CGE model and database of the world economy. In many ways GTAP is more than a model. By making the model and the required software available to all, the Center for Global Trade Analysis based in Purdue University, supported by an international consortium, has made CGE analysis open to a much larger audience than was previously possible and provides a forum to bring together researchers working in similar fields.

CGE models are powerful tools enabling quantitative analysis of trade issues (for a thorough overview see Piermartini and Teh, 2005). GTAP in particular, with its wide country coverage and extensive database, is ideally suited for modelling various aspects of the world trading system and it has been widely employed in such research.

A particular strength of CGE models is that they capture inter-industry and inter-regional effects of a policy change as opposed to the limitations of a partial equilibrium analysis. For example, a topic covered in detail in this thesis is the reduction of protection accorded to agricultural producers. A partial equilibrium analysis may reveal a fall in production of agricultural products, but a general equilibrium model can estimate the benefits to other sectors as resources leave agriculture and are re-distributed across the economy (Hertel, 1999).

In modelling the effects of trade policy more generally, CGE models can present accurate pre and post liberalisation "snapshots" of the economy and estimate the gains or losses from the changes. However, these models have limitations and modellers need to be aware of them and to control for them as thoroughly as possible. For example, they depend heavily on the quality of their data, the parameters used in their specification and on the assumptions of the modeller. For these reasons, the ability of CGE models to predict further effects from liberalisation, such as increases in productivity or technology, is restricted (Kehoe, 2002 or Hertel *et al.*, 2004).

1.4 Structure

This thesis comprises seven chapters, including this introduction, with four core chapters examining the four issues outlined in section 1.2.

The GTAP model and database are well suited for the analysis of trade liberalisation conducted in this thesis. However, the results of any CGE simulation depend on the assumptions of the model and the quality of data available. To enable the reader to understand and interpret the outputs of a model, the researcher must make clear what drives the model. For this purpose, the structure of the model and database are presented in chapter 2. The methods used to run GTAP, the assumptions that underpin the standard modelling framework and the sourcing and construction of the database are described in detail.

Chapter 3 is the first empirical chapter of the thesis, which examines the implications of domestic support disciplines for further agricultural trade liberalisation. The results support the view that the impact of an agreement to reduce domestic support will be

limited and lower than conventionally estimated. Simulations combining domestic support cuts with market access and export competition disciplines show that the effects of import tariff reductions dominate the gains from domestic support cuts once full account is taken of the issues addressed in this chapter.

In chapter 4, the determinants of trade in services are assessed using a gravity model approach. Testing of different estimators indicates the Hausman-Taylor model to be the most appropriate estimator. The gravity model fits services trade flows in a similar manner to trade in goods. Wealth of the importing and exporting countries and a common language are the most important determinants of services trade. Distance is generally found to be insignificant. The variable measuring services trade barriers, introduced to enable a quantified set of tariff equivalents of those barriers to be estimated, is only found to be weakly significant.

Chapter 5 analyses the results of economy-wide trade liberalisation for Ireland based on a stylised simulation. Ireland's welfare is found to increase as a result of further trade liberalisation, with particularly strong gains from services liberalisation. Industrial liberalisation also generates positive gains to Ireland, while agricultural liberalisation has a slightly negative effect on the overall economy. The gains from industrial and services liberalisation are more than double the losses to agricultural producers and farmers.

In chapter 6, the analysis focuses on the differing outcomes for developing countries of agricultural trade liberalisation. While most developing regions can expect strong positive results from this liberalisation, some suffer a decrease in welfare. The magnitude of the welfare benefits for these countries depends on the liberalisation measures to be taken by developing countries themselves. The results highlight the importance of the impact of

further liberalisation of the erosion of preferential trading arrangements enjoyed by many developing regions.

In conclusion, chapter 7 summarises the main contributions and findings of this thesis and discusses areas for further research.

CHAPTER 2

THE GTAP MODEL AND DATABASE

2.1 Introduction

The empirical research in this thesis employs a computable general equilibrium (CGE) model known as GTAP, the Global Trade Analysis Project model and its associated database.

As described by Greenaway *et al.* (1993), the theory of CGE modelling is simple: an analytically consistent, mathematical model of an economy is combined with data on the required variables in the economy at a point in time allowing the model to be solved numerically. The theory of general equilibrium, implying demand equals supply across all markets, and the concept of modelling an economy as a system of simultaneous equations, can be traced back to Walras in the 19th century. However, it was not until relatively recently that the computational power to run such models efficiently became widely available.

The Centre for Global Trade Analysis, based in the Department of Agricultural Economics at Purdue University, is the home of GTAP. Begun in 1992 with the objective of lowering the cost of entry to CGE modelling, GTAP has become more than a model and database. The Centre coordinates an international consortium of agencies working to maintain and develop the model and the software required for its operation, whilst

providing a focal point for a worldwide network of researchers working on international economic issues.

This chapter describes GTAP, beginning with an overview of the model and its implementation in section 2.2. Sections 2.3 and 2.4 then focus on the model structure and database respectively.

2.2 An Overview of the Standard GTAP Model and Database

The simulations and analysis in this thesis are carried out using GTAP model. This is a comparative static, multi-regional, general equilibrium model of the world economy. GTAP is a one period model, without capital accumulation. All markets in the model are perfectly competitive and exhibit constant returns to scale. This chapter focuses on the standard model, however it can be extensively modified to suit more particular modelling requirements.

The world economy consists of many economies (referred to in the model as "regions") interlinked by bilateral trade flows. The structure of these regions is the same, each provides an elaborate representation of the economy including the interactions between the agents in the model (private households, government and firms) and linkages between all of world production and trade. The number of sectors is the same in each region and all commodities are produced in every region.

The functioning of the model economy, including the actions of the represented agents and the sectoral and regional linkages, is determined by the behavioural and accounting equations specified in the model files. These equations in turn draw upon the data. The

GTAP model file is designed for use with the database, however the two can be employed separately. The GTAP database in particular, is often used with other models.

The model described in the following sections is the standard GTAP model (version 6.2) and the current version of the GTAP database (version 6.0). Any extensions to the standard model in the following chapters are documented separately. Fully disaggregated there are five factor endowments (land, skilled and unskilled labour, capital and natural resources), eighty-seven regions and fifty-seven sectors (commodities). A complete list of all regions and sectors is shown in tables 2.1 and 2.2. The primary reference for information on the model and its database are Hertel (1997), Dimaranan and McDougall (2005) and the GTAP website.[6]

The GTAP model, like other CGE models, is essentially a system of simultaneous equations and variables. Although the GTAP model is non-linear, the equations in the main model (the GTAP Tab file) are written in linearised form. The Tab file is written in a programming language known as TABLO code, allowing the model code to be read and implemented using a software package, General Equilibrium Modelling Package (GEMPACK), developed by the Centre for Policy Studies (COPS) in Monash University.[7]

Solving the system of equations is complicated by the fact that the GTAP model is expressed as a linearised representation of the underlying non-linear model. The solution used by GEMPACK to overcome this problem and accurately solve the model makes use of the feature that the initial database is in equilibrium. By including in the model

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[6] GTAP website: www.gtap.org.

[7] GEMPACK is capable of solving other, more complex models than GTAP. For more information on GEMPACK, see Harrison and Pearson (1994) and www.monash.edu.au/policy/gempack.htm.

equations that update variables as the model changes, the shocks implemented in the model can be broken into two or more parts. The model is updated after each step and the changes are used to extrapolate the true (non-linear) solution. Two such methods to solve the model are available in GEMPACK, Euler and Gragg. The latter is the default method in GEMPACK and is used in all simulations in this thesis.

The Centre for Global Trade Analysis, in collaboration with COPS and other members of the GTAP consortium, have developed a suite of programmes to view data (*ViewHAR*), create new aggregations (*GTAPAgg*), to view and modify model code (*TABmate*), implement simulations (*RunGTAP* and *WinGEM*), and to view and analyse solutions (*ViewSOL* and *AnalyseGE*).

The *AnalyseGE* programme is particularly useful. A common criticism of CGE models is that they are "black boxes", i.e., they produce results but fail to justify or explain how the results are generated. GEMPACK, and *AnalyseGE* in particular, allows the user to understand and interpret model results. Any output generated by the model can be traced back, via the system of equations that define the model, to the initial database (the sourcing of which is also documented).

2.3 Model Structure[8]

This section focuses on the behaviour of the agents represented in the model (private households, government and firms) and the links between them. In addition to this

[8] The main source for this model description is Hertel (1997), unless other references are indicated. Much of the material also draws upon the 12th Annual GTAP Short Course, 2004, Purdue (see www.gtap.org).

chapter, appendix I of this thesis supplements this description by providing a more technical overview of the modelling of the key elements of these agents' behaviour.

The agents are brought together within each represented region in the model by a regional household, as shown in figure 2.1 and described in section 2.3.1. This diagram demonstrates the relationship of the agents within a region and also the links between of each region in the model with the rest of the world.[9]

When considering the model structure, it is useful to bear in mind the closure of the model. The meaning of closure has several different levels in a CGE context. A mathematically valid closure ensures the system of equations that forms the model is solvable. Variables must be specified as exogenous, their value is fixed unless altered by the user, or endogenous in which case their value is determined by the model. The number of endogenous variables must equal the number of equations in the model, if this is not the case the system of equations will not solve. The equations must be linearly independent.

Equally important as mathematical validity is economic validity. The closure must be logical in economic terms. In this sense, by defining variables as endogenous or exogenous, the closure specifies how the model economy will function at a macro level (as opposed to the behavioural systems discussed below or the accounting relationships that ensure model consistency). The standard GTAP closure is a neo-classical application. There is assumed to be full employment of all factors, all factors are mobile within regions and investment is driven by savings. All tax rates and technology variables are fixed.

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[9] As it is impossible to show a diagram with all 87 GTAP regions and all the linkages between them, for simplicity only one illustrative region is displayed, the Rest of World in this diagram represents the other 86.

An important distinction to be made is between the different sets in the model, that is the grouping of regions, commodities and factors according to type. Figure 2.2 shows this diagrammatically. Of the factor endowments, capital and skilled and unskilled labour are perfectly mobile between sectors. They will earn the same market return across all sectors in equilibrium. The sluggish factor endowments are land and natural resources, they are slow to adapt and will earn different returns across markets even when all are in equilibrium.[10] All factors are region specific, there is no mobility between different regions.

Tradable commodities are those commodities produced and traded in every region in the model, together with capital goods, they form the produced commodity set. Firms produce the tradable commodities, which are then consumed by private households, government or as an input into other firms' production (discussed in sections 2.3.2, 2.3.3 and 2.3.4 respectively). The capital goods sector functions differently to the others, as it is essentially a link between the supply and demand for investment (section 2.3.5).[11]

Once the representation of agents and their behaviour in the model is dealt with, the final section of this model description looks at price linkages and the functioning of prices in the model (section 2.3.6).

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[10] Note that land and natural resources are only used by agricultural sectors and extraction industries respectively in GTAP. Forestry and fishing are included in extraction industries, they don't use land in GTAP. There is only one type of land used for all agriculture activity.

[11] There is only one capital goods sector in each region, therefore the set CGDS_COMM is composed solely of this one commodity.

2.3.1 The Regional Household

All revenues within a region accrue to the regional household as illustrated in figure 2.1. These revenues come from payments by firms on factor endowments owned by private households and from the assorted net taxes in the model.[12] All factors are assumed to be fully employed.

The distribution of this income is shown in more detail in figure 2.3. The regional household distributes it among private households, government and savings. This distribution is by a Cobb-Douglas utility function, which is in effect a composite that consists of utility from private consumption, utility from government purchases and utility from savings. All three are measured on a per capita basis, hence the demand of the regional household can be treated as the demand of a representative agent / household rather than an aggregation of different demand systems.

Although regional income is distributed using a Cobb-Douglas utility function, this does not necessarily imply constant shares to private, public and saving demands as might be expected. This irregularity is due to the fact that, while savings and government expenditures are homothetic in real income, private consumption is not. For example, as regional income increases, there will be a shift towards public and future consumption (if savings are considering as being intended for consumption in future periods), away from private consumption. The reason for this characteristic is to better model private household behaviour as is explained in the next section.

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[12] Taxes are applied to private expenditure, government expenditure, intermediate inputs of firms and imports and exports. Some taxes are negative, i.e., they are subsidies.

There are some disadvantages to this structure, which are discussed in the following sections. However, it does offer some major advantages, including enforcing the condition that the regional household may not spend more than it receives, removing the need for detailed tax account data in the construction of the data, and, in particular it allows for the computation of a measure of regional welfare and its decomposition.

In GTAP, the change in a region's welfare as the result of a shock is measured as the equivalent variation (EV) in income – the amount of money that the consumer would be willing to pay to avoid a price change. It measures the change in consumers' utility expressed in monetary terms (2001 US dollars in the current version of the database). The GTAP model features an add-on module that decomposes these welfare changes in elaborate detail (Hertel and Huff, 2000). The EV is broken down into allocative efficiency effects, terms of trade effects, technology effects and endowment effects, each of which can be further decomposed into its component parts.[13]

2.3.2 Private Household Behaviour

All private household revenue accrues directly from the regional household. This revenue is spent on purchases of tradable commodities. Private consumption is represented using a constant difference of elasticities (CDE) functional form. Whilst this is not a fully flexible form, it is more flexible than others forms such as the CES used elsewhere (see below).

Parameters of the CDE function are initially calibrated to a pre-specified vector of own price and income elasticities of demand (McDougall, 2002). However, these elasticities

[13] Technology and factor endowments are exogenous and their effect on welfare will be zero unless technology or factor supply has been shocked.

vary with expenditure shares and relative prices and so are not constant (except in a Cobb Douglas – a special case of the CDE).

Whereas government expenditure and saving are assumed to be homothetic (i.e., that budget shares spent on commodities are independent of total expenditures), to force this condition on private consumption would be unrealistic. In general, as income rises, households will spend more on luxury items as a proportion of total income. The importance of food in households' consumption baskets will fall and the purchase of services will increase as they become wealthier. The use of the CDE form allows such non-homothetic behaviour to be incorporated in the model.

In older versions of the model, employing the CDE form for private consumption conflicted with the use of the constant share Cobb-Douglas function at the level of the regional household. However, this was altered by redefining the government consumption utility function as a per capita utility function (McDougall, 2002). Whereas before, the regional household distributed income to maximise per capita composite utility according to a Cobb-Douglas utility function, now all three destinations for income are defined on a per capita basis. This allows the regional household demand system to be treated as the demand system of a representative household as described in the previous section (previously it was simply an aggregate of three different demand systems).

To illustrate this feature, consider an example of a doubling of regional household income. Higher income implies private households will increase their spending on luxury commodities due to the CDE. This will increase the marginal unit cost of utility for private consumption. To maximise utility, the regional household will allocate a larger share of its income to public and future consumption (savings). If this allocation were

based on a strict Cobb-Douglas function, as was the case in previous versions, income of all three would simply have been doubled. Modelling the regional household as a representative household allows for a representation of preferences.

The changing of the (normally) constant Cobb-Douglas budget shares is achieved by treating this parameter as a variable. More precisely, it is a function of the change in the marginal cost of utility. If the change of this cost is zero, then the shares of regional income are constant. However, if the marginal cost of utility changes (as in the example given in the paragraph above), the parameters of the distribution function will vary and there will be a deviation from the Cobb-Douglas.

As is indicated in figure 2.3, the purchase of commodities by private households also takes into account their origin. The price of a commodity purchased by private households is a composite of the weighted prices of domestic and foreign produced goods. Substitution between domestic and imported goods is determined by a constant elasticity of Substitution (CES) function. In turn, imports are a mix of imports from other regions also based on a CES function. These two CES parameters are known as Armington elasticities (*ESUBM* and *ESUBD* in figure 2.3).

GTAP follows the approach of Armington (1969) to determine the sourcing of imports in the model. Known as the 'Armington Assumption', national varieties of a homogenous commodity are differentiated by source. By treating them as imperfect substitutes, this introduces separability between homogenous products from different sources. Consumers of commodities (whether it be public or private consumption or for use as intermediate inputs by firms) follow the same approach. First the sourcing of imports is determined. The resulting composite import price is then used to determine the mix of domestic and

foreign goods produced that is optimal (utility maximising in case of private and public consumers or cost minimising in the case of firms – see section 2.3.4). These elasticities are named as *ESUBM* and *ESUBD* in figure 2.3. They are the same for all regions but vary between sectors. As table 2.5 shows, *ESUBM* elasticities are by assumption double the values of *ESUBD*. The elasticity parameters in the database are based on econometric estimates by Hertel *et al.* (2004).

2.3.3 Government Behaviour

As in the case of private consumption, all revenue to the government flows from the regional household, which is then expended on the purchases of tradable commodities. The government does not use factor endowments. Purchases are modelled using a Cobb-Douglas function, implying the share of expenditure on each commodity is constant (i.e., constant budget shares). A 10 per cent increase in government income will lead to a 10 per cent increase in spending on all goods. If prices are constant, there will be no substitution between commodities. As with private consumption, the Armington assumption is employed to differentiate between the commodities from different regions.

Whereas in the case of private consumption the use of the regional household as the source of revenue has the advantages outlined in the above section, in case of the government there are disadvantages. In particular, there is no explicit link between taxes and subsidies (i.e., government revenue) and public expenditure. The effect of changing a specific tax cannot be traced. The government does not face a budget constraint in the traditional sense.

2.3.4 Production Structure

Production in GTAP is based on the nested structure shown in figure 2.4.[14] Firms' output is produced from a combination of primary factors and intermediate inputs purchased from other sectors. The optimal mix is determined by a CES function.[15] While in theory this implies there can be substitution between intermediate inputs and value-added factors in production (at a constant rate), this is not the case in the standard model. The calibration of the model parameters is such that this becomes a Leontief function, although users may specify other parameter values if they prefer. The Leontief functional form is a special case of the CES that enforces a zero elasticity of substitution and so fixes the mix of value added and intermediates. In a Leontief function, quantity shares are fixed, as opposed to a Cobb-Douglas which implies fixed budget shares.

Within the sub-nests in the production tree, the functional form used in GTAP is also a CES function, but at this level substitution is permitted within both nests. Firms substitute between factors of production and among intermediates. Firms are assumed to select their optimal mix of endowments based on relative prices of the different factors and independently of the price of intermediates. The two subnests are said to be separable, the elasticity of substitution between any one factor and intermediates is equal (i.e., it is the same between labour and food as between labour and manufacturing), as is the elasticity between any particular intermediate input and different factors.[16]

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[14] This diagram illustrates a production tree, convenient for representing separable, constant returns to scale technologies. Each level is referred to as 'nest'. The term within each nest is the elasticity of substitution.

[15] In the case of the production structure, this is sometimes referred to as a constant elasticity of transformation function (CET). This is the elasticity named *ESUBT* in figure 2.4.

[16] This elasticity parameter is named *ESUBVA* in figure 2.4. The estimates employed in GTAP for *ESUBVA* are shown in table 2.5.

Within the intermediate input nest, the Armington assumption is again used to differentiate between domestically produced and imported commodities. Initially, firms decide on the sourcing of their imports, based on the Armington elasticity parameter (*ESUBM* in figure 2.4). A composite import price is calculated based on this and combined with another Armington elasticity (*ESUBD*) to determine firms' optimal mix of domestically and foreign produced inputs.[17]

2.3.5 Investment Demand

The third component of final demand and destination for the revenues from the regional household is savings and investment. The regional household distributes revenue to savings because it is a component of its utility function. GTAP has a global bank, which collects all savings from each of the regional households (this is illustrated in figure 2.5). The sum of savings over all regions is equal to global investment. This total is then distributed to the regions. The amount each region receives minus depreciation equals net investment per region. By definition, the sum of savings over regions equals the net investment summed over regions. Global savings must equal global (net) investment, however this is not the case at a regional level. Investment may exceed savings in any particular region so long as the global constraint is satisfied.

Regional investment (i.e., the share of global investment that goes to a region) is determined by an expected rate of return. The rate of return depends on capital stock accumulation. If, at the end of the period capital stock is higher than it was in the beginning, then the rate of return falls as capital accumulation is assumed to depress expected returns.

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[17] Both the *ESUBM and ESUBD* parameters are the same as used in private and government consumption.

This process would seem to be contradiction of GTAP being a static model with no capital accumulation. In GTAP, capital used in production is fixed at the level of the beginning of the period (i.e., in the base data). Investment into a region increases (or decreases) the end of period capital stock, but does this not affect the current productive capacity.[18]

This investment mechanism is incorporated in the model via the capital goods sector, this is the sector that "produces" investment. The sector intermediates between supply of goods to investment and the demand for savings. The value of output of this sector in each region is defined as the value of regional investment. Capital goods only use intermediate inputs in their production structure, they have no need for factor endowments and hence the only impact they have on demand for primary factors is indirectly through their use of intermediates.

2.3.6 Price Linkages

In GTAP there are many different price levels, summarised in simplified form in figure 2.6. The differences between them are accounted for by taxes or subsidies. Agent price (*pa*) combined with taxes give the market price (*pm*).[19] In the case of a negative tax (i.e., a subsidy) the market price is below agent price. If the good is to be exported a tariff may be imposed, generating the price at the border of the exporting country (*pfob*). Added to this is the cost of transporting the commodity to the importing country, giving the price at

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[18] End of period capital stock is defined as the capital stock in the beginning of the period plus gross investment in the region and minus the value of depreciation in the region.

[19] Not shown in figure 2.6 are the combination of taxes and subsidies that are incorporated in the agent price. Agent price is essentially an aggregate of supply price (*ps*), price of factor endowments (*pfe*) and others (*pfd*, *pfm*, *ppd*, *ppm*, *pgd* and *pgm*).

the border of the destination county (*pcif*).[20] Finally, import tariffs may be imposed before it can be sold on the market (*pm* in the importing country). Therefore, for any one commodity there are two market prices in the source and destination regions and two prices on the world market.

Policy interventions (tax and subsidies) are modelled as price wedges. GTAP does not track individual taxes and subsidies. The value of an intervention is calculated by comparing values of transactions at agent and market prices or market and world prices. Any difference between them is due to a policy intervention. Whether this intervention has a positive or negative impact on prices depends on the net effect of the taxes and subsidies. If taxes on a particular commodity are greater than the subsidies, then the market price will be above the agent price for that commodity.

All prices in GTAP are relative rather than absolute prices. The GTAP model is essentially a large system of simultaneous equations, with the endogenous variables representing the unknown variables. Making use of Walras' Law, if all other markets clear then it must be the case that the final one clears too. In GTAP it is not imposed that the equation setting global savings equal to global investment must hold, but all other markets are fixed (i.e., supply must equal demand). If the model is valid, this market must clear to satisfy Walras' Law. Verifying this acts as a computational check on the model.

This approach allows for a powerful check of model validity but also means that, as the model is not solved for all markets, it cannot be solved for all prices. One price must be set exogenously. This price is known as the numeraire and provides a point of reference

[20] In GTAP transportation services are modelled by the use of margin commodities – see section 2.4.2.

against which the changes in all others prices are compared. The numeraire used in the standard GTAP closure is a composite world price index of primary factors.

2.4 The GTAP Database

The construction and calibration of the database is documented in Dimaranan and McDougall (2005).[21] The database is composed of three broad parts: national input-output tables; international trade data and protection data. The base year of the current version is 2001 and all data is represented in 2001 US dollars.

2.4.1 Input-Output Data

Every region in the GTAP database is represented by an input-output (IO) table. Each IO table is an input matrix showing employment of factor endowments and use of intermediates in production for each sector per region (fifty-seven industries each producing a single commodity). IO tables represent only domestically produced commodities and the allocation of the regional factor endowments between sectors, however the intermediate inputs in any sector can be sourced from abroad. Also included is final demand for domestic and imported goods by private households and governments, and for gross capital formation. Finally, tax and subsidy data are added.

In general, the national statistics offices of the relevant countries produce the input-output tables, in a few cases where no tables exist they are created from scratch. In some cases composite regions are created in which several countries are grouped together to

[21] The main source for the database description is Dimaranan and McDougall (2005), unless other references are indicated.

form a singe region in the data. Regional IO tables contributed to GTAP are harmonised to the same regional and sectoral aggregation and base year.

For Ireland, the last full set of input-output tables produced by the Central Statistics Office are for 1998. However, this data has yet to be incorporated in the database. The IO table for Ireland in the current version is based on the 1990 figures.

2.4.2 Bilateral Trade Data

The main sources for data on bilateral flows of commodities between regions are the United Nations COMTRADE (Commodity Trade) database for trade in goods and the International Monetary Fund's Balance of Payments Statistics for services trade respectively. Due to the number of countries involved and the large amount of data required, it is often the case that there are gaps in the bilateral matrix. Methodology developed by the US Department of Agriculture's Economic Research Service (USDA ERS) is used to calculate estimates of missing values. These estimates are made at the 4-digit level (following the Standard International Trade Classification system) and then aggregated up to the relevant sectors used in the GTAP database.

The next step in the database assembly is to reconcile the data as inconsistencies in reporting of data between trading partners are commonplace. For a CGE model is it important that these bilateral flows match up, value of imports reported from country i to country j must equal reported export values from j to i when adjusted for differences in import and export prices. When this isn't the case, the differences must be reconciled. This is resolved in GTAP through the construction of a reliability index for each country based on how well it reports with all its partners.

As noted above, for international trade in services, COMTRADE data is supplemented with IMF Balance of Trade Statistics. Following the General Agreement on Trade in Services (GATS) classification, services can be broken down into four categories: margin, non-margin, travellers and commercial presence.

To illustrate the representation of margin commodities in GTAP, Dimaranan and McDougall (2005) uses the example of a Norwegian cargo ship being used to export cars to Canada from Germany. Trade in margin services is specified by supply (the value of water transport services supplied by Norway) and by usage (the value of transport services used in exporting cars from Germany to Canada). The margin services are considered exports of the country that supplies them and imports of the country that receives the merchandise (the cars in this example). The margin service sectors in GTAP are air, water and other transport.

Travellers' expenditure is considered as consumption abroad, whilst trade in non-margin services is treated as cross-border supply and temporary presence of persons. Non-margin services are traded in all GTAP service sectors except for electricity, gas, water and dwellings. The only sector in which travellers' expenditure is not traded is dwellings. The fourth category, commercial presence, is not modelled.

Foreign direct investment (FDI) is not modelled in the standard GTAP model.[22] All factors including capital are region specific and hence cannot flow between regions. Whilst this presents a limitation for modellers, it does greatly reduce the data requirement.

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[22] There are modified versions of the model that attempt to incorporate FDI (e.g., Dee and Hanslow, 2000).

2.4.3 Protection Data

A wide range of protection measures are covered, with data from a variety of sources (Dimaranan and McDougall, 2005). Table 2.3 provides a summary of the protection measures represented in the standard version of the database and the sources of the data used.

Whereas in previous versions of the database, different resources were used for agricultural and non-agricultural tariff data, both are now derived from the same source. The Market Access Map (MAcMap) database is used to generate applied tariff rates for 2001 for all regions in GTAP.[23] MAcMap assembles data on applied and bound tariffs, preferential tariffs, applied tariff quota data and anti-dumping data at the six digit level of the Harmonised System classification (HS-6). This data is then aggregated to the sectoral and regional level of the GTAP database.

A number of preferential trade agreements (PTAs) are represented in the database. This has been facilitated by the use of MAcMap to generate import tariff data, as many more PTAs and other preferential trading agreements are taken into account compared to the previous data sources.

Export subsidies are calculated based on countries' submissions of export subsidy expenditures to the WTO and export values from the UNCTAD trade database.

For all service sectors both import tariffs and export subsidies are set to zero. Generally restrictions to trade in services are qualitative rather than quantitative. The difficulties in

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[23] MAcMap is developed by the Centre d'Etudes Prospectives et d'Informations Internationales (CEPII) and the International Trade Centre (ITC). See **http://www.macmap.org/**.

accurately estimating tariff equivalents to these barriers are discussed in detail in chapter 4 of the thesis.

A significant proportion of thesis relates to the modelling of agricultural trade liberalisation, in particular disciplines on domestic support. Therefore, the structure and sourcing of domestic support in GTAP are discussed in detail here to facilitate the understanding of later chapters.

The main source of the domestic agricultural support data in the current version of the database is the Producer Subsidy Estimates (PSE) produced by the Organisation for Economic Cooperation and Development (OECD) for 2001. PSE as measured and reported by the OECD has two constituent parts: market price support (the gap between domestic market prices and world prices) and direct domestic supports (OECD, 2001).

The representation of this data in GTAP was substantially improved in the construction of version 5 of the database. In earlier versions of the database, market price support was implicitly modelled via import tariffs and the remaining domestic support was modelled as subsidies on output. The PSE database was used for both market price support and domestic support data. Agricultural support in version 5 and later is structured differently. Market price support is still modelled via border protection rates in the current version, but now with tariff data taken from the MAcMap database. The most significant improvement is the representation of domestic support. As a result of work by researchers at the Danish Institute of Agricultural and Fisheries Economics (FOI) to make GTAP more suitable for modelling scenarios concerning EU agricultural reform, domestic support in the PSE database has been broken down into four categories: output subsidies, intermediate input subsidies, land-based payments and capital-based payments.

Frandsen *et al.* (2001) describe how domestic support levels in the GTAP database are derived from the original PSE data for OECD countries.[24] The first step is to aggregate the PSE data to the GTAP level of commodity aggregation. This is done for the following GTAP commodities: wheat, rice, cereal grains, other crops, oilseeds, sugar, raw milk, cattle and sheep, other livestock[25], vegetables and fruit, and plant-based fibres.

Support payments reported in the PSE data are allocated into five different categories for each commodity (the four noted above and market price support). Table 2.4 shows the mapping of the PSE definitions to the GTAP categories. For cattle and sheep, other livestock and raw milk sectors in GTAP, C1, C2 and F2 are allocated to capital-based payments, this refers to suckler cow premia, ewe premia and special premia for male animals used to produce slaughter animals in the EU. For arable crop sectors, C1, C2 and F2 are hectare and set-aside premiums, these are allocated to land-based payments. Payments to the cattle and sheep sector and the other livestock sector remain in the output subsidy category.

The next step is to calculate the power of domestic support in each country for sector level in GTAP. The power of support is one plus the total domestic support payments divided by the overall value of production (from PSE data). Such payments were worth about 20 per cent of the total value of production in 2001, just under three quarters of which were land-based payments (hectare premia).

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[24] See also database documentation: Dimaranan and McDougall (2005) and Jensen (2003).

[25] 'Other livestock' refers to pigs and poultry, is sometimes called 'other animal products' as includes eggs and some of animal products, but will continue to be referred to other livestock in the thesis.

This data is then translated into value payments in GTAP by multiplying value of output at market prices of the sector in question by the power calculated. The percentage shares of the four categories of domestic support are then used to represent these values as their associated tax wedges in the database.

The above procedure is undertaken for the EU15 as a group, other OECD countries and the non-OECD countries that acceded to the EU in mid-2004. It is necessary to further allocate domestic support between member states (the allocation of domestic support to the EU15 is more detailed than for other OECD countries). The overall EU15 hectare and animal premia based on the PSE data are distributed among member states based on 2001 and 2002 EAGGF Guarantee expenditures. This is done for wheat, rice, other cereals, oilseeds, and cattle and sheep; for other sectors the overall EU15 level of support is used as an average for all member states (i.e., other livestock, sugar and raw milk). As noted before, payments to animal product sectors (cattle and sheep and other livestock) remain as output subsidies.

The method used to disaggregate the EU15 power of support (from Appendix 3 in Frandsen *et al.* 2001) is as follows:

- Total value of production is split between individual member states.
- Assuming there is only one price for each commodity in the EU: for crops, value of production is allocated to member states based on reported tons of production in each country. For animal sectors, each member's share of total value of production is used.
- For wheat, other cereals, other crops, vegetables and fruits, plant-based fibres and oilseeds: output subsidies, intermediate input subsidies and capital based payments are allocated to members based on their share of total EU production. Land-based

payments (hectare and set aside premia) are allocated to cereals and oilseeds based on their share of total acreage within each member state.

- For cattle and sheep, output and intermediate subsidies are allocated among EU15 members based on the share in total production across the EU. Capital based payments (suckler cow, male animal and ewe premia) are allocated according to EAGGF expenditures per country. Although Frandsen *et al.* do not explicitly state it, it seems land based payments in these sectors are allocated according to their share of total acreage in the country.

In version 5, the support measures relating to vegetables and fruits, plant-based fibres, other crops and some oilseed payments were allocated to a 'miscellaneous' category as output subsidies and so were not fully represented. The current version (6.0) is a major improvement as these sectors are disaggregated to the same level (output, land, capital and intermediate subsides) as other sectors. As Frandsen *et al.* (2001) note, this is particularly important in countries like USA and Japan where this 'miscellaneous' sector accounts for a large proportion of domestic support (28 and 52 per cent respectively), even in the EU the figure is relatively large (15 per cent).

Another improvement in version 6 was the extension of domestic support measures in the data to include not only the EU15 and other OECD countries but also the non-OECD central and eastern European states, including all ten that acceded to the EU in 2004. The implementation of these and other changes relating specifically to agricultural protection between versions 5 and 6 are discussed in Jensen (2003).

In chapter 3, the standard GTAP model and database are extended in two ways to improve the modelling of agricultural trade liberalisation. First, the model is extended to

incorporate an explicit representation of the market price support instruments. Second, an extensive domestic support dataset is assembled to identify the impact of binding overhang and of accurately modelling the different support categories ("boxes") in liberalisation simulations.

2.5 Conclusion

This chapter has described the standard GTAP model and database that is used for much of the empirical analysis in the remainder of this thesis. A clear understanding, in particular of the behaviour of agents and the structure of the base data, is fundamental to identifying the causes and effects underlying the simulations implemented and results generated. This is supplemented by the technical annex presented in appendix I.

Furthermore, strengths and weaknesses of the model are indicated. In some cases these are applicable to all CGE models, but in others they relate to specific attributes of GTAP. Among the model's major advantages are its welfare decomposition feature, the treatment of consumer preferences and the elaborate detail of the database, particularly in the area of trade and protection data.

Some limitations to the GTAP framework have also been identified, including its static nature, the gaps in the treatment of services trade or lack of differentiation between land types. In many cases these have proved to be the focus for modifying or extending the standard model, such as the development of a dynamic version of GTAP. The development of new extensions to the model and database is also an objective of this thesis.

2.6 Tables

Table 2.1: Region (87) Listing for GTAP Database Version 6.0

Regions	
Australia	Ireland
New Zealand	Italy
Rest of Oceania	Luxembourg
China	Netherlands
Hong Kong	Portugal
Japan	Spain
Korea	Sweden
Taiwan	Switzerland
Rest of East Asia	Rest of EFTA
Indonesia	Rest of Europe
Malaysia	Albania
Philippines	Bulgaria
Singapore	Croatia
Thailand	Cyprus
Vietnam	Czech Republic
Rest of Southeast Asia	Hungary
Bangladesh	Malta
India	Poland
Sri Lanka	Romania
Rest of South Asia	Slovakia
Canada	Slovenia
United States	Estonia
Mexico	Latvia
Rest of North America	Lithuania
Colombia	Russian Federation
Peru	Rest of Former Soviet Union
Venezuela	Turkey
Rest of Andean Pact	Rest of Middle East
Argentina	Morocco
Brazil	Rest of North Africa
Chile	Botswana
Uruguay	South Africa
Rest of South America	Rest of South African CU
Central America	Malawi
Rest of FTAA	Mozambique
Rest of the Caribbean	Tanzania
Austria	Zambia
Belgium	Zimbabwe
Denmark	Rest of SADC
Finland	Uganda
France	Rest of Sub-Saharan Africa
Germany	Tunisia
United Kingdom	Madagascar
Greece	

Source: Dimaranan and McDougall (2005).

Table 2.2: Sector (57) Listing for GTAP Database Version 6.0

Sectors	
Paddy rice	Wood products
Wheat	Paper products & publishing
Other cereal grains	Petroleum & coal products
Vegetables, fruit & nuts	Chemical, rubber & plastic products
Oil seeds	Other mineral products
Sugar cane & sugar beet	Ferrous metals
Plant-based fibres	Other metal
Other crops	Metal products
Cattle, sheep, goats & horses	Motor vehicles & parts
Other animal products	Other transport equipment
Raw milk	Electronic equipment
Wool & silk-worm cocoons	Other machinery & equipment
Forestry	Other manufactures
Fishing	Electricity
Coal	Gas manufacture & distribution
Oil	Water
Gas	Construction
Other minerals	Trade
Meat: cattle, sheep, goats & horses	Other transport
Other meat products	Sea transport
Vegetable oils and fats	Air transport
Dairy products	Communication
Processed rice	Other financial services
Sugar	Insurance
Other food products	Other business services
Beverages & tobacco products	Recreation and other services
Textiles	Public administration, defence, health & education
Wearing apparel	Dwellings
Leather products	

Source: Dimaranan and McDougall (2005).

Table 2.3: Protection Instruments in the Standard GTAP Database

Protection Mechanism	Data Sources
Import Tariffs	MAcMap (CEPII) – Applied tariff rates.
Export Subsidies	Based on country submissions to the WTO. Any missing data is extracted from the input-output tables.
Domestic Support	OECD Producer subsidy equivalents (PSE) data for 2001 supplemented with EAGGF Guarantee expenditures for the same year.
Agreement on Textiles and Clothing (ATC)	Data on export tax equivalents of the quotas allowed under the ATC are based on estimates by Francois and Spinanger (2001).
Other Protection Measures ▪ Anti-dumping duties ▪ Price undertakings ▪ Voluntary Export Restraints	Due to lack of available data, these have been reported as zero values in this version of the database.
Preferential Trade Agreements	Numerous preferential trade agreements (including several free trade areas) are recognised in the database. These are incorporated in the applied tariff data supplied by MAcMap.

Source: Dimaranan and McDougall (2005).

Table 2.4: Mapping of OECD Support Measures to GTAP Support Categories

PSE Support Categories	GTAP
A. Market Price Support	
1. Based on unlimited output	Market Price Support
2. Based on limited output	Market Price Support
B. Payments based on output	
1. Based on unlimited output	Output Subsidies
2. Based on limited output	Output Subsidies
C. Payments based on area planted / animal numbers	
1. Based on unlimited area or animal numbers	Capital or Land Based Payments
2. Based on limited area or animal numbers	Capital or Land Based Payments
D. Payments based on historical entitlements	
1. Based on historical plantings / animal numbers or production	Land Based Payments
2. Based on historical support programmes	Land Based Payments
E. Payments based on input use	
1. Based on use of variable inputs	Intermediate Input Subsidies
2. Based on use of on-farm services	Intermediate Input Subsidies
3. Based on use of fixed inputs	Capital Based Payments
F. Payments based on input constraints	
1. Based on constraints on variable inputs	Land Based Payments
2. Based on constraints on fixed inputs	Capital or Land Based Payments
3. Based on constraints on a set of inputs	Land Based Payments
G. Payments based on overall farming income	
1. Based on farm income level	Land Based Payments
2. Based on established minimum income	Land Based Payments
H. Miscellaneous	
1. National payments	Output Subsidies
2. Sub-national payments	Output Subsidies

Source: Table 1 and Appendix 1 in Frandsen *et al.* 2001.

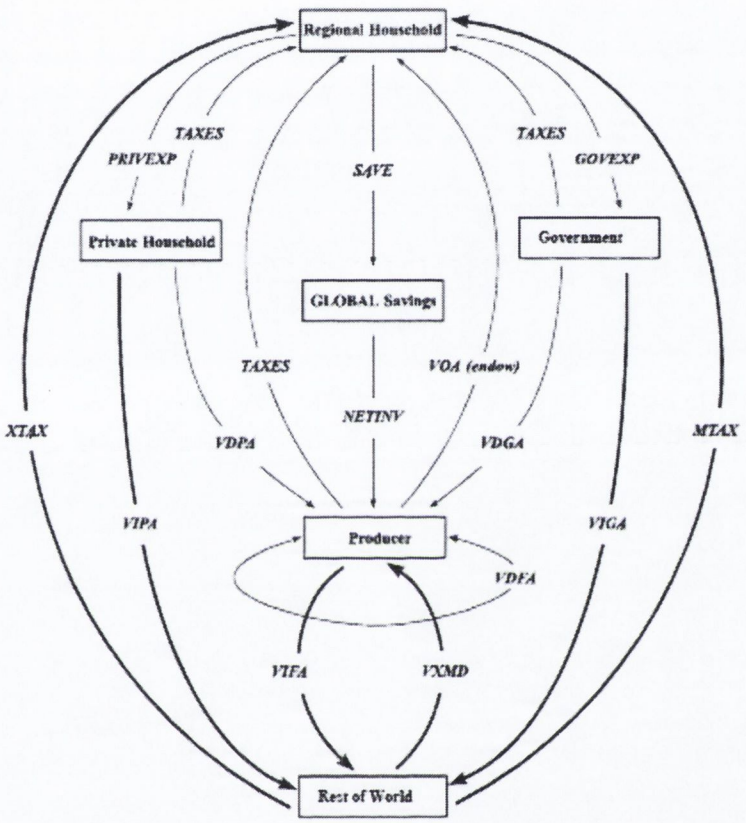
Table 2.5: Elasticities in GTAP

Sector	*ESUBVA*	*ESUBD*	*ESUBM*	Sector	*ESUBVA*	*ESUBD*	*ESUBM*
Paddy rice	0.24	2.2	4.4	Wood products	1.26	2.8	5.6
Wheat	0.24	2.2	4.4	Paper products & publishing	1.26	1.8	3.6
Other cereal grains	0.24	2.2	4.4	Petroleum & coal products	1.26	1.9	3.8
Vegetables, fruit & nuts	0.24	2.2	4.4	Chemical, rubber & plastic products	1.26	1.9	3.8
Oil seeds	0.24	2.2	4.4	Other mineral products	1.26	2.8	5.6
Sugar cane & sugar beet	0.24	2.2	4.4	Ferrous metals	1.26	2.8	5.6
Plant-based fibres	0.24	2.2	4.4	Other metal	1.26	2.8	5.6
Other crops	0.24	2.2	4.4	Metal products	1.26	2.8	5.6
Cattle, sheep, goats & horses	0.24	2.8	5.6	Motor vehicles & parts	1.26	5.2	10.4
Other animal products	0.24	2.8	5.6	Other transport equipment	1.26	5.2	10.4
Raw milk	0.24	2.2	4.4	Electronic equipment	1.26	2.8	5.6
Wool & silk-worm cocoons	0.24	2.2	4.4	Other machinery & equipment	1.26	2.8	5.6
Forestry	0.2	2.8	5.6	Other manufactures	1.26	2.8	5.6
Fishing	0.2	2.8	5.6	Electricity	1.26	2.8	5.6
Coal	0.2	2.8	5.6	Gas manufacture & distribution	1.26	2.8	5.6
Oil	0.2	2.8	5.6	Water	1.26	2.8	5.6
Gas	0.2	2.8	5.6	Construction	1.4	1.9	3.8
Other minerals	0.2	2.8	5.6	Trade	1.68	1.9	3.8
Meat: cattle, sheep, goats & horses	1.12	2.2	4.4	Other transport	1.68	1.9	3.8
Other meat products	1.12	2.2	4.4	Sea transport	1.68	1.9	3.8
Vegetable oils and fats	1.12	2.2	4.4	Air transport	1.68	1.9	3.8
Dairy products	1.12	2.2	4.4	Communication	1.26	1.9	3.8
Processed rice	1.12	2.2	4.4	Other financial services	1.26	1.9	3.8
Sugar	1.12	2.2	4.4	Insurance	1.26	1.9	3.8
Other food products	1.12	2.2	4.4	Other business services	1.26	1.9	3.8
Beverages & tobacco products	1.12	3.1	6.2	Recreation and other services	1.26	1.9	3.8
Textiles	1.26	2.2	4.4	Public administration, defence, health & education	1.26	1.9	3.8
Wearing apparel	1.26	4.4	8.8	Dwellings	1.26	1.9	3.8
Leather products	1.26	4.4	8.8				

Source: GTAP Database.

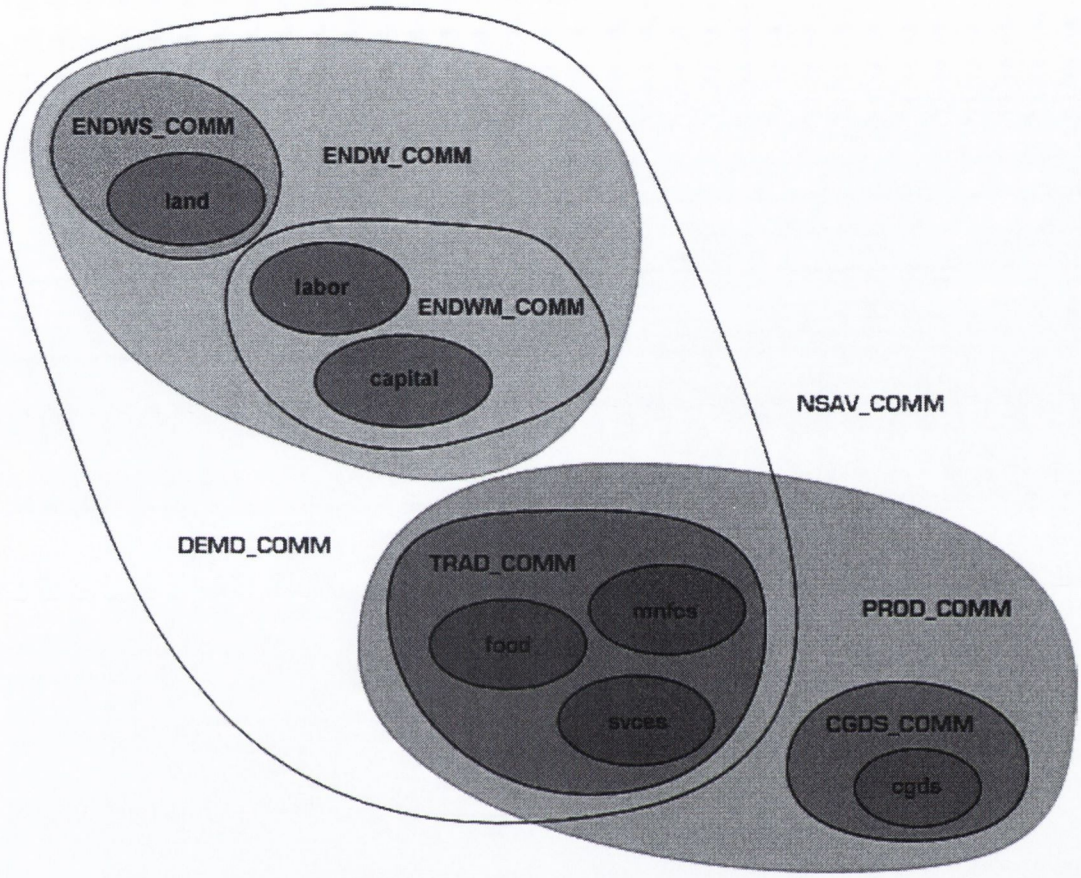
2.7 Figures

Figure 2.1: Structure of an Economic Region in GTAP



Source: Brockmeier, 2001 (Figure 6, p16)

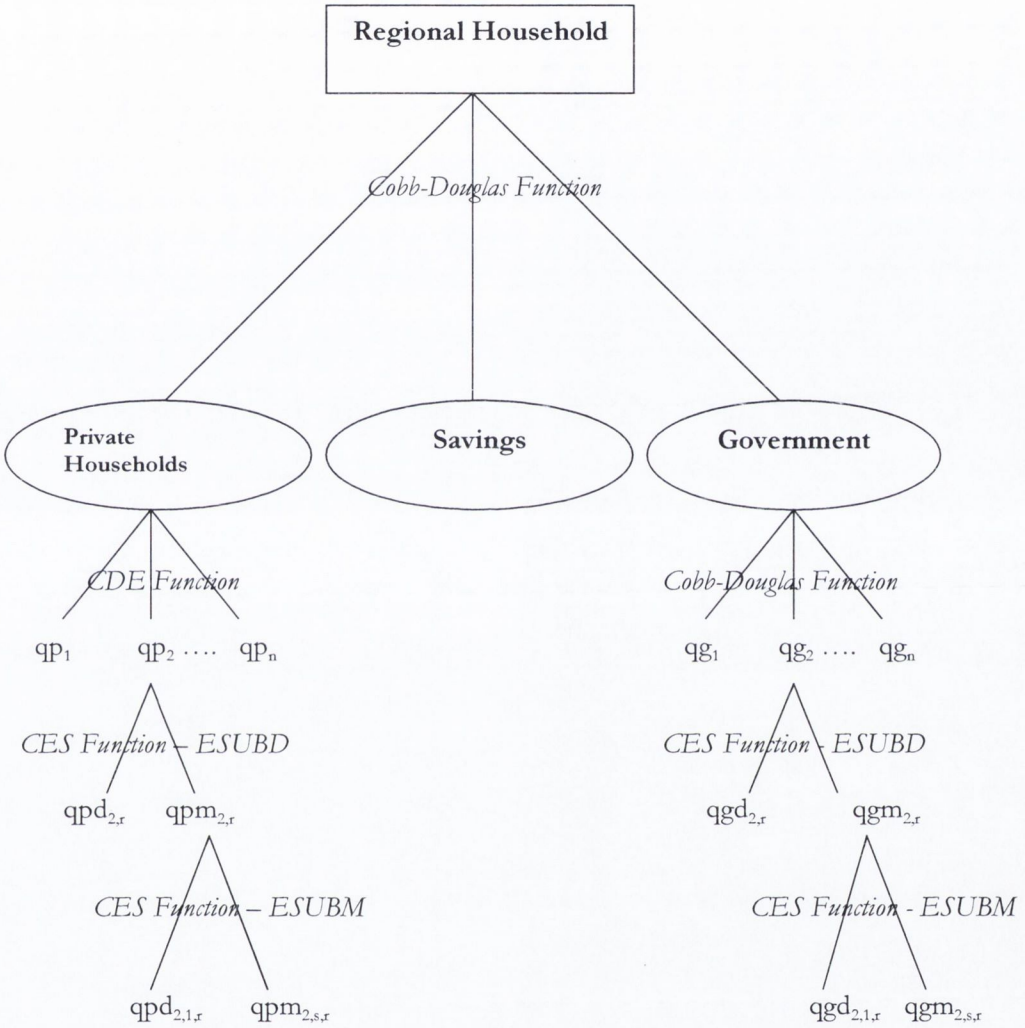
Figure 2.2: Standard Commodity Sets in the GTAP Model



Source: Jensen, J. (2004 GTAP Short Course).

Where:
TRAD_COMM = Tradable Commodities
CGDS_COMM = Capital Goods Commodities
PROD_COMM = Production Commodities
ENDWM_COMM = Mobile Endowment Commodities
ENDSW_COMM = Sluggish Endowment Commodities
ENDW_COMM = Endowment Commodities
DEMD_COMM = Demand Commodities
NSAV_COMM = Non-Savings Commodities

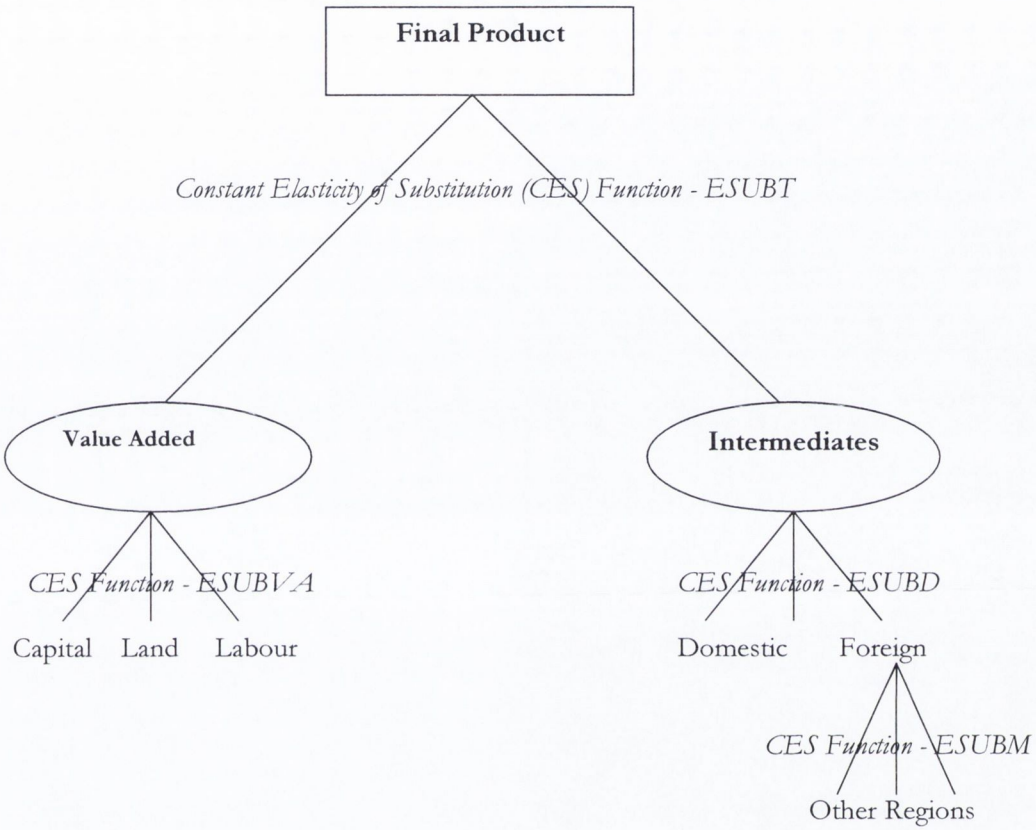
Figure 2.3: Simplified Distribution of Regional Income



Source: based on Hertel (1997).

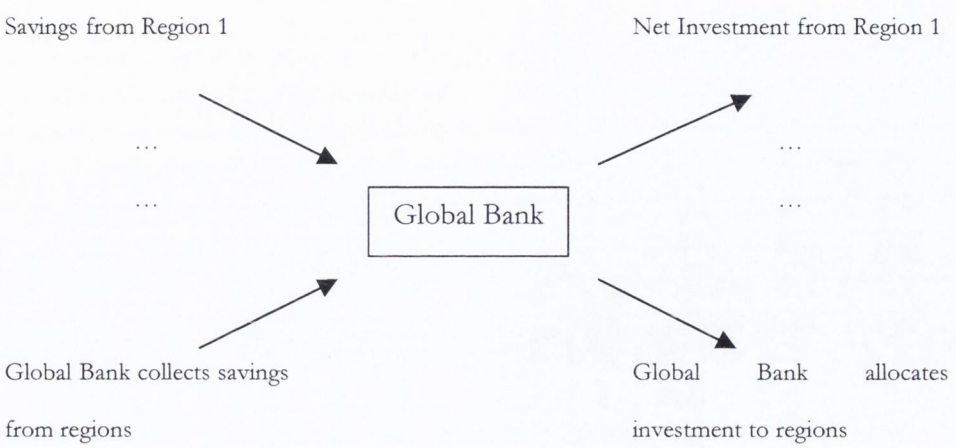
Where:
qp_i and qg_i represent individual quantities consumed by private households and government.
qpm and qpd indicate that commodity is produced domestically or imported respectively.
$qpd_{2,s,r}$ = quantity of commodity i imported from s into r.
ESUBM and *ESUBD* are the Armington elasticities.

Figure 2.4: Production Structure



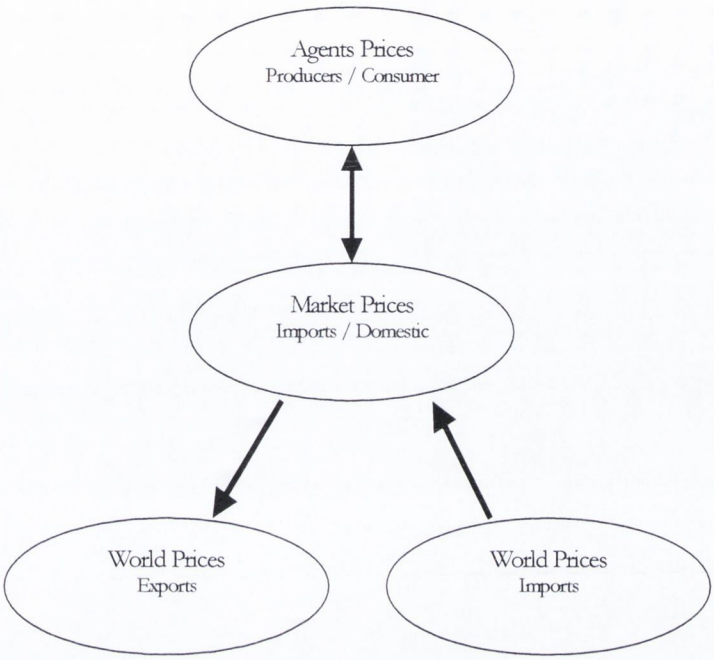
Source: based on Hertel (1997).

Figure 2.5: The Global Bank



Source: Tsigas, M., the 2004 GTAP Short Course ("The Global Bank", slide 11).

Figure 2.6: Price Linkages in GTAP



Source: Dimaranan, B., the 2004 GTAP Short Course ("Price Linkage Equations in GTAP", slide 3).

CHAPTER 3

IMPLICATIONS OF DOMESTIC SUPPORT DISCIPLINES FOR FURTHER AGRICULTURAL TRADE LIBERALISATION

In this chapter the Global Trade Analysis Project (GTAP) model and database are employed to analyse the consequences of domestic support reductions in the context of agricultural trade liberalisation. The primary focus in this chapter is on the different methods used to represent and model domestic support in GTAP and their implications for simulation results. Later chapters provide more detailed analysis of the welfare and production effects of trade liberalisation.

3.1 Introduction

The Doha Round of World Trade Organisation (WTO) trade negotiations launched in November 2001 was suspended in July 2006, in part because of the inability of member countries to reach agreement on the level of ambition for and structure of reductions in tariff barriers and trade-distorting domestic support in agriculture (for overviews of the negotiating issues in agriculture, see WTO, 2004 or IPC, 2005). The difficulties in the agricultural negotiations stem partly from the lack of political will to face down the domestic interest groups that benefit from agricultural protection, but also from more technical issues concerning the lack of transparency of the extent to which particular rule changes would actually lead to increased market access and trade.

This uncertainty about negotiating outcomes is reflected in empirical studies which attempt to estimate the likely impact of a Doha Round agreement on agriculture. A wide range of estimates can be found in the literature, depending on the liberalisation scenarios examined, the data used, behavioural parameters assumed and model specification (Bouet, 2006). While model results will always be sensitive to the specific assumptions made, progress in modelling should help to narrow these differences and separate good modelling practice from bad.

Keeney and Hertel (2005) show the importance of correctly modelling agricultural policies if computable general equilibrium (CGE) estimates of the impacts of agricultural trade liberalisation are to be considered accurate and realistic. For example, the importance of taking into account the distinction between bound and applied tariffs is now well recognised in empirical studies (e.g., Bouet *et al.*, 2004). The availability of databases such as MAcMap, which contain both bound and applied tariffs at the individual tariff line level (usually HS-6), facilitates this analysis.[26]

A similar issue of redundant support entitlements exists in negotiating reductions in domestic support – sometimes referred to as domestic support overhang. Domestic support is disciplined under the WTO Agriculture Agreement by setting an upper limit on each country's total Aggregate Measure of Support (AMS). For many WTO members, their current level of total AMS is considerably lower than their total commitment level. Thus simulating further domestic support reduction by cutting current support by the headline reduction in bound rates leads to unrealistic and disproportionate results.

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[26] See chapter 2 or www.macmap.org for more information on MAcMap.

Analysis of domestic support reductions is further complicated by the categorisation of support (the categories are known as "boxes") in the Uruguay Round Agreement on Agriculture (URAA). Cuts in domestic support are often simulated as reductions of all direct payment measures in the GTAP model and database, whereas in reality some supports such as green or blue box payments and *de minimis* amounts are exempted in negotiations. The Doha Round agreement will see the blue box disciplined for the first time as well as new disciplines on overall trade-distorting support (see section 3.3.3).

A further issue is the modelling of reductions in amber box (trade distorting) support. Protection measures allocated to this box include market price support and direct payments coupled to production. Market price support is included in the amber box when it is underpinned by an administered support price. Cutting market price support contributes to reducing total AMS and, consequently, reduces the need to cut non-exempt direct payments as a way of meeting AMS disciplines. Most studies ignore the fact that the AMS can be lowered by reducing the administered price, in part because market price support measures are only implicitly represented via border protection in the standard GTAP model.

WTO disciplines will affect trade-distorting support, but countries can continue to provide green box support without restriction. To date, green box measures include decoupled payments. To the extent that countries change explicitly trade-distorting payments into decoupled payments in response to future WTO disciplines rather than eliminate them, the simulated impact of the policy change will depend on how these green box payments are modelled. Even decoupled payments are likely to affect production decisions, although the magnitude of this effect is uncertain (FAO, 2004 and Goodwin

and Mishra, 2006). Jensen and Frandsen (2003) implement the decoupling of direct payments in the EU by transferring direct payments into a uniform payment to agricultural land. Because land has no other use outside of agriculture in GTAP, this treatment implies no production response. Bouet *et al.* (2004) model decoupled payments as a payment to self-employed labour. They argue that, although this may result in some other resources being pulled into agriculture as the sector is still subsidised, this is realistic as no payments can be completely decoupled from production. The impact of simulating a reduction in domestic support which is brought about by "box shifting" and an increase in green box payments will thus depend on the way these payments are modelled. While important, this issue is not addressed in this chapter.

The aim of this chapter is to assess the implications of accurately modelling particular features of domestic support in the simulation of further agricultural trade liberalisation in the context of the current Doha Round of multilateral trade negotiations when using the GTAP model and database. The GTAP database is very widely used in empirical studies of trade policy reform. In this chapter, three issues related to the modelling of domestic support in GTAP are addressed: the issue of overhang in domestic support; the distinction between the different domestic support boxes in GTAP; and the representation of the market price support component of domestic support in the model. The purpose is to alert users of the GTAP database and model to the need for more careful modelling of this aspect of agricultural trade reform. Explicit modelling of these features of domestic support will help researchers to improve our understanding of possible outcomes of an eventual Doha Round agreement in agriculture.

Two sets of experiments are run, called single pillar and three pillar simulations respectively. The single pillar simulations focus on reductions in domestic support only

(domestic support is one of the three pillars of the URAA, the others being market access and export competition). A series of experiments is run to demonstrate the impact of the three identified issues on the simulation results. The three pillar simulations encompass disciplines on all three pillars. This allows the interaction between tariff reductions and AMS reductions to be explored. One of the lessons from these simulations is that there is considerable flexibility in the way countries can decide to meet stricter domestic support disciplines in an eventual Doha Round agreement. Any simulated liberalisation is sensitive to the specific assumptions made regarding how countries will strike the balance between market price support and direct payment reductions, between reductions in the different components of overall trade-distorting support, as well as between support reductions across commodities.

Section 3.2 outlines the representation of domestic support in the standard GTAP model and briefly reviews the current literature on modelling domestic support in the context of further agricultural trade liberalisation. Section 3.3 outlines the construction of a domestic support dataset and assesses its implications. It also describes the extension of the standard GTAP model to incorporate the improved treatment of domestic support. Simulations and results are discussed in sections 3.4 and 3.5, respectively. Section 3.6 reflects on the implications of the results.

3.2 Domestic Support and Trade Liberalisation

3.2.1 Agriculture and the Uruguay Round

Following the conclusion of the URAA in 1994, member countries of the WTO entered into effective commitments in the area of agricultural trade for the first time.[27] One element of this Agreement was the commitment to bind and reduce domestic support measures.

Under the Agreement, agricultural domestic support measures are assigned to different categories depending on the type of measure and the nature of the commitment. These categories are referred to as boxes. The "colour" of a box indicates the fate of the subsidies allocated to it.

Measures that distort trade and production fall into the amber box (as defined in Article 6 of the Agreement). These include market price support, direct payments coupled to production and other budgetary outlays on production distorting policies. The value of market price support is calculated as the difference between an applied administered price per ton and an external reference price per ton, multiplied by eligible tonnage. The monetary value of such support, excluding permitted exemptions described below, is referred to as the AMS. The bound total AMS is the maximum level of such support which may be provided by a country under the Agreement. The current total AMS (or current AMS) is the actual amount of such support provided and reported by each member country in its annual notifications to the WTO. Members commit to bind and reduce their amber box support.

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[27] See http://www.wto.org/english/tratop_e/agric_e/ag_intro00_contents_e.htm for further details on the URAA.

Certain support measures are exempted from the amber box. Support that has little or no impact on trade and production and meets specific criteria defined in Annex 2 of the Agreement qualifies for the green box. As it is considered not to be traded distorting, green box support is exempt from reductions.

Some distorting payments are exempt from the amber box and are not counted in a country's current AMS. First, programmes in developing countries are exempted if they conform to the criteria in Article 6.2 (sometimes referred to as the development box). Second, distorting payments may be excluded and placed in a separate blue box category if they are conditioned on limiting production. The blue box category was introduced at the instigation of the EU and the US, the eligibility criteria are defined in Article 6.5 of the Agreement). Third, domestic support that is less than a *de minimis* threshold of 5 per cent of the value of production (10 per cent for developing countries) is excluded from a country's calculation of its current AMS. The *de minimis* thresholds apply to product specific and non-product specific supports.

Under the URAA, members committed to bind and reduce their total AMS in percentage terms over a period of six years from 1995 (ten years for developing countries). Industrialised countries agreed to cuts of 20 per cent, with special and differential treatment applied to developing countries (13.3 per cent) and least-developed regions (no cuts). As noted in the introduction, it is often the case that a domestic support overhang exists, whereby a country's current AMS is lower than its permitted bound total AMS. Countries without total AMS commitments are only allowed *de minimis* levels in future. Under the URAA, no limits were placed on the value of the blue and green boxes other than the need to meet the eligibility requirements laid out in the Agreement. As countries

transfer more support to the blue and green boxes, the importance of accurately analysing these boxes increases (FAO, 2004).

3.2.2 Domestic Support in the Standard GTAP Model and Database

The GTAP model and database are fully documented in chapter 2. The domestic support elements of the model and database are summarised again in this section.

In the standard model, agricultural support is represented in two ways. First, market price support is modelled implicitly via border protection rates with tariff data taken from the MAcMap dataset. The applied administered prices are not represented directly. Second, non-market price support is represented by various kinds of subsidy wedges. The source of the agricultural support data for non-market price support protection in industrialised countries is the Producer Support Estimates (PSE) produced by the Organisation for Economic Cooperation and Development (OECD, 2002a).[28] To incorporate the direct payments reported in the PSE data into the GTAP model, they are allocated to four different categories of support for each commodity: output subsidies, intermediate input subsidies, land-based payments and capital-based payments. These PSE categories include direct payments corresponding to both the blue and green boxes of the WTO classification of agricultural subsidies as well as *de minimis* payments. This issue is raised again in section 3.3.

3.2.3 Review of the Literature on Modelling Liberalisation and Domestic Support

The literature assessing the implications of agricultural trade liberalisation is growing rapidly. Many applications use the GTAP model for this purpose. While much of this

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[28] For the EU, the source of the OECD database is the EAGGF disbursements for 2001.

research fails to account for the issues at the heart of this study, some more recent work has begun to consider their implications.

In a non-CGE context, several papers assess the effects on agricultural support of various proposed reforms. Hart and Beghin (2006) focus on calculating the impact of redefining AMS and the blue and green boxes. Noting the importance of market price support in total AMS in the US and the EU, among others, they demonstrate the impact of using different applied and external reference prices in the calculation of AMS. They also highlight the option for WTO members to reduce their notified levels of domestic support via cuts in market price support, without actual reductions in support provided to producers.

Brink (2006) examines the October 2005 proposals of the US, EU and the G20 on domestic support. Based on projections of agricultural production to 2014, Brink calculates future levels of domestic support commitments and concludes that there is substantial potential for the EU, the US and other producers to reduce their commitment levels (i.e., their bound ceilings) in all three proposals, without implementing any major reform of agricultural policies. Similar conclusions are drawn by de Gorter and Cook (2005) based on the 2004 Framework Agreement. Calculations by Jensen and Zobbe (2006), which take into account reforms of agricultural policy such as the Mid-term Review in the EU and the 2002 US Farm Bill, confirm the findings of Brink, but they also show that many other countries, even those with relatively low domestic support ceilings, have high levels of overhang in their AMS.

Many CGE studies have implemented agricultural liberalisation scenarios by cutting overall domestic support with no attempt to distinguish between allowed and disciplined

subsidies nor between the direct payment and market price support elements of the AMS (e.g., Bouet *et al.*, 2003; Dimaranan *et al.*, 2003; Francois *et al.*, 2005; Hertel and Keeney, 2006 and Polanski, 2006). To better address the distinction of the boxes, Rae and Strutt (2003) consider land- and capital-based payments to be proxies for the blue and green boxes and output and intermediate subsidies as approximating amber box payments. However, this overestimates the size of amber box support in the GTAP database (for reasons discussed in section 3.3.1). Some recent studies have constructed extensive domestic support databases. Papers that have followed this approach include Bouet *et al.* (2004), Anderson *et al.* (2006) and Jensen and Yu (2005).[29] This only allows for trade distorting domestic support to be reduced and takes into account the degree of overhang. However, none explicitly model the fact that the AMS includes Market price support as well as direct payments. Using a CGE model and data from GTAP, Burfisher *et al.* (2002) distinguish between the boxes and model price support. However, like some of the above studies (e.g., Hertel and Keeney, 2005) they implement a full liberalisation scenario and thus the degree of overhang is not relevant to their simulation design.

These more recent papers address two of the domestic support issues raised in this study, although no study has yet attempted to explicitly model the fact that the AMS measure covers market price support as well as direct payments. The design of the experimental scenarios in this study is intended to show the likely magnitude of the bias associated with modelling strategies which do not take these features into account. For this purpose, support data in the GTAP database is explicitly allocated into amber, green and blue box supports. This classification has also been made in previous papers but the underlying

[29] Anderson *et al.* (2006) base their calculations on Jensen and Zobbe (2006).

data are not easily accessible. A method to take into account the dual nature of the AMS measure as well as modelling *de minimis* thresholds for each commodity is also proposed.

3.3 Construction of a Domestic Support Dataset and its Implications

3.3.1 Construction of the Domestic Support Dataset

Member countries must annually notify the WTO of their current levels of domestic support. These notifications are the primary data source used in this study, other than the GTAP database itself. They are used to assemble a domestic support dataset for the five countries providing the highest levels of support to their agricultural producers in absolute terms: the European Union (EU),[30] the United States of America, Japan, Canada and Brazil. Although for some of these countries more recent figures are available, notifications for the year 2001 are used to enable better comparison with the current GTAP database.[31]

Based on these notifications, a detailed dataset of the domestic support for each country is constructed. Table 3.1 summarises the total value of current domestic support in each of these regions, broken down into amber, blue and green boxes as well as de minimis. The amber box is further disaggregated to show the separate contributions of market price support and direct payments. Not included in this table are Brazilian payments to development programmes, which are excluded from reduction commitments under special and differential treatment for developing countries under Article 6.2. These

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[30] The EU is assumed to be comprised of twenty seven members in this chapter. Figures for the EU27 are based on the assumption that commitments for the enlarged EU are the sum of those for the old EU15 and the twelve new members.

[31] The most recent notifications available for Brazil and Canada are 1998 and 1999 respectively. For 2001, the EU15 reports as a single entity. Those countries that acceded to the EU in 2004 report separately. Among EU countries, the most recently available year for Malta and Latvia is 2000. No figures are available for Lithuania. WTO (2005) is also used in the case of missing data for some regions.

payments were valued at $375 million in 1998. For the remainder of the analysis these development programmes are treated in the same way as green box supports.

The values in the table are the total values for each country. The figures can be further broken down to indicate the total for each commodity reported, distinguishing between product specific and non-product specific support. For the EU, product specific EMS is considered equivalent to AMS, hence all figures for AMS are in the sum of EMS and AMS.[32] The table shows the sum of total AMS across all commodities. In the calculation of current total AMS, some support is excluded if it falls below the *de minimis* threshold level.

The calculation of the threshold level requires data on the value of production for each commodity. The primary source for this data is the notifications. In for some commodities in the EU and Japan no production values are reported. In these cases data are taken from EAGGF reports (EC, 2003) and the OECD (2002a) in addition to the notifications.

As noted in section 3.2.2, the direct payments component of domestic support in the GTAP database is allocated to four categories of subsidies: output, intermediate input, land-based and capital-based. Table 3.1 also shows the total value of domestic support in the GTAP database and the breakdown into these four subsidy categories.

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[32] The equivalent measure of support (EMS) measures the value of policies extended to producers that cannot be calculated based on the method used for AMS (Goode, 2003). Of the five countries examined in this chapter, only the EU makes use of this measure.

A comparison of data from the WTO notifications and the GTAP database in table 3.1 shows considerable differences. The main source of the differences in trade distorting support arises from the exclusion of the market price support component in GTAP.[33] In addition, whilst a substantial share of green box measures is represented in the database, others are excluded leading to another source of the differences between the figures.[34]

To enable a better comparison and to run simulations on this data, the domestic support data in GTAP are allocated to amber, green and blue box supports for each region in the construction of the domestic support dataset, based on Jensen (2005) and Young *et al.* (2002). Jensen provides the allocation of PSE commodities to the GTAP subsidy categories used in the construction of the database for EU members. Given this, it is possible to allocate the output, export, intermediate and land and capital based subsidies to the boxes. For the other regions examined, this process is simplified as they did not make use of the blue box in 2001 (with the exception of payments to rice producers in Japan). Young *et al.* provide a classification of subsidies that further aids this process. The resulting allocation is shown at the end of table 3.1.

3.3.2 Differences between Bound and Current Levels of Domestic Support

Following the URAA, WTO members agreed to bind and cut their levels of trade distorting support to agriculture. For industrialised countries, the final phase of those reductions was implemented in 2000. The bindings act as a ceiling that members may not breach. For many countries, the level of their current total AMS (amber box) payments is

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[33] Domestic support in the model and database is based on the OECD's PSE categories B to H. Market price support (category A) is not included in GTAP, other than an implicit representation through border protection.

[34] For example, a measure excluded as it is classified in category R in the OECD database is domestic food aid and assistance programmes in the US which are valued at over $10bn in 2001.

lower than their bound commitments. Table 3.1 shows the extent of this binding overhang in the countries examined in this chapter.

As table 3.1 indicates, there is clearly substantial scope for Canada, Japan and, to a lesser extent, the US and EU to cut bound levels of support without the need to reform current agricultural policies. As Brazil is a developing country, its bound level for 2001 is not final and will be reduced further to $912 million by 2004. At 2001 levels of protection, this still implies a 90 per cent degree of overhang.

3.3.3 The July 2004 Framework

The agreement reached by ministers in July 2004 provides the framework for negotiations towards a final agreement on agricultural trade in the Doha Round. Although containing few specific figures, the Framework lays out the broad structure of such an agreement.[35] Its domestic support proposals are outlined here and are assessed in the context of the current levels of domestic support as discussed in the previous section.

The Framework envisages substantial cuts in overall distorting support (ODS – measured as the sum of total AMS, *de minimis* and blue box payments). These reductions will be based on a tiered formula such that those members with higher levels of support will implement the largest cuts.[36] This is to be achieved via a reduction in bound commitments and by cuts in two of the components of ODS – total AMS and *de minimis*. There will be a downpayment reduction of 20 per cent in the first year of implementation.

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[35] Available online at: http://www.wto.org/english/tratop_e/dda_e/draft_text_gc_dg_31july04_e.htm.

[36] It is not clear from the text whether higher support levels refers to AMS in absolute or relative terms.

The amber box (total AMS) is also to be cut based on a tiered formula. Product specific support to individual commodities is to be capped to prevent shifting support between commodities. In addition, there may also be product specific cuts agreed for some commodities (WTO, 2004). The *de minimis* threshold is also to be reduced. This is interpreted to imply a linear cut.

Blue box support, the final part of ODS, is to be capped at 5 per cent of the value of total agricultural production. The contribution of the reduction of blue box payments to the overall reduction target is to be measured against the higher of the existing level of payments or the 5 per cent cap.

The reductions in total AMS, *de minimis* and blue box must sum to equal the target reduction in ODS. If this overall target is not achieved, deeper cuts in one or more of the components of ODS are required.

Table 3.1 indicates the levels of ODS in 2001 for the countries in this chapter. Bound ODS is defined as the sum bound total AMS, current *de minimis* and current blue box support. Current ODS is defined as the sum of current total AMS, current *de minimis* and current blue box support. The difference between bound and current ODS is due to differences between bound and current total AMS.[37]

As table 3.1 shows, there is considerable scope for countries to cut bound commitments with little or no impact on current levels of support. Blue box payments are under the 5

[37] It could argued that bound ODS should be defined as including full *de minimis* and blue box amounts (both equal to 5 per cent of the value of production). This would have the effect of increasing the degree of ODS overhang but would not significantly change the results of the simulations.

per cent threshold in all regions except for the EU. The USA notified no support measures under the blue box to the WTO in 2001. Roberts (2005) calculates that countercyclical payments, the most likely source of future blue box provisions under new farm legislation, would not exceed the 5 per cent limit. In the case of the EU, the majority of current blue box support is due to be decoupled from production and transferred to the green box (therefore excluded from ODS). If it is assumed that the EU implements 100 per cent decoupling and the pre-decoupling level of support is used as the base against which to measure reductions, not only does the blue box no longer exceed the 5 per cent cap, it also further reduces current ODS to $38 billion. In this scenario, the EU's degree of overhang is increased to 56 per cent.

3.4 Methodology

3.4.1 Aggregation and Closure

The GTAP aggregation used in this chapter is shown in table 3.2. The regional aggregation focuses on the five countries discussed in the previous section: EU, US, Canada, Japan and Brazil. Other major agricultural producers identified are Australia-New Zealand and Rest of Mercosur. China and the Everything But Arms (EBA) group of countries are also separately distinguished. At the sector level, all twelve primary agricultural commodities in GTAP remain separated, as well as the six food-processing sectors such as beef and sheepmeat and dairy. Manufacturing and services are aggregated into one consolidated sector each.

A standard medium-term, general equilibrium closure is assumed. All prices (except the numeraire), regional incomes and quantities of producible commodities are endogenously determined. Tax and subsidy rates, regional trade balances, technology and factor

endowments are fixed exogenously. Labour and capital are perfectly mobile within regions, whilst land and natural resources are sluggish (imperfectly mobile). No factor endowments are mobile between regions and all are fully employed within regions. Investment is assumed to be savings-driven.

3.4.2 Extension of the Standard GTAP Model

The standard GTAP model described in chapter 2 is extended to incorporate an explicit representation of the market price support element of the AMS. The calculation of the value of market price support, summed together with the appropriate, non-exempt direct payments, enables the calculation of AMS in the model. *De minimis* thresholds are also modelled for each commodity. Combined with data from the domestic support dataset described in the previous section, the amber, blue and green boxes can now be accurately represented and distinguished at the GTAP aggregation level.

For the calculation of market price support, applied administered prices and external reference prices are exogenously read into the model. As all prices in the model are initially equal to one, the applied and external reference prices are adjusted relative to those prices.[38] The domestic market price received by producers in the model is assumed to be equivalent to the producer price as reported by the OECD.[39]

The linkage between domestic market prices and applied administered prices is introduced to the model via a complementarity function (Harrison *et al.*, 2002). The complementarity

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[38] Consider an example of common wheat in the EU. The producer or farm gate price is €118/t and the applied price is €101/t (these are post-Agenda 2000 reform prices). If the initial market price in the model is 1, the adjusted relative applied price is 0.85. The same calculation is made for the external reference price.

[39] For refined sugar in the EU, the applied price exceeds the domestic market price due to levies on A and B sugar (EC, 2004a). The applied administered price is assumed to be equal to one.

function is a recently developed feature of GEMPACK (Harrison and Pearson, 1994), the software that is used to implement the GTAP model.[40] It allows CGE models containing inequality constraints or non-differentiable functions to be solved.

The use of the complementarity function ensures that, if the market price of a commodity falls sufficiently, this will result in a cut in the commodity's applied administered price for the purposes of the AMS calculation, thus endogenously reducing the level of current AMS. This approach makes an explicit assumption about the reaction function of policy makers. To take the EU as an example, if the market price falls below the administered price (which is the intervention price), this would lead to a build up of stocks to unsustainable levels. Policy makers are then assumed to react by lowering the intervention price.[41]

In addition to these modifications made to the model to represent the amber box, the model is also adapted to take account of decoupling of direct payments in the European Union, as foreseen under the Mid-term Review (MTR) of the CAP. Following the approach of Jensen and Frandsen (2003) and Conforti and Salvatici (2004), decoupled direct payments are modelled as uniform payments to agricultural land across all sectors in the EU – "the single farm payment". The justification for this approach is that land must be kept in good agricultural condition to receive the payment and that land has no other use outside of agriculture in GTAP.

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[40] This method is not the same as the complementarity algorithms used in GAMS (Harrison *et al.*, 2002).

[41] Alternatively, export subsidies may be used to dispose of surpluses. In the case of the EU, van Meijl and van Tongeren (2002) model the price transmission between market and intervention prices and the gap between them as a function of the EU's net exports.

3.4.3 Baseline Pre-Experiment

A detailed pre-simulation experiment is implemented to construct a baseline against which the results of the simulations in the chapter can be compared. The baseline introduces changes to the policy landscape that have already taken place since 2001 (the base year of the Version 6 GTAP database) or that are expected to occur during the following years. The baseline focuses on policy changes; changes in household preferences, technology or macroeconomic conditions are not included.

The policy changes included in the baseline are: the accession of the People's Republic of China to the WTO in 2001; the completion of the Agenda 2000 Reform of the CAP; the eastern enlargement of the European Union; the MTR of the CAP reform (including decoupling of direct payments from production); the complete implementation of the EU's Everything But Arms (EBA) agreement and the elimination of MFA textile quotas. The construction and implementation of this baseline are described in detail in the thesis appendix II.

There are two important caveats to be noted regarding this baseline. First, this approach does not consider that the system of quotas which exists as a result of the EU's Common Agricultural Policy and the EBA scheme implies the existence of quota rents. These are likely to have important political economy consequences that are not considered in the analysis in this chapter or the remainder of the thesis.

Second, this baseline provides a counterfactual of the development of the world economy in the absence of a Doha Round agreement. It assumes that the policy changes implemented in the baseline will occur with or without a successful conclusion to the Round. The baseline acts as a starting point against which to measure further trade

liberalisation. However, there is some disagreement regarding the inclusion of MTR and the EBA scheme as part of a baseline in measuring the impact of the Doha Round Agreement. It may be argued that the starting point for a new Agreement is the Uruguay Round baseline of bound tariffs, export subsidy disciplines and ceilings on trade-distorting domestic support. Arguably, the EU undertook the MTR in part to allow it to make a meaningful offer in the Doha Round negotiations. A similar point might be argued in the case of the EBA scheme. This should be considered when analysing the results.

3.5 Simulations and Results

Two sets of simulations are implemented. The first set of simulations focuses on the domestic support pillar of the URAA only (referred to as single-pillar simulations hereafter). These simulations focus on methodology, they identify and illustrate the three issues in modelling domestic support addressed in this chapter. The second set of simulations is composed of two experiments that model the interaction between domestic support reductions and liberalisation of the other two pillars, i.e., market access and export competition (referred to hereafter as three-pillar simulations).

3.5.1 Single-Pillar Simulations

There are four single-pillar simulations, summarised in box 3.1. Beginning with a simple domestic support reduction based on the standard GTAP dataset, successive simulations build on this to illustrate the importance of domestic support overhang, the accurate distinction of the boxes and modelling both the direct payment and market price support elements of the amber box.

These experiments do not focus on simulating particular policy scenarios. They draw inspiration from the July 2004 Framework as discussed in the previous section. Cuts are implemented based on tiered reductions in ODS. Three tiers are assumed in the implementation of the reductions, with cuts of 90, 80 and 70 per cent in ODS. The assumption made in this research is that WTO member countries are assigned to tiers based on their absolute levels of protection as measured by their current level of bound ODS as shown in table 3.1. On this basis, the EU is assigned to the top tier, the USA and Japan to tier two, and Canada and Brazil to the lowest tier. The sensitivity of products is not considered and all reductions are linear across commodities within each region.

The first simulation is implemented with the standard GTAP dataset. All domestic support measures in the GTAP database (the direct payments modelled as output subsidies, intermediate input subsidies and land- and capital-based subsidies) are reduced by the headline reduction targets assumed for ODS. Therefore the assumed cut is 90 per cent for the EU, 80 per cent for the US and Japan, and 70 per cent for Canada and Brazil. This simulation acts as a base case, illustrating cuts in bound rates implemented on domestic support as represented in the standard GTAP database, against which to compare the results of the following experiments.

Simulation 2 also employs the standard version of the dataset, but in this case the degree of domestic support overhang is taken into account. The reduction in current ODS required to meet the cut in bound level of ODS is calculated. As indicated in table 3.1 and figure 3.1, the levels of current and bound ODS vary widely between countries. For example, in the case of the US, the 80 per cent cut in the bound level requires a 76 per cent reduction in current ODS, while for Japan and Brazil the degree of overhang is such that they do not need to make any cuts in current domestic support to achieve the target

reductions. A comparison of the results from simulation 1 illustrates the relative importance of the issue of overhang in modelling domestic support.

In the first two simulations, all measures of domestic support in the GTAP database are reduced by the target amounts. In simulation 3, the different boxes in the database are distinguished based on the classification of subsidies in the domestic support dataset described in section 3.3.1. As shown in figure 3.2, for all regions, green box measures notified to the WTO account for 50 per cent or more of total notified domestic support. Only two regions (Japan and the EU) make use of the blue box in 2001.[42] The same target cuts as in simulation 2 are implemented, but only amber box and blue box direct payments are cut by the target percentage (the market price support element of the amber box is not cut). Thus, green box supports are excluded from reduction.

Simulation 4 employs the extended GTAP model described in section 3.4.2. This allows market price support changes to be modelled. In this simulation, domestic support is reduced by the same target rates as simulation 3, taking into account the degree of overhang, and only amber and blue box supports are cut. The reductions in the amber box are the same as those in simulation 3. However, these cuts are now applied equally to the market price support and non-exempt direct payment elements of the current AMS, whereas in the previous simulation the reduction in amber box support is achieved by cutting coupled direct payments alone. The exact contribution of each component to the total AMS cut will depend on their share of total amber box support in each region. The distribution of amber box support between market price support and direct payments in each region is shown in table 3.1 and figure 3.3.

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[42] The simulation is based on post-baseline data. It incorporates the transfer of decoupled direct payments in the EU from the green to the blue box and increases the degree of overhang for the region.

The results of the first set of single-pillar simulations examine the impact of domestic support reductions alone. As the focus of these simulations is on the techniques used in modelling domestic support, the interpretation of the figures is not dwelt upon. Rather the focus is on comparisons of the change in welfare across the four simulations and this allows an analysis of the three issues (table 3.3). For this purpose, the results of simulation one provide a benchmark against which to compare the other experiments.

In simulation 1 all domestic support in the standard database is reduced by the headline rate. The world economy achieves welfare gains of almost $6 billion overall. This is driven by gains in the EU and US as these regions reduce their levels of distorting support (figure 3.4). Most of this increase comes from improved allocative efficiency, allowing for a more efficient allocation of resources within countries. The EU enjoys the greatest allocative efficiency gain, as a result of being the region with the highest level of support and being placed in the top tier of domestic support cuts.

There is also a terms of trade effect from the liberalisation scenario, with mixed impacts across regions. In the EU this effect makes a small negative contribution to welfare change. In Japan the effect is also negative, but much larger. This drives the welfare loss for Japan from domestic support liberalisation in this simulation (figure 3.4). The US enjoys a strongly positive terms of trade effect, even greater than the allocative efficiency effect. These effects reflect the net trade position of the various regions, particularly for those commodities in receipt of domestic support.

For the other five regions disaggregated in this chapter which do not implement any domestic support reductions, the terms of trade effect generally dominates their welfare changes.

In simulation 2, the degree of overhang in domestic support is taken into account in the calculation of the shocks to be implemented in the model. The domestic support reductions implemented are lower in this simulation compared to the first, and the total gain to global welfare is reduced to $5 billion (table 3.3). This result holds across all regions except Japan (whose welfare loss increases) and the EBA group of countries (almost no change). If the headline reduction was any lower (and the figures chosen are at the high end of the likely range), the disparity between this result and simulation 1 would be even greater.

As figure 3.4 illustrates, the results in the EU and the US are again driven by allocative efficiency gains and a positive terms of trade effect in the US case, as in simulation 1. The increase in welfare loss for Japan is caused by a substantial decrease in allocative efficiency, from a small gain to a large loss. As Japan has a high degree of overhang in domestic support, once this is taken into account in simulation 2, it can implement the bound cuts with no reductions in applied domestic support (the same is true for Brazil). Cuts in bound rates in simulation 1 generated small allocative efficiency gains. The elimination of these gains leads to an overall loss in allocative efficiency terms.

In the third simulation, only coupled (amber box) direct payments and the blue box are reduced by the target rates taking into account the degree of overhang. Because a substantial share of the blue box in the EU has been decoupled and transferred to the

green box in the baseline experiment, this further reduces the amount of support cut in this simulation.

The overall welfare change is valued at $3.3 billion, lower than in the first two simulations, and the magnitude of the results for each individual region is also lower compared to simulation 2. Figure 3.4 shows that the decomposition of the welfare changes for the EU, the US and Japan remains the same as simulation 2 (as with the previous experiment, the degree of overhang in Japan and Brazil allows them to achieve the bound cuts without any reductions in current support).

Simulation 4 employs the extended model to reduce the amber box by the same amount as the previous simulation. However, in this experiment the market price support and direct payments components of the amber box are cut equally (in simulation 3 the same cut is achieved by reducing direct payments only). The results show smaller impacts compared to simulation 3 (table 3.3). The total welfare change to the world economy is $1.6 billion, approximately half the figure from simulation 3. This is because reducing the market price support component by lowering the applied administered price does not directly impact on producers. Countries can reduce applied administered prices without changing the level of effective protection provided to producers (as long as the market price exceeds the applied administered price). The distribution of AMS between market price support and direct payments also influences the result for each country.

A comparison across the four single-pillar simulations illustrates the impact of taking into account the issues of domestic support overhang, the distinction between the boxes and a more complete representation of the amber box instruments. The welfare gains are

reduced overall, but the effects for individual regions are determined by the interaction of allocative efficiency and terms of trade effects.

3.5.2 Three-Pillar Simulations

The second set of simulations combine domestic support reductions with improvements in market access and export competition. In addition, the modelling of the reductions in domestic support is more detailed than in the single-pillar simulations. The July 2004 Framework Agreement provides the structure used to model the domestic support disciplines, although many assumptions must be made in order to generate a series of implementable shocks (these assumptions are summarised in box 3.2).

As with the single-pillar simulations, three tiers are assumed in the implementation of cuts in bound ODS, with reductions of 90, 80 and 70 per cent for the EU; the USA and Japan; and Canada and Brazil respectively. The total AMS is also reduced based on a tiered formula. Although not specified in the Framework text, the placement of tiers for cuts in AMS in this chapter is assumed to be same for ODS. The reductions in bound total AMS are assumed to be 80, 70 and 60 per cent respectively for the three tiers. Blue box supports are reduced and capped at 5 per cent of total agricultural production in 2001. A linear 60 per cent cut is imposed on *de minimis* support, the final component of ODS. The threshold is therefore reduced to 2 per cent for industrialised countries and to 6 per cent for developing countries, based on the assumption of special and differential treatment.

Given the reductions assumed in the headline cuts in ODS and AMS above, members must then decide how to implement these cuts.

For the reduction in AMS, an initial comparison between the bound commitment and the current total level identifies the degree of overhang and the actual cut necessary to achieve the target reduction. For the EU the implementation of CAP reform implemented in the baseline further increases the AMS overhang to 47 per cent compared to table 3.1. The degree of overhang is sufficient for Japan, Canada and Brazil to implement the cuts to their bound total AMS levels without reducing current total AMS.

Once the level of reduction required in AMS is calculated, countries face a choice in distributing the cuts across commodities. Reductions may be proportionate for all commodities (i.e., cut support to each product by the same percentage) or certain sensitive commodities may face less than proportionate cuts. The scenario considered is based on the latter option. Relative levels of current domestic support compared to total output value are used as a proxy for the sensitivity of each commodity (shown in table 3.4). Products are placed in tiers depending on their level of sensitivity and deeper cuts are implemented for those commodities deemed less sensitive. In addition, product specific supports are capped at their 2001 levels to prevent shifting of support between commodities.

The countries also face a choice of how to implement this reduction. AMS can be cut by reducing non-exempt direct payments or by cutting market price support, or both. Under the assumptions made here, the USA and the EU must reduce current total AMS by 60 and 62 per cent respectively, but their distribution of current AMS between market price support and direct payments is markedly different (table 3.1).

Countries are assumed to implement AMS cuts by reducing coupled direct payments initially. For some commodities, depending on the distribution of amber box support

between coupled direct payments and market price support, even reducing direct payments to zero is not sufficient to achieve the target AMS cut. In such cases, it is assumed that the remainder of the cut is achieved by reducing the market price support element of the amber box. This assumption is made on the basis that it reduces the interaction between the domestic support discipline and the market access discipline in the simulation, but it is only one out of a number of strategies that affected countries might pursue. It also maximises the likely impact of domestic support reduction commitments.

The other components of ODS are also considered. As table 3.1 shows, for all countries except the EU, blue payments were already less than the 5 per cent cap in 2001. For the EU, assuming decoupled support is classified in the green box, blue box payments will also fall below the new 5 per cent cap with ease. This effectively becomes another source of overhang and therefore assists the EU in achieving its overall target commitment.

The effectiveness of a reduction in *de minimis* support is felt differently across regions. The reduction is particularly large in the US, owing to the fact that non-product specific support now exceeds the new threshold level. The interaction of reducing *de minimis* with the levels of current AMS is also modelled. For those countries with AMS commitments, any reduction in the threshold level results in an equivalent increase in current AMS as support payments, which previously fell below the *de minimis* level, now exceed the new threshold.

The sum of the reductions of the individual components of ODS are then compared to the overall reduction target (which depends on the tier in which the country in placed). If the overall target is not achieved, members must implement deeper cuts to some element

or elements of ODS. Whether they choose to reduce AMS or blue box or *de minimis* further is at their discretion.

In the simulation described above, the only country of the five modelled here to achieve the final ODS target reduction is Japan. Further cuts are required for the US, the EU, Canada and Brazil. These countries are assumed to further reduce their current AMS as a result, with the cuts applied equally to market price support and direct payments. For Canada and Brazil, linear 20 and 10 per cent cuts are implemented across all commodities respectively. For the EU and the US, the reduction is again implemented based on the sensitivity of the commodities. The US achieves the target by increasing the cut applied to non-sensitive products. The average cut to these products is now 85 per cent, compared to 80 per cent previously. For the EU, the depth of cuts to both sensitive and non-sensitive products is increased (average cuts are now 75 per cent and 90 per cent).

These assumptions can be altered, but they illustrate the extent to which any ex-ante assessment will have to make assumptions about how cuts in ODS and its components are implemented even when the headline reductions are known. The calculations are made outside of the model to avoid an aggregation bias, and the data are then aggregated to the level of the agricultural sectors in GTAP to produce estimates of total AMS for each sector (12 sectors).[43] For the calculation of applied prices and external reference prices for GTAP sectors, production tonnages are used as weights to calculate average prices. As part of this aggregation process, non-product specific support for a country is

[43] Consider a simple example in the cereal sector to illustrate the concept of aggregation bias: Barley: AMS = €8; Production = €100. AMS exceeds the de minimis threshold (5 per cent) and is included in current total AMS. Rye: AMS = €1; Production = €100. AMS falls below the threshold (5per cent) and is therefore excluded from current total AMS. When these are treated as separate commodities, current total AMS is equal to €8. However, if aggregated barley and rye are aggregated to create a new sector ("Other Cereals"): AMS = €8+€1; Production = €200. AMS now falls below the *de minimis* threshold and therefore current total AMS will be €0.

distributed across the agricultural sectors of each region based on the value of production. It is modelled as direct payments in the form of output subsidies to each commodity.

Simulations 5 and 6 implement reductions in domestic support combined with disciplines on market access and export competition for agricultural goods. They are summarised in box 3.3. In both simulations, these are modelled as a linear 50 per cent reduction of global agricultural import tariffs and the elimination of export subsidies on agricultural goods by all countries. This is an illustrative cut in applied tariff rates and the degree of tariff overhang is not explicitly considered, nor is any special and differential treatment for developing countries implemented. The only difference between the two simulations is the treatment of domestic support.

In simulation 5, the standard database is employed and domestic support is reduced by the headline bound ODS rates (90, 80 or 70 per cent cuts for the three tiers).[44] Domestic support cuts are the same as the first simulation described above, with all direct payments in the model being reduced and linear cuts implemented across commodities. The degree of domestic support overhang, the distinction between the boxes and the market price support component of the AMS are not considered.

Simulation 6 employs the extended GTAP model and database to implement a reduction in domestic support combined with the disciplines on market access and export competition in agricultural markets. The domestic support element of the simulation is structured on the July 2004 Framework, based on the assumptions outlined above. Of

[44] Note that the EU, USA, Canada, Japan and Brazil liberalise all three pillars. Other regions only implement market access and export competition liberalisation as their domestic support policies are not modelled explicitly in this chapter.

particular interest in simulation 6 is the interaction between the AMS and import tariff reductions. Improved market access for agricultural goods may lead to domestic market prices falling below the applied administered prices used to calculate the market price support component of AMS. Should this occur, it is assumed that this will lead to a further reduction in total AMS by endogenously lowering the level of market price support.

The results from the two three-pillar simulations are shown in table 3.5. In simulation 5, the gains to the world economy in welfare terms are valued at $30 billion. Allocative efficiency improvements are the main sources of welfare gains for the EU, Japan and Canada, while for the US and Brazil welfare gains are driven by improvements in their terms of trade. The latter two are net exporters of many agricultural commodities and benefit from higher world prices received for their goods.

In simulation 6 the global welfare gain is reduced to $24 billion. With the degree of domestic support overhang and the exclusion of green box measures from reduction, the size of the cuts is considerably reduced. In addition, the option for countries to implement lower cuts on commodities deemed to be sensitive further shields high levels of support from deep cuts. Comparison across regions shows that this change is not uniform. The difference can be seen in the decrease in allocative efficiency gains between simulations for the EU and US. The terms of trade benefit to the US, as a net-exporter of many agricultural products, is also reduced. This contributes to the welfare change of the US decreasing by two-thirds in simulation 6 compared to simulation 5.

For the EU, the reduction in welfare from simulation 5 to 6 is only approximately 30 per cent. Aside from the reduced gains from improved allocative efficiency, there is also a

reduction in the EU's terms of trade loss, which is mainly driven by the manufactured goods sector. This sector benefits from liberalisation as resources are reallocated from agricultural sectors and its output expands. The increased supply of manufactured goods reduces the price received by EU exporters on world markets. However, the fall in price is less in simulation 6 compared to simulation 5, contributing to the reduction in the welfare loss between simulations.

That the Japanese welfare figure remains almost unchanged confirms the relative importance of tariff cuts compared to domestic support reductions for that country. Canada's levels of domestic support are low and few products have high levels of protection. Despite a relatively high degree of overhang there is little change between simulations. Most other regions see their welfare gains increasing (or losses decreasing) in simulation 6 compared to simulation 5.

Table 3.5 also shows an alternative decomposition of the welfare changes.[45] In place of decomposing the welfare results in terms of allocative efficiency, terms of trade and investment-saving effects, the results can be linked back to the initial shocks implemented in the experiment. In this case, the welfare change is decomposed into the effects of liberalising market access, domestic support and export subsidies.

As expected, the domestic support subtotal accounts for most changes between simulations 5 and 6. In the former, reductions in domestic support account for 20 per cent of the total welfare gains from liberalisation. This figure falls to 3 per cent in

[45] A feature of GTAP / GEMPACK allows for the results of any particular shock in a simulation to be decomposed into parts known as "subtotals". The sum of subtotals need not necessarily equal the total result, as will be the case if all component parts of a shock are not specified. The result of a shock specified as a subtotal as part of larger simulation is equivalent to the result of implementing the same shock individually. See Harrison *et al.* (1999) for more detailed discussion.

simulation 6. The improvements in market access remain almost unchanged in absolute terms at $24 billion, or 78 and 94 per cent of the total gains in simulations 5 and 6 respectively. The contribution of the elimination of agricultural export subsidies increases from $440 million to $713 million from simulation 5 to 6 (with its contribution to total welfare increasing from 1.4 to 2.9 per cent). This decomposition also confirms the importance of the contribution of improved market access towards welfare gains in Japan and the EU (and export subsidy elimination in the latter's case)

The final aim of simulation 6 is to observe the interaction between domestic support liberalisation and improved market access via the reduction in import tariffs. It is possible for a reduction in the tariff or export subsidy to reduce the domestic market price of a commodity to a level below its applied administered price. This would further reduce the value of market price support in the country in question, and thus also require a smaller reduction in the direct payment element of the AMS. However, this has not occurred in this simulation. The changes in market prices are not sufficient to reduce market prices below the applied intervention prices for any of the market price supported commodities in any region. The full effect of a 50 per cent reduction in import tariffs is not transmitted to the market price. For most commodities the change in price is less than 1 per cent in the EU and the US. This suggests that these tariffs contain a good amount of water, and that the effect of even a significant reduction in applied tariffs may have a relatively limited effect on producer prices in these regions.

3.6 Conclusion

This chapter provides an analysis of the implications of domestic support disciplines as part of further agricultural trade liberalisation. Three major issues are addressed, the

degree of domestic support overhang, the distinction between the agricultural boxes and the incorporation of the market price support component of the AMS. Two series of experiments are run using the GTAP model, one to illustrate the effect of successively introducing improvements in the way domestic support reductions are modelled in liberalisation simulations, and the second to examine the interactions between stricter disciplines on domestic support, market access and export competition.

The results suggest that more accurate modelling of domestic support reduces the estimated impact of likely disciplines. Comparing simulations 5 and 6, the gain in total global welfare is reduced by 20 per cent between the simulations, with even larger reductions for some regions such as the US or EU. The contribution of domestic support reductions to global welfare change from agricultural liberalisation is reduced from 20 per cent to 3 per cent.

The results, although based on illustrative improvements in market access, show that the impact of trade liberalisation from stricter WTO disciplines on domestic support measures is likely to be quite small. This confirms the finding of papers, such as Burfisher (2001), Hoekman *et al.* (2004) and Hertel and Keeney (2006), that the major gains from further agricultural liberalisation are expected to come from reductions in agricultural tariffs and other measures to improve market access. This chapter shows that the effect of domestic support reductions is likely to be even smaller than previous research suggests.

Comparing simulations 1 through 4 provides insight into which elements of the domestic support modelling are most likely to account for its diminished importance. Taking account of domestic support overhang and the distinction between the boxes plays a role, with the latter turning out to be more important in practice. This is partly because this

experiment includes the EU Mid-Term Review of its Common Agricultural Policy as part of the baseline which is assumed to place a large proportion of the EU's direct payments into the green box. Incorporating the possibility of meeting AMS reduction targets by lowering market price support could, potentially, be a significant source in eroding the trade-creating effects of domestic support disciplines. Taking into account the possibility of meeting Total AMS reduction targets by lowering market price support could be an even more significant factor in eroding the trade-creating effects of domestic support disciplines. Lowering administered support prices without any change in the protection provided to farmers through continued high tariff protection reduces the effectiveness of domestic support disciplines by a corresponding amount. The confusion created by merging both forms of producer support in a single indicator, and the potential this creates for undermining domestic support disciplines, has been noted by a number of authors (de Gorter and Cook, 2005)

Three further points can be made about this conclusion. First, treating direct payments as a policy wedge ignores any eligibility criteria which may influence the production response to the payments (e.g., land set-aside for arable payments or stocking rate restrictions for animal premia in the EU in the pre-Single Farm Payment era). To the extent that these eligibility criteria dampen the production response to amber or blue box payments, this reinforces the conclusion that their reduction will have only limited effects on world markets. Second, our simulations assume decoupled payments have no impact on production. Although a number of ways in which decoupled payments could influence farmers' incentives to produce have been identified in theory, the magnitude of these effects in practice is uncertain (FAO, 2004 and Goodwin and Mishra, 2006). To the extent that decoupled payments are assumed to have an output response, this would further dampen the output, price and welfare effects in practice of tightening domestic support

disciplines if it led countries to substitute green box for amber or blue box payments. Third, developing countries in particular, have been critical of the possibility of "box shifting", arguing that giving farmers money, even if unrelated to production, will influence the amount produced. If the classification of decoupled measures as green box was challenged, or the criteria for green box measures tightened, then this would increase the importance of domestic support disciplines beyond that set out in this chapter.

3.7 Tables

Table 3.1: Levels of Domestic Support in 2001

(Pre-Baseline Experiment - Millions of 2001 US$)

Domestic Support		EU	USA	Canada	Japan	Brazil
Amber Box						
Bound AMS		65,383	19,103	2,893	32,691	997
Market Price Support		25,085	5,826	284	3,235	15
Direct Payments[1]		12,117	15,630	1,034	2,540	392
De minimis		411	7,043	846	555	379
Current AMS[2]		36,791	14,413	472	5,220	27
Degree of AMS Overhang[3]		44%	25%	84%	84%	97%
Blue Box						
$ Millions		21,262	0	0	749	0
% Value of Agricultural Production		7%	0	0	1%	0
Green Box		19,452	50,672	1,129	21,023	2,422
Overall Distorting Support (ODS)						
Bound ODS[4]		87,056	26,146	3,739	33,995	1,376
Current ODS[5]		58,464	21,456	1,318	6,524	406
Degree of ODS Overhang[3]		33%	18%	65%	81%	70%
Domestic Support in GTAP						
Total		39,981	26,714	2,296	3,908	496
Output Subsidies		3,800	9,537	263	1,465	496
Intermediate Subsidies		1,227	1,161	80	300	0
Land-based Payments		20,955	15,588	1,863	974	0
Capital-based Payments		13,999	428	90	1,169	0
Classification of GTAP Support to Boxes						
Amber Box	Output Subsidies	3,653	8,859	249	667	481
	Intermediate Subsidies	1,101	1,051	67	223	0
	Land-based Subsidies	103	486	403	907	0
	Capital-based Subsidies	905	392	84	989	0
Blue Box	Output Subsidies	0	0	0	750	0
	Intermediate Subsidies	22	0	0	0	0
	Land-based Subsidies	16,715	0	0	0	0
	Capital-based Subsidies	7,144	0	0	0	0
Green Box	Output Subsidies	147	678	14	798	15
	Intermediate Subsidies	104	110	13	77	0
	Land-based Subsidies	4,137	15,102	1,460	67	0
	Capital-based Subsidies	5,950	36	6	180	0

Source: GTAP Database, Domestic Support Notifications to the WTO (Various) and own calculations.
Note 1: non-product specific support included in the direct payments category.
Note 2: current AMS is the sum of market price support and direct payments less *de minimis* support.
Note 3: overhang is the difference between current and bound levels, expressed as a percentage of the bound total.
Note 4: bound ODS is the sum of bound total AMS, *de minimis* and blue box payments.
Note 5: current ODS is the sum of current total AMS, *de minimis* and blue box payments.

Table 3.2: Regional and Sectoral Aggregation

Regions	Sectors	
European Union	Rice	Raw Milk
United States of America	Wheat	Silkworm Cocoons, Wool
Canada	Other Cereals	Beef and Sheepmeat
Japan	Vegetables and Fruits	Other Meat Products
Brazil	Oilseeds	Vegetable Oils and Fats
Australia & New Zealand	Sugar Cane and Beet	Dairy Products
Rest of Mercosur	Plant-based Fibers	Processed Rice
Everything But Arms Countries	Other Crops	Sugar
China	Cattle, Sheep and Goats	Manufacturing
Rest of the World	Pigs and Poultry	Services

Table 3.3: Welfare Change in Simulations 1-4

(Millions of 2001 US$)

Region	Simulation 1	Simulation 2	Simulation 3	Simulation 4
EU	4,608	4,457	2,858	1,200
USA	2,369	2,198	1,111	787
Canada	451	323	127	73
Japan	-323	-637	-225	-149
Brazil	484	344	67	35
Australia/New Zealand	382	313	86	46
Rest of Mercosur	319	275	79	47
EBA Countries	-129	-133	-82	-47
China	-404	-355	-89	-50
Rest of the World	-1,775	-1,673	-585	-339
World Total	5,984	5,112	3,348	1,603

Source: GTAP model simulation results.
Note: welfare is measured as equivalent variation in millions of US dollars.

Table 3.4: Commodity Sensitivity Measure (%)

%	EU	USA	Japan	Canada	Brazil
Rice	14	87	5	0	3
Wheat	53	3	86	2	11
Other Cereals	57	7	42	7	2
Fruit and Vegetables	15	1	3	1	0
Olive oil and oilseeds	101	1	22	1	0
Sugar	107	46	37	0	0
Plant Based Fibres	58	39	2	0	7
Other Crops	9	12	4	1	2
Cattle and Sheep	68	0	39	1	0
Pig and Poultry	2	0	24	3	0
Raw Milk	14	18	5	12	0
Silkworm cocoons, wool	0	0	3	0	0
NPS Support	0	3	0	3	0

Source: Domestic Support Notifications to the WTO (various) and own calculations.
Note: commodity sensitivity is the value of protection (sum of amber, blue and green boxes) as a percentage of the value of production.

Table 3.5: Welfare Change in Simulations 5 and 6

(Millions of 2001 US$)

SIMULATION 5	Total	Domestic Support	Market Access	Export Competition	Allocative Efficiency	Terms of Trade	Investment-Savings
EU	11,342	4,160	4,709	2,473	12,789	-1,508	62
USA	3,333	2,421	961	-50	1,028	2,378	-74
Canada	843	391	499	-47	528	314	0
Japan	5,929	-376	6,772	-468	7,184	-1,329	73
Brazil	1,553	535	984	34	120	1,348	86
Australia/New Zealand	1,152	327	488	336	-60	1,231	-20
Rest of Mercosur	594	308	225	61	79	534	-19
EBA Countries	-243	-98	31	-176	350	-545	-48
China	287	-348	728	-93	454	-135	-32
Rest of the World	5,345	-1,231	8,206	-1,631	7,684	-2,310	-29
World Total	30,133	6,090	23,604	440	30,156	-22	0

SIMULATION 6	Total	Domestic Support	Market Access	Export Competition	Allocative Efficiency	Terms of Trade	Investment-Savings
EU	7,996	450	4,701	2,845	8,303	-351	44
USA	1,085	238	903	-56	-71	1,053	103
Canada	514	55	502	-44	512	3	-1
Japan	6,223	-124	6,823	-476	7,170	-982	35
Brazil	996	70	893	32	88	854	54
Australia/New Zealand	911	64	504	342	-58	987	-17
Rest of Mercosur	312	26	223	63	49	275	-12
EBA Countries	-116	49	21	-186	381	-459	-38
China	639	17	719	-97	586	132	-78
Rest of the World	6,335	-68	8,116	-1,714	7,946	-1,522	-89
World Total	24,895	779	23,406	710	24,906	-11	0

Source: GTAP model simulation results.
Note: welfare is measured as equivalent variation in millions of US dollars.

3.8 Boxes

Box 3.1: Summary of Single-Pillar Simulations

Simulation 1:

Headline cuts in bound ODS.

Applied to all domestic support payments in standard GTAP model.

Simulation 2:

Degree of domestic support overhang taken into account.

All domestic support in standard GTAP model.

Cuts based on applied rates.

Simulation 3:

Domestic support reductions based on applied rates.

Only amber box direct payments and blue box are reduced.

Standard GTAP model employed.

Simulation 4:

Domestic support reductions based on applied rates.

GTAP model extended to explicitly incorporate market price support.

Only amber box supports reduced, by the same rate as Simulation 3.

Coupled direct payments and market price support cut equally.

Domestic support reductions in Simulations 1-4 are linear cuts across all products.

Regions are placed in tiers depending their relative levels of protection:

90% (EU) / 80 % (USA and Japan) / 70% (Canada and Brazil)

Box 3.2: Summary of July 2004 Framework Assumptions on Domestic Support Reductions

Overall Distorting Support (ODS): Reduction in tiers:

-90% EU;

-80% USA & Japan;

-70% Canada & Brazil.

Current Total Aggregate Measure of Support (AMS): Reduction in tiers:

-80% EU;

-70% US & Japan;

-60% Canada & Brazil.

Blue Box: Capped at 5% of value of total agricultural production in 2001.

De minimis: Linear 50% cut, threshold is reduced to:

2% for industrialised countries;

6% for developing countries.

Green Box: No change.

Box 3.3: Summary of Three-Pillar Simulations

Simulation 5:

Standard GTAP model

Market access:

50% linear cut in global agricultural import tariffs.

Export competition:

Elimination of export subsidies on agricultural products.

Domestic support:

All support in the standard model cut by headline bound ODS rates.

Regions placed in tiers based on level of current protection.

Reductions are linear across commodities.

Simulation 6:

Extended GTAP model incorporating market price support.

Market access:

50% linear cut in global agricultural import tariffs.

Export competition:

Elimination of export subsidies on agricultural products.

Domestic support:

Reductions based on the July 2004 Framework.

All components of ODS considered.

Regions placed in tiers based on level of current protection.

Degree of overhang and necessary applied cuts calculated.

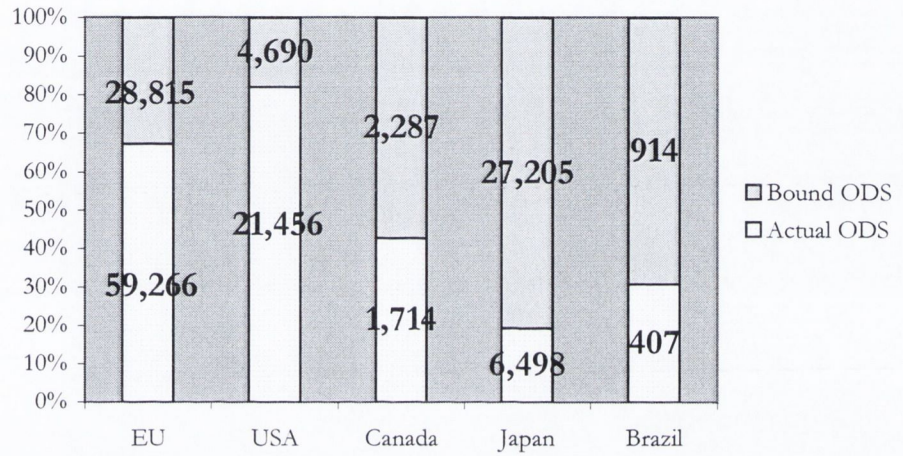
Blue box capped, only amber box reduced.

Cuts for individual products depend on product sensitivity.

3.9 Figures

Figure 3.1: Degree of Overhang in Overall Distorting Support (ODS)

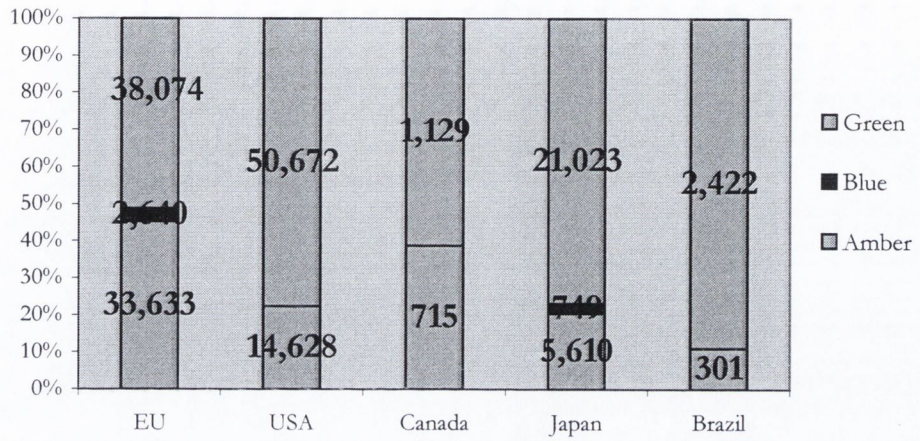
(Post-Baseline – Millions of 2001 US$)



Source: Domestic Support Notifications to the WTO (Various) and own calculations.
Note: figures imposed on bar chart represent the USD (millions) value of ODS in each region.

Figure 3.2: Distribution of Support between Green, Blue and Amber Boxes

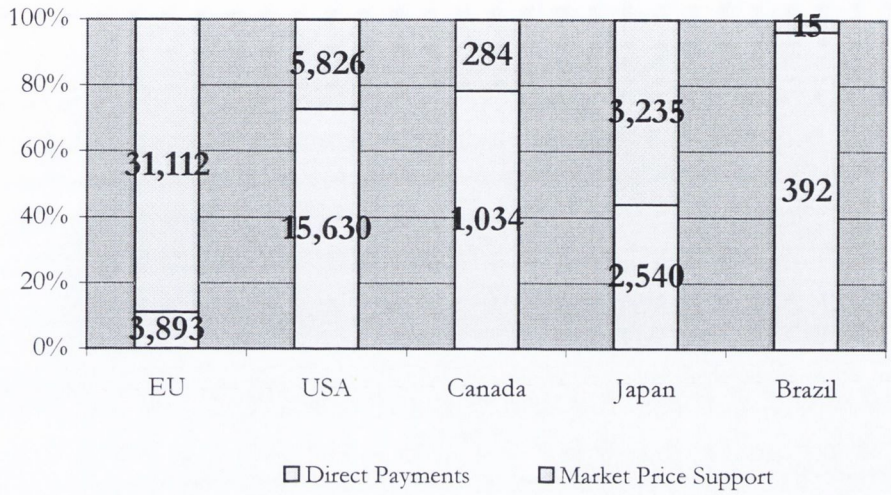
(Post-Baseline – Millions of 2001 US$)



Source: Domestic Support Notifications to the WTO (Various) and own calculations.
Note: figures imposed on bar chart represent the USD (millions) value of support in each box.

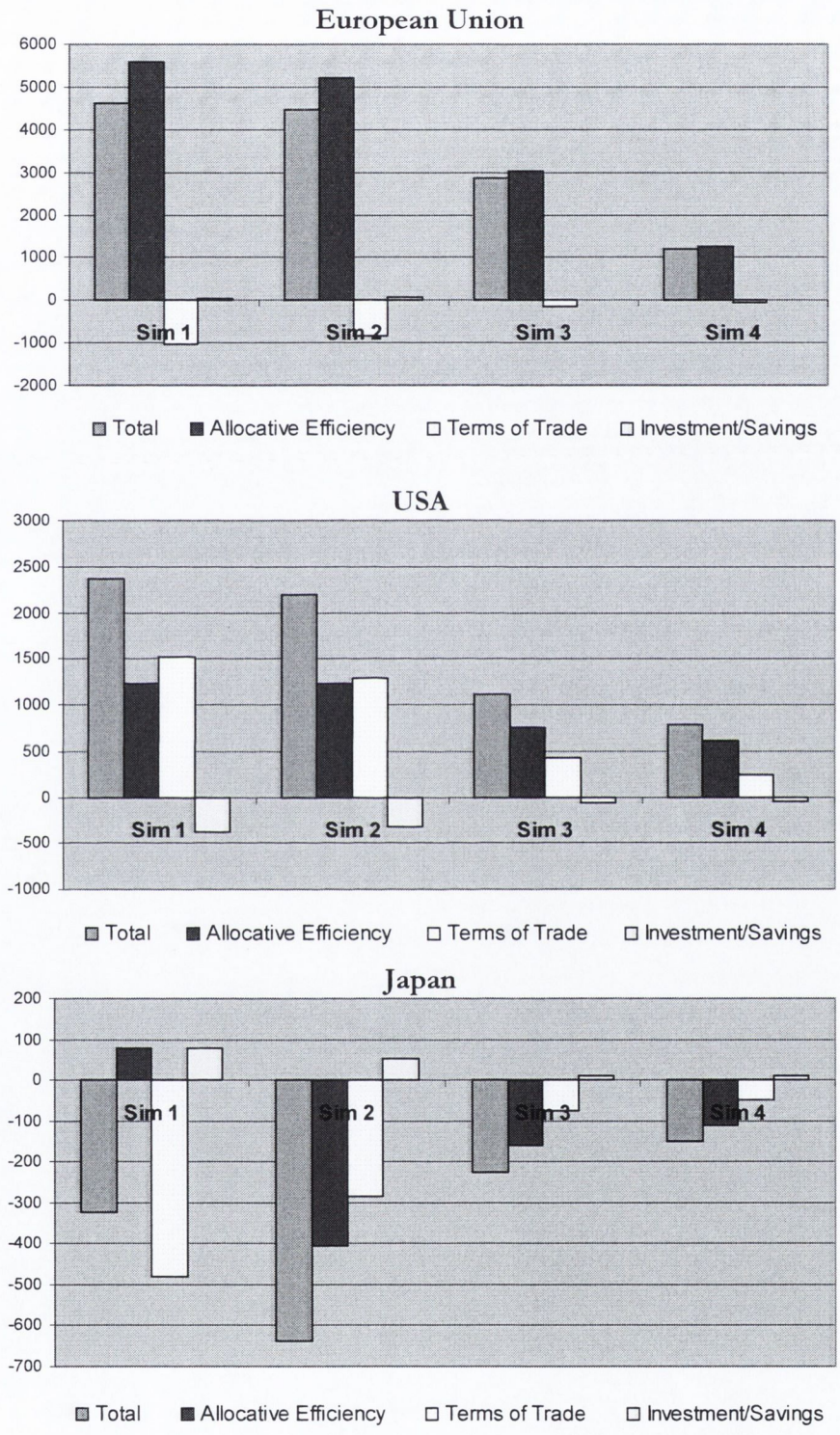
Figure 3.3: Direct Payments and Market Price Support in the Amber Box

(Post-Baseline – Millions of 2001 US$)



Source: Domestic Support Notifications to the WTO (Various) and own calculations.
Note: figures imposed on bar chart represent the USD (millions) value of support.
Non-product specific support included in the direct payments category.

Figure 3.4: Welfare Decomposition for Simulations 1-4



Source: GTAP model simulation results.
Note: welfare is measured as equivalent variation in millions of US$.

CHAPTER 4

TRADE IN SERVICES: DOES GRAVITY HOLD?

A GRAVITY MODEL APPROACH TO ESTIMATING BARRIERS TO SERVICES TRADE

This chapter analyses the determinants of services trade. Unlike the other topics addressed in this thesis, this chapter does not employ the Global Trade Analysis Project (GTAP) model. It is based on an econometrically estimated gravity equation.

The usefulness of GTAP in analysing services trade is limited by the lack of foreign direct investment (FDI) flows (an important mode of supply of services between countries) in the model and database. There have been attempts to adapt the standard GTAP model in this respect (e.g., the FTAP model, documented in Hanslow *et al.* 1999) and some other computable general equilibrium (CGE) models do incorporate FDI flows (e.g., the Michigan model employed in Brown and Stern, 2001).

As noted in chapter 2, the GTAP database includes services trade flows based on International Monetary Fund (IMF) Balance of Payments Statistics. However, there are no barriers to trade in services in GTAP, reflecting the difficulty of accurately estimating such barriers due to their qualitative nature, a topic which is addressed in detail in this chapter.

4.1 Introduction

Services are the largest sector in the global economy and their importance is expected to continue to grow. Services account for approximately two thirds of world Gross Domestic Product (GDP) and over half of total employment in industrialised countries (WTO, 2005c). However, the share of services in world trade has lagged behind. The World Trade Organisation (WTO, 2005c) estimates that services account for only 20 per cent of global trade flows. While this figure may underestimate the level of service trade, due to the intangible nature of services and the interdependence of services and foreign direct investment flows that makes the measurement of services trade difficult, the difference is still significant.

The growing role of services and their increasing importance to trade flows led to the General Agreement on Trade in Services (GATS) in 1995. This agreement governs the rights and obligations of WTO member countries in the area of services trade. The outcome of the current Doha Round world trade negotiations is expected to continue the process of liberalisation in services trade. The aim of these negotiations is to further reduce the barriers that restrict trade in services.

One contribution of this chapter is to further analyse the determinants of trade in services, with particular attention paid to the role and measurement of barriers to services trade. When an agricultural or manufacturing good is imported into a country, the most common form of protection imposed is a tariff. The level of a tariff is usually known and its impact on the price of the good can be estimated. This is not the case for service products. A commercial bank wishing to establish a branch in another country or a doctor hoping to set up a practice in a foreign country cannot simply pay a tariff and establish

their business. Trade in services such as these typically requires the movement of people and capital between countries. In most countries there exist a range of legal and regulatory requirements that must be satisfied before the establishment of such services.[46]

The effects of these non-tariff barriers are difficult to measure. A second objective of this chapter is to generate a series of quantified estimates of the barriers to services trade for a range of industrialised countries, primarily the Organisation for Economic Cooperation and Development (OECD) countries, and their main trading partners.

These objectives are achieved using a gravity model approach, which relates the level of trade between countries to their physical and economic characteristics. Introducing a variable measuring the level of a country's barriers to services trade into the gravity equation allows for a tariff equivalent of the barriers to be estimated. This set of estimates can then be used in further research.

The gravity approach has been applied to services trade before, yet this chapter makes several contributions to the existing literature. Previous research has generally focused on total services trade; in this research the application of the model is extended to four disaggregated service sectors (government, travel, transport and other commercial services). The econometric specification of the model is also improved by the application of the Hausman-Taylor estimator. This type of estimator is increasingly used to estimate gravity models of goods trade flows but it has never previously been applied to services.

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[46] For example, a commercial bank wishing to establish a branch in another country must satisfy the prudential and non-prudential regulations of that country. Many countries will only recognise medical qualifications from specific institutions or require doctors to be proficient in the language of the country.

Two observations should be noted at this point. First, while the analysis in this chapter focuses on services trade, much of the methodology draws on similar research conducted on non-tariff barriers that exist in agricultural and manufacturing goods trade.

Second, the focus of this chapter is on services that move across borders (the manner of this movement will depend on the nature of the service in question). The provision of services by affiliates of companies based in foreign countries is not considered. In other words, the role of FDI as a conduit for trade in services is not addressed.

The chapter begins by presenting an overview of the types of barriers to trade in services and the methods that can be used to estimate their impact on trade flows. Section 4.3 presents the gravity model approach used and reviews the existing literature on gravity model applications to services. In section 4.4 the standard gravity model is estimated for services trade and the results are discussed. The model is then extended in section 4.5 to incorporate measures of the barriers to trade in services and from this tariff equivalents of those trade restrictions are calculated. Section 4.6 concludes.

4.2 An Overview of Barriers to Trade in Services

4.2.1 What Barriers Exist?

The service sector encompasses a largely heterogeneous selection of activities. The operation of the financial or communications sectors is very different to that of health services or transport for example. With some exceptions, the majority of goods are considered to be tradable. Many services are by their nature non-tradable. This heterogeneity gives rise to a range of different types of barriers to services trade. As noted in the introduction, these barriers tend to be qualitative or non-tariff barriers (NTBs) such

as legal or regulatory restrictions on the import of services. The types of restrictions imposed will vary between service sectors and modes of supply that are relevant in each.

The GATS classification identifies four modes of supply: (i) cross-border supply (the service product crosses the border); (ii) consumption abroad (the consumer crosses the border, e.g., visiting a bank in a foreign country); (iii) commercial presence (a firm establishes a branch abroad, this includes foreign direct investment); and (iv) the presence of natural persons (the supplier of the service moves temporarily to the country of the consumer). The importance of each of the modes of supply will vary from sector to sector. As will be discussed in later sections, not all modes will be relevant for the data employed in this chapter. However, the overview of the types of barriers that exist in this section is not restricted to any particular mode of supply.

Hoekman and Braga (1997) summarise the major barriers to services trade under four headings. Quantity based restrictions impose quotas or other types of quantity limitations. These tend to be imposed on the providers of the services rather than the flows of services themselves. Examples include local content requirements or bilateral air space agreements. An extreme case of this type of restriction is simply to ban the import of services entirely.

The second category is restrictions imposed on the price of services. In some sectors government-appointed industry regulators will impose controls on prices. Such restrictions act as barriers to trade if they differentiate between firms based on their origin. Although the discussion of barriers thus far has focussed on non-tariff measures, tariff measures occasional do apply in services. Some price measures that impose fees may

effectively function as tariffs. Hoekman and Braga cite examples such as entry visa charges to travellers or airport landing fees.

A third type of restriction arises from more direct government involvement in services sectors. Individuals may be legally required to hold a licence or qualification from a particular institution to be allowed to offer a service. Such restrictions act as barriers to trade if they discriminate in favour of domestic service providers. This type of restriction is especially common in medical service sectors, but it frequently applies to legal or financial services also. In sectors in which the government is one of main consumers, public procurement regulations will often discriminate against foreign firms.

The final category of barrier identified by Hoekman and Braga (1997) occurs when importers of services' access to secondary services is restricted. If the service provider relies on local industries to supply their product, any discrimination against them will harm their competitiveness. Hoekman and Braga show that this can be a particular concern in transport and communication service sectors.

The Hoekman and Braga paper classifies barriers to trade in services. However, their classification is somewhat limited. The types of barriers they consider are discriminatory barriers that treat importers of services differently to domestic suppliers. Findlay and Warren (2000) show the importance of non-discriminatory barriers, i.e., barriers that restrict the supply of services by domestic and foreign producers equally. The role of such barriers needs to be considered in making cross-country comparisons of services trade.

In recent years the number of regional free trade agreements (FTAs) and customs unions promoting trade in goods has increased significantly. Many provide for free trade in goods

but include few or no measures to facilitate trade in services. Crawford and Fiorentino (2005) show that only 17 per cent of FTAs notified to the WTO include some commitments to services trade liberalisation. The presence of FTAs and their relevance to services trade is discussed in later sections. It is generally accepted that the EU has made the biggest strides in liberalising services trade, thus it is useful to include a summary of the barriers to trade that remain within the European Union at this point.

A European Commission report (EC, 2002) surveys the barriers that remain to trade in services in the internal market of the EU. The findings suggest that physical or technical barriers to intra-EU services trade have been replaced by legal barriers. In addition to cultural and linguistic barriers across countries, several categories of legal restrictions are common across the (at the time) fifteen member countries: barriers to establishment (qualification requirements); restrictions on use of inputs (employment of workers and use of equipment); barriers to the promotion of the services (control on commercial communications varies across member states); sales restrictions (legal requirements and price controls); and differences in legislation governing after-sale requirements (differing post-sale liabilities for example). The majority of the restrictions fit into the classification of Hoekman and Braga (1997). For most sectors and countries, the "rule of origin" or "rule of destination" principles do not apply as many service providers face regulatory restrictions in both the origin and destination countries. Overall, EC (2002) concludes there is a strong bias against foreign producers in the supply of services in the EU and this serves to underline the importance of the services directive currently under debate within the EU.[47]

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[47] For more information on the services directive see:
http://ec.europa.eu/internal_market/services/services-dir/index_en.htm

4.2.2 Estimation of Tariff Equivalents

Much analysis has already been undertaken on quantitatively assessing the effects of NTBs. Anderson and van Wincoop (2004) survey and critique the literature on modelling and quantifying trade costs. Ferrantino (2006) provides a more detailed review of the literature that focuses specifically on quantifying NTBs to trade in goods.

In this section, the three most widely used methods for quantifying NTBs to services trade and the subsequent generation of the tariff equivalents of these barriers are described: frequency indexes, price-based measures and quantity-based measures. These techniques can be applied to goods or services trade, although the majority of the literature to date has focussed on the former.

A frequency index is essentially a list of the barriers that are in place, in this case the barriers to the import of services into a country, which is used as a measure of the policy stance of that country. Typically in the case of services, a country's GATS commitment schedule is used as the source for information on barriers imposed by each country.[48] Hoekman (1995) was one of the first to construct such a frequency index. The tariff equivalents are calculated by assigning a tariff equivalent to the most protectionist country for the sector in question. Other countries' tariff equivalents are calculated by comparing their coverage ratios (the level of their commitments) relative to this benchmark.

There are severe limitations to this method, the principal being the arbitrary estimate of the tariff equivalent of the most protectionist member. In addition, the effect of the same

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[48] Under the General Agreement on Trade in Services each WTO member country must list the level of market access and degree of national treatment they provide for each of the four modes of supply in each service sector. This is referred to as a country's schedule of commitments. A low number of commitments implies a relatively protectionist policy position.

barrier may vary across sectors or countries (Whalley, 2004) and the index is based on the GATS classification rather than information on actual policies.[49] Despite these drawbacks, Hoekman's (1995) estimates and approach have been widely used in the literature.[50]

Others have developed ways to improve frequency indexes to better reflect actual barriers. Researchers at the Australian Productivity Commission (APC) have developed a series of augmented frequency indexes for a range of sectors and countries.[51] Improved data sources (in many cases based on surveys) are used to assemble data on actual barriers to trade (rather than based on GATS commitments), allowing a better distinction of different types of barriers and the development of a more accurate system for weighting the barriers.[52]

The OECD has assembled a database on the level of product market regulation in a number of OECD countries (Nicoletti *et al.*, 2000). The regulations are classified and weighted by their distortionary effect on the market to give an aggregate measure of the regulatory burden for each country.

Price impact approaches are based on the assumption that barriers to trade will result in differences in prices. In an undistorted market domestic and world prices would be equal. Whilst Deardorff and Stern (1997) and others have econometrically estimated the impact

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[49] There is some evidence to suggest that GATS commitments are close to actual policies. For example, Mattoo (1999) finds a close resemblance in many cases in the financial services sector.

[50] See for example: Brown *et al.* (1996), Hertel *et al.* (2000), Robinson *et al.* (2002) or Francois and Eschenbach (2004).

[51] Most of the APC research is published in Findlay and Warren (2000) and is available at http://www.pc.gov.au/research/rm/servicesrestriction/index.html. Dee (2004) provides a broad summary of the APC methodology.

[52] The APC's estimates of tariff equivalents are widely used in the literature and often incorporated in GTAP and other CGE models (e.g., Dee and Hanslow, 2000). In some cases the APC methodology is employed with more region specific survey data (e.g., Jensen *et al.* (2004) simulation of Russian accession to the WTO).

of NTBs on the gaps between domestic and world prices (price wedges), many of the applications to services trade have been by APC researchers.

Chen and Schembri (2002) summarise the APC method of measuring price impacts as follows: an econometric model of the determinants of prices is estimated (based on a suitable proxy for domestic prices). One of the explanatory variables in the model is a measure of the NTBs in the sector in question. Typically this is based on an augmented frequency index. The estimated coefficient for the NTB variable can then be used to calculate the tariff equivalents of the restrictions to trade.

Whalley (2004) notes several limitations of price based approaches. First, differences in prices and costs may reflect differences across countries of domestic policies that regulate firm activities (many of the APC studies take this into consideration). Second, price differences may simply arise because of differences in quality across countries rather than differences on policies.

Quantity based methods to estimating the impact of NTBs on trade focus on comparing actual levels of trade flows to potential (or benchmark) levels of trade. The most commonly used quantity based method is the gravity model approach, in which potential trade flows are predicted based on the physical and economic characteristics of countries and their trading partners.

There are several difficulties that arise in the use of this approach. Initial studies on services were severely limited by the lack of available data. As Findlay and Warren (2000) note, research tended to use domestic service consumption data rather than data on services trade between countries. Although the quality of the data has improved

significantly in recent years, the availability of information on services trade is still quite poor relative to that for trade in goods.[53]

Problems also arise in calculating tariff equivalents based on the results of quantity based models (Whalley, 2004). Taking the total difference between actual and predicted trade flows will likely overestimate the importance of any NTBs present. Factors other than the presence of NTBs are also likely to generate deviations of trade flows from their predicted values (tariff equivalents may even be generated in the absence of any barriers). This has led to the refinement of the specification of the models to include an explanatory variable measuring NTBs in the gravity equation. The variable in question is often based on the frequency index and price based approaches discussed above. This is the approach followed in this chapter. The precise specification of the gravity model used is described in later sections, as is the methodology used to calculate tariff equivalents of NTBs based on a comparison of actual and predicted trade flows.

4.3 The Gravity Model and Services Trade

4.3.1 Historical Development

The concept of the gravity model is based on Newton's Law of Universal Gravitation relating the force of attraction between two objects to their combined mass and the distance between them. The application of gravity to the social sciences was first proposed by James Stewart in the 1940s (Fitzsimons *et al.*, 1999). Originally applied to

[53] Another issue related to the lack of data, shown in Egger (2002), is the problem that arises in making predictions for a group of countries using data from a different set of countries (Egger refers to this as out-of-sample projection), rather than the countries themselves (in-sample projection).

international trade by Tinbergen (1962), the gravity model predicts bilateral trade flows between any two countries as a function of their size and the distance between them.

Economic size is measured as GDP, population or per capita income. Distance is typically measured as the distance between the countries capital cities. In some studies this is replaced by measures of remoteness that weight distances by GDP or measure bilateral distances relative to the country's average distance from all trading partners.

The gravity model has been widely applied in international trade studies. Its popularity is due to the simplicity of the concept, the fact that it appears to fit the available data well and the ease with which models can be estimated econometrically.[54] Increasingly, the model specification has been augmented through the addition of other variables that are thought to impact on trade flows such as dummy variables for a common language, common borders or historical relationships between countries. The gravity model is also used for policy analysis, for example the effects on trade flows between countries of membership of trade agreements or common currency areas can be assessed. A common extension of the gravity approach is to calculate the trade cost of different types of barriers and various other restrictions (observed and unobserved) on trade flows by comparing predicted and actual levels of trade.

As the empirical applications of the gravity model have grown, the theoretical foundations of the model have also been developed. Beginning with Anderson (1979), who showed that the gravity framework is consistent with a model of world trade in which products are differentiated by the country of origin (the Armington assumption,

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[54] Traditionally the gravity model has been estimated using Ordinary Least Squares. As is discussed later in this chapter, it is increasingly the case that more sophisticated estimation techniques are employed.

discussed in chapter 2), a series of papers have shown the gravity model framework to be consistent with a number of standard trade theories such as Heckscher-Ohlin and monopolistic competition.[55] Deardorff (1995, p8) goes as far as to state that "just about any plausible model of trade would yield something very like the gravity equation, whose empirical success is therefore not evidence of anything, but just a fact of life."

Anderson and van Wincoop (2003) show that the estimation of the gravity model can be greatly improved by incorporating what they refer to as multilateral resistance measures. Trade between any two regions depends negatively on the trade barriers of each region relative to the average barrier of the two regions with all trade partners.[56] If a country has a relatively high average trade barrier, it will trade more with a country with which it has a low bilateral barrier. Anderson and van Wincoop argue that multilateral resistance cannot be measured using remoteness variables based on measures of distance as this does not capture border effects, rather the gravity model must be solved by taking into account the impact of barriers on prices.[57]

The importance of Anderson and van Wincoops' (2003) contribution is acknowledged in the literature. However, as Feenstra (2004) and others note, it has not been widely adopted in empirical research given the difficulties in its implementation (a customised programme is needed as the endogenous nature of the price terms requires a non-linear

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[55] See Anderson (1979), Bergstand (1985, 1989), Helpman and Krugman (1985) and Deardorff (1995).

[56] The primary aim of Anderson and van Wincoop (2003) is explain the "border puzzle" listed by Obstfeld and Rogoff (2000) as one of the six puzzles of open economy macroeconomics: McCallum (1995) finds intra-province trade in Canada to be 2200 per cent greater than the level of trade between US states and Canadian provinces despite the presence of only minimal impediments to trade between the two countries. Anderson and van Wincoop argue that as a result of the omission of the multilateral resistance terms McCallum's approach suffered from omitted variable bias. They find that the border between the US and Canada reduces trade by only 44 per cent.

[57] Ferrantino (2006, p25) refers to this as taking into account the endogenous nature of prices in a general equilibrium context.

solution). Feenstra (2004) shows that the inclusion of country specific fixed effects generates the same results as Anderson and van Winccop (2003) with little loss of efficiency.[58] A limitation of this approach is that it does not allow for the multilateral resistance (price) effects to be calculated explicitly. An alternative solution proposed by Baier and Bergstrand (2005a) is to use a Taylor series expansion to approximate for the price effect terms. The results are consistent with Anderson and van Wincoop (2003) and, unlike the fixed effects approach, this method allows for the multilateral resistance terms to be solved explicitly.

Recognising the nature of trading flows between countries as relationships that develop and change over time has resulted in an increasing use of panel (longitudinal) data approaches to the estimation of gravity models. This method is chosen in this chapter. Anderson and van Wincoop (2004, p29) note that "improved econometric techniques based on careful consideration of the error structure are likely to pay off." The use of different panel data methods, such as random or fixed (within) effects estimators, allows for various assumptions regarding trade flows to be analysed and tested. In particular, as is discussed in a later section, in panel data analysis of gravity models possible heterogeneity and endogeneity issues can be examined by isolating the effects of country pair effects (factors that influence trade between two countries).

4.3.2 Existing Studies Applying the Gravity Model to Services Trade

The existing literature on the application of the gravity model to services trade is quite limited. One of the first papers on the subject is Francois (2001), with the methodology

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[58] The inclusion of country dummy variables for importers and exporters is now widely employed, including research by van Wincoop (e.g., Rose and van Wincoop, 2001). Another option discussed but rejected by Feenstra (2004) is to include price indexes in the gravity equation to model the multilateral resistance terms.

further developed in Francois *et al.* (2003). Francois models the demand for imports of services as a function of the recipient country's GDP per capita and population. Data on services trade flows are taken from the GTAP database.[59] The gravity equation is estimated using Ordinary Least Squares (OLS) and the resulting levels of predicted trade between countries are compared to actual trade flows to calculate tariff equivalents of the barrier to services using a constant elasticity import demand function. Francois's estimated tariff equivalents have been widely employed in other studies, often being incorporated into CGE models.[60]

In an extension of this approach, Park (2002) also uses services data from GTAP to calculate tariff equivalents for a larger selection of countries and sectors. The gravity model is modified to include price indices to capture differences in prices between countries. This approach combines the price-based and quantity based methods of tariff equivalent estimation discussed in section 4.2.2. The inclusion of price indices in the gravity equation is first suggested in Bergstrand (1985, 1989). However, Feenstra (2004) argues that an aggregate domestic price index does not accurately capture the cost of importing a service into a country and that a comparison of differences between c.i.f. and f.o.b. prices would be more useful. The approach of Anderson and van Wincoop (2003) is based on such an approach, in that it implicitly solves for differences in prices to measure border effects.

Grunfeld and Moxnes (2003) apply a gravity model to the bilateral export of services and FDI flows using data from the OECD. Their regressors include the level of GDP and GDP per capita in the importing and exporting countries, the distance between them, a

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[59] This data is based on IMF Balance of Payments statistics.

[60] Including Hertel *et al.* (2000), Francois *et al.* (2003) and Hertel and Keeney (2005).

dummy variable if they are both members of a FTA, a measure of corruption in the importing country and a trade restrictiveness index (TRI) to measure the barriers to services trade in the importing country. The TRI is an augmented frequency index based on research by the Australian Productivity Commission.

Their results suggest that the standard gravity model effects found in studies on trade in goods apply to services too. Trade between two countries is positively related to their size and negatively related to the distance between them and barriers to services in place in the importing country (measured by the TRI). They find that the presence of a FTA is not significant in the case of services. This result might be expected as many FTAs do not cover trade in services.

Grunfeld and Moxnes then proceed to model the impact of trade liberalisation on the flows of services using the estimated coefficients of the TRI variable. To model full liberalisation, they calculate the percentage change in services trade from reducing the TRI to equal that of the lowest country in the sample (arguing that simulating the effect of reducing the TRI to zero is unrealistic as it is unlikely that all barriers to trade would be removed entirely).

Kimura and Lee (2004) apply the standard gravity framework to services trade with the aim of comparing the results to the estimates for trade in goods. As with Grunfeld and Moxnes (2003), they use the OECD statistics on trade in services. They include the standard gravity model variables including adjacency and language dummies and in

addition they include a measure of remoteness as a regressor (a trade weighted measure of the distance between the two countries).[61]

Kimura and Lee estimate their gravity equation using a mixture of OLS and time-fixed effects. The major difference they report is that distance between countries is more important in services trade than goods trade. They suggest this implies there are higher transport costs for services but fail to provide any reason why this may be the case. Unlike Park (2002), who found language to positively influence trade in several service sectors, common language between the importer and the exporter is not found to be significant. FTAs are found to correlate positively with trade, which contradicts the finding of Grunfeld and Moxnes (2003) discussed above. The authors argue that whilst many FTAs do not explicitly cover trade in services, their presence may indirectly facilitate the process.

Lejour and de Paiva Verheijden (2004) also compare gravity model estimates for trade in goods and services, examining intra-regional trade in Canada and the EU using the OECD services trade statistics used in the above studies and data from the official Canadian statistical agency. Unlike Kimura and Lee (2004), distance is found to be less important for services compared to goods.

Lennon (2006) contrasts trade in goods and services, focusing in the case of the services on the commercial services sector of the OECD database. Distance and adjacency are found to be less significant for trade in services than goods, common language is found to be more important for services trade.

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[61] As noted in the previous section, this type of measure of remoteness does not correspond to the underlying theory of the gravity model.

The opposing nature of the results regarding the importance of distance in services trade is reflected elsewhere in the literature. Portes and Rey (2005) examine international equity flows with a gravity model and find distance to be negative and significant, which they note is counter-intuitive given the weightlessness of the commodity. They argue that distance proxies for informational frictions that restrict international equity flows. Park (2002) also finds distance to be negative and statistically significant across all service sectors examined. Tharakan *et al.* (2005) find distance to be insignificant in a gravity model analysis comparing Indian software exports to overall goods trade flows.

In addition to the standard gravity model features, Lejour and de Paiva Verheijden (2004) also incorporate the OECD's PMR indicator (described in section 4.2.2) as a measure of the non-tariff barriers to trade, which they find has a significant negative impact on trade in services. The use of this measure is further explored in Kox and Lejour (2005), building on the approach of Nicoletti *et al.* (2003) who estimate a gravity equation using relative levels of PMR in the importing country compared to its trading partners, which they find to have a negative impact on trade in services. As well as the standard gravity model regressors in estimating trade between two countries, Kox and Lejour (2005) include the level of PMR in both countries and a variable measuring the level of heterogeneity between the PMR of the two countries. They argue that it is the differences between regulations across countries that are an important determinant of trade flows.

Their model employs the OECD services trade statistics and is estimated using OLS, several fixed effects models and a SUR model. Due to the limits of the PMR data, the model is only estimated for trading pairs of EU15 member countries. They find significant impacts on trade from the level of PMR and the level of heterogeneity.

Distance between countries negatively effects trade whilst GDP and similar language increase the level of trade.

The literature analysing the determinants of services trade using gravity-based approaches shows a lack of consensus on many of the key findings. The aim of this chapter is to improve upon these results. In the next section, the gravity model is applied to services trade and a variety of estimation techniques are tested to find the most appropriate. The standard gravity equation is augmented with new variables to further develop the model. In the following section, a measure of the level of barriers to trade is included in the model to assess their role in services trade and to estimate a set of non-tariff equivalents.

4.4 Model Estimation and Results

4.4.1 Standard Model

The initial gravity model estimated is (1), in which all continuous variables are expressed in logarithms. Data sources for each variable are described fully in the next section.

$$\ln M_{ijt} = \alpha_{ij} + \beta_1 \ln GDPpc_{it} + \beta_2 \ln GDPpc_{jt} + \beta_3 \ln Pop_{it} + \beta_4 \ln Pop_{jt} + \beta_5 \ln Distance_{ij} + \beta_6 Adjacency_{ij} + \beta_7 Language_{ij} + \beta_8 EU_{ij} + \theta_t + \varepsilon_{ijt} \quad (1)$$

The dependent variable M_{ijt} is imports of services from country i into country j at time t. The OECD (2003) data used covers imports between twenty-seven OECD countries and up to fifty-five of their trading partners over a three year period (1999-2001). The gravity model is estimated five times, with total services, government services, transport services, travel and other commercial services as dependent variables. Whilst the OECD (2003)

database on services trade has been employed in gravity based studies before, as discussed in section 4.3.2, previous research has focussed on the total services category.[62]

As explanatory variables, five continuous variables and three dummies are included. In the literature on gravity models, three variables are used as measures of the size of a country: GDP, GDP per capita and population. Clearly all three can not be included simultaneously due to multicollinearity. In this research the latter two are employed. As countries tend to consume more service commodities as they become richer, GDP per capita is of more relevance than GDP itself. The choice of population over GDP also facilitates the interpretation of the model results (Fitzsimons *et al.*, 1999).

The first two continuous variables are real GDP per capita of the exporting and importing countries at time t ($\beta_1 \ln GDPpc_{it}$ and $\beta_2 \ln GDPpc_{jt}$ respectively). The coefficients β_1 and β_2 are expected to be positive. A higher level of income in the importing country should indicate a higher level of demand for services (produced domestically or imported), whilst a higher income level in the exporting country should be positively related to that country's ability to produce more services for export. Mirza and Nicoletti (2006) show that the supply of services to foreign markets is strongly linked to the availability of inputs in both domestic and foreign markets.

The coefficients on $\ln Pop_{it}$ and $\ln Pop_{jt}$, the population in the importing and exporting countries at time t, may be expected to take either a negative or positive sign. As Martinez-Zarzosa and Nowak-Lehmann (2002) show, population size may have a negative effect on exports if countries export less as they become larger (as they rely more

[62] Kox and Lejour (2005) consider the other commercial services sector, but not the other three.

on internal trade) or a positive effect if they export more as they become larger as they are able to achieve economies of scale. Population size will have a similar effect on imports.

Although distance between the importer and exporter ($\beta_5 \ln Distance_{ij}$) is typically expected to have a negative impact on trade in goods, it is not clear from the review of the existing literature that this is necessarily the case for services. Service products do not have to be physically transported from location to location. Depending on the nature of the service, in some cases it will require movement of physical persons, but in others it may be communicated electronically. Consequently, the importance of distance in services trade may be low or even insignificant.

The standard measure of distance, also employed here, is to measure the distance between the countries' capitals. This has several problems associated with it: (i) it assumes no difference between air, sea and land transportation costs; and (ii) the capital city may not be the economic centre of the country or some countries may have several economic centres.[63] To overcome some of these problems, different measures of distance have been developed (such as trade-weighted distances and distance measured relative to all other trading partners). However, given the possibility that distance is not particularly relevant for services trade as discussed above, the standard measure is used.

The final three regressors are dummy variables indicating whether the importing country and exporting country are adjacent ($\beta_6 Adjacency_{ij}$), share a common language ($\beta_7 Language_{ij}$), and whether both are members of the European Union ($\beta_8 EU_{ij}$). All three

[63] Consider the case of the US-Japanese trade for example: measuring the distance from Washington DC to Tokyo fails to consider the economic importance of numerous major cities on the Pacific coast of the US.

are expected to be positively related to the level of trade. Finally, θ_t are year dummies to control for any time trends in the data.

Language has been found to be significant in gravity model assessments of goods trade flows and this effect could be expected to be particularly strong in services, as common language should greatly facilitate many transactions. There is evidence to suggest that a common language variable may also capture other effects such as cultural or institutional similarities between countries. This should be borne in mind when interpreting the results of the model.

The final dummy variable is used to capture the effects of European Union membership on services trade flows. It is common in the literature applying the gravity model to goods trade to include a variable measuring the impact of FTAs but is not clear that this is appropriate for services trade as the majority of such agreements focus on the free movement of goods rather than services. The only agreement considered in this research is the EU. Whilst trade in services within the EU is not fully liberalised, there are elements of EU policy that promote or facilitate trade in services and foreign direct investment, as opposed to EFTA (European Free Trade Area) for example, which provides only for free trade in goods.[64]

[64] The EU is taken to be the fifteen member states as of 1999-2001 (the period covered by the dataset).

4.4.2 Data Sources

Imports of Services

The primary data source employed in this chapter is the OECD's statistics on international trade in services (OECD, 2003), assembled by the OECD with assistance from Eurostat. The dataset provides data on exports and imports of services between twenty-seven OECD countries and up to fifty-five non-OECD partner countries for three years (1999-2001). The collection of the data is based on the Manual on Statistics of International Trade in Services guidelines which extend the International Monetary Fund's balance of payments methodology to account more fully for services transactions.

Total services trade flows are further disaggregated into transport services, travel services, other commercial services and government services. The use of FDI as a vehicle for the provision of services in foreign countries is not considered in this research. In terms of the GATS modes of supply of services, the most relevant to services trade data in OECD (2003) are modes 1 and 2 (cross border supply and consumption abroad). The database provides little coverage of commercial presence and the presence of natural persons (modes 3 and 4).

Transport services cover air, sea, land, internal waterway and pipeline transport services. Trade in these services involves their provision by suppliers from one country to customers in another. The products transported include passengers, freight (goods) and some ancillary services provided in terminals and ports. Transport accounts for approximately 10 per cent of the total value of service imports in the OECD database.

Also accounting for 10 per cent of total services imports, travel services are goods and services purchased by travellers whilst abroad. The destination country is considered the exporter of the service, the home country of the traveller is the importer. The most common products purchased are accommodation, food, entertainment and transport within the country and any goods taken out of the country by the traveller. Business and personal travellers are both included, provided their visit lasts less than one year. For business travellers, purchases made on behalf of their companies are excluded.

Trade in government services is quite limited (less than 1 per cent of total services imports). This category covers government purchases not included elsewhere such as transactions by embassies or other government agencies based abroad and general purchases of services by government institutions.

The largest component of total services imports are commercial services (80 per cent in the OECD database). This cover a wide range of products not included in the above categories (communications, construction, insurance, intermediary and auxiliary financial, computer and IT, royalties, recreational and other business services) supplied to customers in another country. In particular, other business services is an extremely broad category that includes, amongst other items, advertising, R&D services, legal and other technical services. In some cases, the goods imported into a country for use on a specific project are also included in services rather than goods trade (e.g., materials for use in construction).

In total there are over two thousand bilateral pairs of countries in the database, however many fail to report trade with some, or even all in some cases, of their partners. As some of the bilateral pairs of countries report differing level for the trade between them, the

approach of Kox and Lejour (2005) is followed to determine a ranking of countries in terms of their reporting reliability. After the duplicate bilateral pairs and missing data are removed, there remain approximately 1400 bilateral country pairs reporting imports of total services for at least one of the years in the sample (1999-2001). Pooled across the three years there are just over 3800 observations. The number of country pairs and observations for the disaggregated sector data are lower as countries are less likely to provide full information on the four sub-categories of services.

GDP, GDP per capita and Population

Data on GDP, GDP per capita (both in US dollars) and population variables are from the World Development Indicators database (World Bank, 2005).[65]

Distance

Distances are measured as the distance between capital cities of each country in kilometres and are from the Great Circle Distance programme.[66]

Dummy Variables

The dummy for adjacency takes the value of one if the two countries have a common border and zero otherwise. In the dataset there are 47 country pairs that share a common border. The EU dummy takes a value of one if the two countries are members of the European Union. The language dummy takes the value of one if the two countries share a common (official) language and zero otherwise. In total there are 174 pairs of countries that share a common language in the data.

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[65] Belgium and Luxembourg are treated as single country in OECD (2003), so the sum is used for GDP per capita and population variables.

[66] Available at: http://www.wcrl.ars.usda.gov/cec/moregen.htm.

The summary statistics for each of the explanatory variables are shown in table 4.1. To examine the possibility of multicollinearity amongst the explanatory variables, the Spearman rank correlation coefficients are shown in table 4.2. As there are no two variables with a correlation greater than 0.37, there is no evidence that multicollinearity is a major issue with these variables

4.4.3 Specification Testing

A number of estimation techniques are applied to the model. The results for total services imports using these estimators are shown in table 4.3. Initially, the observations are pooled over the three years in the dataset and the model is estimated with OLS. However, it has been shown that OLS suffers from heterogeneity bias in the gravity model context (Cheng and Wall, 2005). Trade between any pair of countries is likely to be influenced by certain unobserved individual effects. If these effects are correlated with the explanatory variables, which an examination of the OLS residuals supports, this will lead to pooled OLS estimates being biased.

Using panel data techniques captures the relationships between variables over the period of the sample and can control for the possibility that the unobserved effects may be correlated with the regressors.[67] The two most commonly employed panel models are the fixed effects model (FEM) and the random effects model (REM). In the FEM, the intercept terms are allowed to vary over the individual units (in this case the importing

[67] Baier and Bergstrand (2005b) provide a detailed discussion of the potential sources of bias in gravity model estimation and the techniques that may be used to overcome this problem.

and exporting country pairs) but are held constant over time.[68] REM assumes that the intercepts of individual units are randomly distributed and independent of the explanatory variables. *A priori*, the FEM would be expected to be a better fit in the gravity model context as the panel tracks pairs of countries over time and it is not realistic to consider them to be randomly drawn. If this is the case and the unobserved effects are correlated with regressors, the REM estimates will be biased.[69]

A shortcoming of the FEM is that variables that do not vary over time (distance or common language for example) cannot be estimated as they are dropped in the fixed effects transformation. Cheng and Wall (2005) solve this problem by estimating an auxiliary equation in the FEM in which the time invariant explanatory variables are regressed on the estimated country pair intercepts α_{ij} from the FEM regression using OLS:[70]

$$\hat{\alpha}_{ij} = \beta_1 + \beta_2 \text{lnDistance}_{ij} + \beta_3 \text{Adjacency}_{ij} + \beta_4 \text{Language}_{ij} + \beta_5 \text{EU}_{ij} + \nu_{ij} \qquad (2)$$

Both FEM and REM are estimated and their efficiency compared. First, the Breusch-Pagan test is applied to the REM and compared to the pooled OLS estimator. The null

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[68] This is sometimes implemented in gravity models by adding a dummy for each country in the standard OLS regression (Feenstra, 2004).

[69] In the gravity model relationship it is more likely than not that the REM will be biased. Egger (2005, p883) cites the example of an observed variable such as GDP being correlated with unobservable determinants of trade such as human capital stock or trade barriers in the importing and exporting countries. The explanatory variables are considered to be endogenous as they are correlated with the error term. See Cheng and Wall (2005) or Egger and Nelson (2006) for a more detailed discussion.

[70] Traditionally this second step equation has been estimated using OLS, however Egger (2001) suggests that it should correctly be estimated using GLS.

hypothesis is rejected, indicating that REM is a better estimator than OLS.[71] Second, as noted above it is likely that OLS and REM suffer from heterogeneity bias and endogenous explanatory variables respectively. Table 4.3 shows that the estimated coefficients using OLS and REM are very close. The Hausman test is applied to REM and FEM. The test statistic of 14.61 is greater than the chi-squared critical value at six degrees of freedom at the 5 percent significance level (12.59), therefore the null hypothesis that the REM is consistent is rejected, the REM is shown to suffer from correlation and generate biased estimates.

As an alternative to both the fixed effects and random effects models, Egger (2002, 2005) proposes using the Hausman and Taylor model (HTM).[72] The HTM employs an instrumental variable approach that uses information solely from within the dataset to eliminate the correlation between the explanatory variables and the unobserved individual effects that undermines the appropriateness of the REM in the gravity model context. The HTM is increasingly applied in gravity models of trade in goods, but this is the first time it has been applied to services trade.[73]

The variables chosen as exogenous (the same variables are used in the model for total services and four disaggregated service categories) are the year dummies, which are the only time variant exogenous variables, distance, common language and adjacency. These variables are used to instrument the remaining variables, which are assumed to be endogenous. In addition, time invariant variables can be estimated using the HTM, giving it an advantage over the FEM.

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[71] A test statistic of 2597 is greater than the critical chi-squared value at one degree of freedom at 1 per cent significance level (6.63).

[72] See Hausman and Taylor (1981).

[73] Egger and Pfaffermayr (2004) apply a HTM to FDI flows.

To test the appropriateness of the HTM, the Hausman-Taylor over-identification test is applied to the FEM and HTM specifications. The test statistic of 1.39 is less than the critical chi-squared value with six degrees of freedom at 1 percent significance, so the null hypothesis that the unobserved effects are correlated with other regressors is not rejected: HTM is more efficient. Testing of the different specifications appears to confirm the findings of Egger (2002, 2005), that the HTM is the most appropriate estimator for the gravity equation of trade in goods, also holds for trade in services. This result holds for total services and the four sub-sectors. Consequently, the discussion of the results for these four sectors will focus on those obtained using the HTM estimator.

Prior to the interpretation of the results, it is useful to examine the changes in estimated coefficients between the pooled OLS and HTM. The differences are due to the bias in the OLS estimator (Egger, 2005). The OLS estimate of importer GDP per capita is likely to be biased downward by unobserved effects, such as restrictions on trade, that have been omitted from the model but are negatively correlated with imports. The OLS estimator overstates the importance of exporter GDP per capita due the correlation of this variable with omitted variables such as the technology and capital stock of the country. Similarly, the significance of EU membership in the OLS model is likely due to the high levels of factor endowments in EU members. While distance is negatively correlated with imports in the OLS model, using the HTM to control for unobserved characteristics shows it to be statistically insignificant. Egger (2005) suggests poor institutional standards of many peripheral economies as a possible source of the negative correlation.

4.4.3 Results and Extensions to the Model

Total Service Imports

As shown in table 4.3, when the gravity model is estimated using pooled OLS, all variables are significant and their coefficients take the signs that would be expected from the standard gravity literature. GDP per capita of the importer and exporter, common language, adjacency and EU membership all positively influence trade, as do the populations of the respective countries indicating that larger countries produce more services commodities for export and demand more services imports. Distance is the only variable that has a negative influence on trade.

In the HTM estimation (IV in table 4.3), the only variables that remain statistically significant are GDP per capita of both the importing and the exporting countries and the common language dummy. As discussed above, the HTM is the most appropriate choice for estimating this gravity model. The results from this estimator produce several interesting conclusions regarding trade in services.

First, GDP per capita rather than the population of the country (i.e., wealth of the country rather than size) determines the importer's demand for service commodities. A 1 percent increase in GDP per head increases imports of services by 1.3 per cent. Intuitively, this would be expected as individuals and countries tend to consume more services as they become richer. A similar effect holds in the exporting country: a richer country (rather than a larger country) will be able to produce more service commodities and will export more services.

Second, a common language is the only other explanatory variable that is significant. A shared language will increase trade between two countries. As discussed in section 4.1, it is reasonable to expect a common language to have a positive impact on trade services (perhaps even more so than in trade in goods). Many service transactions rely on the movement of physical persons and person to person communication, both of which will be greatly facilitated by a common language.

Distance has no significant influence on trade flows using the HTM. Similar to adjacency, this may reflect the fact that physical distances have little or no relevance for the movement of service commodities. The lack of a statistically significant coefficient on the distance variable is particularly interesting because it confirms an earlier finding of Egger (2002) in relation to the application of the HTM gravity model to goods trade.[74]

Finally, the insignificance of both countries being members of the EU is likely due to the fact that service trade is not fully liberalised within the EU. This finding differs from the majority of research on goods trade that finds free trade areas and customs unions to be positively related to trade in those commodities. Perhaps surprisingly, adjacency has no impact on trade levels. This may reflect the fact that physical borders have little relevance to trade in services.

The effects of distance and borders are likely to vary for different types of services. In the following sections, the results for the four disaggregated services sectors (travel, transport, government and commercial services) are examined.

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[74] McPherson and Trumbell (2003) also find evidence in support of this argument. However, others have found distance to be statistically significant in trade in goods using a Hausman-Taylor estimator (e.g., De Santis and Vicarelli, 2006 and Boudier-Bensebaa and Lamotte, 2006).

Travel Services

The results of the standard gravity model estimated for imports of travel services are shown in panel I of table 4.4. As noted in section 4.2, the Hausman and Hausman-Taylor over-identification tests indicate that the HTM is most appropriate in this case. Imports of travel services are found to be positively influenced by a common language, GDP per capita and population in the importing country, but the population of the exporting country is also statistically significant and exerts a strong negative effect on trade.[75] The significance of GDP per capita indicates that countries with higher incomes produce more travellers. The GDP per capita of the exporting country is insignificant, contrary to an earlier finding of Hamilton *et al.* (2005) who suggest that travellers are attracted to richer countries.

For total services, population was found to be insignificant, however intuitively it seems reasonable that absolute size of population will have a direct impact on traveller numbers and consequently also on travel services (this is calculated as the sum of the expenditure of travellers on goods and services in the destination country). As discussed in section 4.1, the coefficient on population can be expected to be positive or negative. The positive coefficient on population of the importing country implies that larger countries produce more travellers and so import higher values of travel services. The negative coefficient on exporter population is counter-intuitive, it suggests that countries with larger home populations attract less travellers. It may reflect the importance of several small, high profile destinations (e.g., Cyprus or Malta).

[75] In the case of travel, care must be taken in the interpretation of the variables. For travel services, the importing country is the "home" of traveller. The country visited, where the service is purchased, is the exporter.

To further examine the flows of travel services between countries, the standard gravity equation is augmented and (3) is estimated. The additional variables $\beta_9 Temp_i$ and $\beta_{10} Temp_j$, from New *et al.* (1999), measures the average annual temperature between 1961 and 1990 for each importing and exporting country.[76] Although, the data does not correspond to the time period of the dataset used in this research, global temperatures have not changed considerably despite global warming and it is unlikely that relative temperatures between countries have changed.

$$\begin{aligned} \ln M_{ijt} = {} & \alpha_{ij} + \beta_1 \ln GDPpc_{it} + \beta_2 \ln GDPpc_{jt} + \beta_3 \ln Pop_{it} \\ & + \beta_4 \ln Pop_{jt} + \beta_5 \ln Distance_{ij} + \beta_6 Adjacency_{ij} + \beta_7 Language_{ij} \\ & + \beta_8 EU_{ij} + \beta_9 \ln Temp_i + \beta_{10} \ln Temp_j + \theta_t + \varepsilon_{ijt} \end{aligned} \qquad (3)$$

Previous research (Lise and Tol, 2002) suggests that travellers, in particular tourist travellers, are attracted to warm climates and this is supported by the results of model (3), shown in panel II of table 4.4. Warmer average temperatures in the exporting country (i.e., the destination country of the traveller) have a statistically significant, positive effect on imports of travel services. The impact of temperature in the home country (the importer) is insignificant.

Transport Services

In the case of transport services (panel I in table 4.5), the HTM is again found to be the most efficient specification. GDP per capita and population size of both the importer and

[76] These temperature variables and other variables measuring economic freedom and government efficiency added to later equations in this section are sourced from the Sustainability and Global Change dataset assembled by Hamilton *et al.* (2002). This dataset brings together a wide range of other data sources available elsewhere on the web (http://www.uniamburg.de/Wiss/FB/15/Sustainability/Models.htm).

the exporter are found to be positively related to the level of imports, as is distance, adjacency and EU membership.

The positive coefficient on distance is counter-intuitive in the gravity context, but perhaps in the case of transport services it may be more reasonable. A positive coefficient implies that, as distance increases, the value of transport services (air, land and sea transport) increases. It costs more to transport material as the distance increases. The significance of the EU variable is a change from the case of total services. This may be because the value of transport services is closely related to the value of trade in physical goods. If EU membership has a positive impact of the goods trade (as previous studies have found), this may have a knock-on effect on the demand for transport services to transport those goods within the Union. A similar effect may explain the importance of adjacency in this model.

Population (of both the importer and exporter) has a negative impact on imports. Again, this reflects that larger countries may be less likely to import or export certain types of services, instead they may rely more on internal trade flows.

Government Services

The first panel in table 4.6 shows the results of the standard gravity model applied to imports of government services. The estimated coefficients using the HTM are quite different from for the other service sectors and don't correspond to the standard gravity model findings. The only statistically significant variable is the GDP per capita of the exporting country. The reason for this is unclear. It suggests that a country needs a sufficiently high level of income before it may begin to export government services.

In an attempt to augment the standard gravity equation for imports of government services equation (4) is estimated. The additional variables included measure the perceived quality of the provision of public (government) services in the importing and exporting countries. Kaufman *et al.* (1999) base their variable on a database of three hundred governance indicators. A higher score implies more effective government provision of services. The results of equation (4) are shown in the second panel of table 4.6. The new variables have no statistically significant effect on the import of government services.

$$\begin{aligned} \ln M_{ijt} = {} & \alpha_{ij} + \beta_1 \ln GDPpc_{it} + \beta_2 \ln GDPpc_{jt} + \beta_3 \ln Pop_{it} \\ & + \beta_4 \ln Pop_{jt} + \beta_5 \ln Distance_{ij} + \beta_6 Adjacency_{ij} + \beta_7 Language_{ij} \\ & + \beta_8 EU_{ij} + \beta_9 \ln GovtEff_i + \beta_{10} \ln GovtEff_j + \theta_t + \varepsilon_{ijt} \end{aligned} \quad (4)$$

Commercial Services

For other commercial services (not included elsewhere), the HTM is found to be best specification. The results of estimating equation (1) are shown in the first panel of table 4.7. Only GDP per capita (of both countries) and language are found to be significant and all three have positive coefficients. It is reasonable to assume that commercial services rely even more on wealth than the other service categories and this is shown in the relatively large coefficients on GDP per capita. This type of service is also likely to depend heavily on person to person communication and a common language promotes higher levels of trade.

To explore the possibility that trade in commercial services may be sensitive to the investment climate in countries, even more so than the other services categories, equation (5) incorporates a broad measure of economic freedom in the importing and exporting countries. $\beta_9 EcoFree_i$ and $\beta_{10} EcoFree_j$ are based on the Heritage Foundation's Index of

Economic Freedom (Miles *et al.*, 2006). Countries are scored on an annual basis on a number of headings related to their level of economic freedom. The variable is measured on a scale of 1 to 5, lower scores indicate higher levels of economic freedom and lower government intervention.

$$\begin{aligned} \ln M_{ijt} = {} & \alpha_{ij} + \beta_1 \ln GDPpc_{it} + \beta_2 \ln GDPpc_{jt} + \beta_3 \ln Pop_{it} \\ & + \beta_4 \ln Pop_{jt} + \beta_5 \ln Distance_{ij} + \beta_6 Adjacency_{ij} + \beta_7 Language_{ij} \\ & + \beta_8 EU_{ij} + \beta_9 \ln EcoFree_i + \beta_{10} \ln EcoFree_j + \theta_t + \varepsilon_{ijt} \end{aligned} \quad (5)$$

The results, in the second panel of table 4.7, indicate that only the level of economic freedom in the exporting country significantly influence commercial services flows. However, the positive sign of the coefficient is counter-intuitive. A lower value of the variable ($\beta_9 EcoFree_i$) indicates greater economic freedom, therefore a positive coefficient suggests lower economic freedom in the exporting country encourages exports of services.

Overall, the results from the application of the standard gravity model approach to services are similar to those found in studies of trade in physical goods. The explanatory variables that are consistently the most influential are the GDP per capita of the importer and exporter and the presence of a common language. Unlike trade in goods, adjacency, distance between countries and EU membership are not found to significantly influence the level of services trade.

The results are quite robust. For example, alternating the combinations of GDP per capita, GDP and population used in the gravity equation does not significantly alter the estimated coefficients. Some regressions were implemented using GDP per capita at

purchasing power parity but this was not found to significantly change the results. Nor does the adoption of an extended language variable incorporating data on the prevalence of non-official languages and the degree to which they are spoken in countries, or replacing the EU dummy with dummies for EU and NAFTA.[77]

4.5 Estimating Tariff Equivalents

4.5.1 Non-Tariff Barriers in the Gravity Equation

A key objective of this chapter is to estimate tariff equivalents of the barriers to services trade using the gravity framework. This is accomplished by adding a new variable ($\beta_9 \ln NTBTotal_j$) that measures the total level of NTBs of the importing country j to the gravity equation.

This variable is primarily based on a TRI (an augmented frequency index) produced by the APC. The TRI measures the level of protection imposed by each country on the provision of services on a scale of 0 (liberal) to 1 (restrictive). The TRI data are shown in table 4.8

The APC provides two sets of TRIs: domestic and foreign. The first measures all restrictions imposed on the operation of firms within the country (such barriers are considered to be non-discriminatory). The second measures the restrictions that hinder the establishment and operation of foreign service providers (discriminatory and non-

[77] The extended language variable is based on Clair *et al.* (2002). It is a continuous variable that ranks the degree of similarity of the languages of trading partners (or the linguistic difference between them). This had little influence of the results compared to the use of the standard dummy variable. This may reflect the fact that the sample of countries covered in the model are primarily OECD countries, the majority of which have one dominate language in use.

discriminatory measures). The difference between the two indicates the level of discrimination against foreign firms and this measure is used in this analysis.

TRIs are provided for a number of service sectors, some of which broadly match the four sectors covered in OECD (2003). For total services imports, the average of all the sectoral TRIs is used. If the TRI country coverage is not a perfect match for the OECD services database, a coverage ratio based on Hoekman (1995) is used to supplement the TRI database. The coverage ratio (CR) sums up the number of GATS commitments of each country. The more commitments signed up by a country, the more liberal it is considered. To equate this measure to the TRI, the ratio is subtracted from one (1-CR) to give a scale of 0 (liberal) to 1 (restrictive). The correlation between the TRI and (1-CR) is 0.62. Although this may seem quite low, the country coverage of the TRI and the OECD database are quite close, the coverage ratio is only used for a few countries.

The model estimated for total services imports is (6). A higher level of protection in the importer should reduce the level of services trade between countries.

$$\begin{aligned} \ln M_{ijt} = {} & \alpha_{ij} + \beta_1 \ln GDPpc_{it} + \beta_2 \ln GDPpc_{jt} + \beta_3 \ln Pop_{it} \\ & + \beta_4 \ln Pop_{jt} + \beta_5 \ln Distance_{ij} + \beta_6 Adjacency_{ij} \\ & + \beta_7 Language_{ij} + \beta_8 EU_{ij} + \beta_9 \ln NTBTotal_j + \theta_t + \varepsilon_{ijt} \end{aligned} \qquad (6)$$

The results are shown in panel V of table 4.3. The new variable is statistically significant at the 15 per cent level and the coefficient has the expected sign. GDP per capita of the importer and common language remain positive determinants of imports of total services, however GDP per capita of the exporter is no longer statistically significant.

For travel services, the same variable measuring the total levels of NTBs in the exporting country (the destination of the traveller) is added to (3) to give (7). The results are shown in table 4.4, in the final panel. In this case, the NTB variable is not found to be statistically significant.

$$\begin{aligned} \ln M_{ijt} = {} & \alpha_{ij} + \beta_1 \ln GDPpc_{it} + \beta_2 \ln GDPpc_{jt} + \beta_3 \ln Pop_{it} \\ & + \beta_4 \ln Pop_{jt} + \beta_5 \ln Distance_{ij} + \beta_6 Adjacency_{ij} + \beta_7 Language_{ij} \\ & + \beta_8 EU_{ij} + \beta_9 \ln Temp_i + \beta_{10} \ln Temp_j + \beta_{10} \ln NTBTotal_i + \theta_t + \varepsilon_{ijt} \end{aligned} \quad (7)$$

In the case of transport services, rather than using a measure of the total barriers to services trade, a more specific TRI measuring restrictions in maritime transport is used to proxy for NTBs in the transport sector. To supplement this measure, several coverage ratios from Hoekman (1995) were considered (maritime, air, land and total transport are among the sectors for which coverage ratios are provided). However, these measures are found to be poorly correlated with the TRI for transport and were not used. The $\beta_9 \ln NTBTsp_j$ variable is added to equation (1) to give (8). This variable is not found to be statistically significant (table 4.5, second panel).[78]

$$\begin{aligned} \ln M_{ijt} = {} & \alpha_{ij} + \beta_1 \ln GDPpc_{it} + \beta_2 \ln GDPpc_{jt} + \beta_3 \ln Pop_{it} \\ & + \beta_4 \ln Pop_{jt} + \beta_5 \ln Distance_{ij} + \beta_6 Adjacency_{ij} \\ & + \beta_7 Language_{ij} + \beta_8 EU_{ij} + \beta_9 \ln NTBTsp_j + \theta_t + \varepsilon_{ijt} \end{aligned} \quad (8)$$

[78] Replacing the transport specific NTB variable with the total services NTB measure used in earlier equations does not change the results for transport services.

No specific variable measuring barriers to the import of government services is provided by the APC, therefore the total services NTB variable is included in the model to give (9).[79] As with transport and travel services, the NTB variable is again not found to be statistically significant.

$$\begin{aligned} \ln M_{ijt} = {} & \alpha_{ij} + \beta_1 \ln GDPpc_{it} + \beta_2 \ln GDPpc_{jt} + \beta_3 \ln Pop_{it} \\ & + \beta_4 \ln Pop_{jt} + \beta_5 \ln Distance_{ij} + \beta_6 Adjacency_{ij} + \beta_7 Language_{ij} \\ & + \beta_8 EU_{ij} + \beta_{10} \ln NTBTotal_j + \theta_t + \varepsilon_{ijt} \end{aligned} \tag{9}$$

To measure NTBs in commercial services, a TRI measuring restrictions in the banking sector is the primary source for the variable ($\beta_{11} \ln NTBComm_j$) added to equation (5) to give (10). This sector is broader than simply banking and services but this TRI provides the closest match and it is reasonable to assume that banking and financial services account for a large share of the total value of commercial services. For a small number of countries for which a TRI is not provided, a coverage ratio for business and financial services is used (correlation coefficient of 0.76). Once again, the results show that the variable does not significantly influence trade flows (table 4.7, third panel).

$$\begin{aligned} \ln M_{ijt} = {} & \alpha_{ij} + \beta_1 \ln GDPpc_{it} + \beta_2 \ln GDPpc_{jt} + \beta_3 \ln Pop_{it} \\ & + \beta_4 \ln Pop_{jt} + \beta_5 \ln Distance_{ij} + \beta_6 Adjacency_{ij} + \beta_7 Language_{ij} + \beta_8 EU_{ij} \\ & + \beta_9 \ln EcoFree_i + \beta_{10} \ln EcoFree_j + \beta_{11} NTBComm_j + \theta_t + \varepsilon_{ijt} \end{aligned} \tag{10}$$

The results from the inclusion of the NTB variables are not satisfactory. Only in the case of total services is this variable found to significantly influence trade flows (at the 15 per

[79] Hoekman (1995) provides coverage ratios for education and health and social services but it is not clear from OECD (2003) that these sectors match the commodities included in the government services category.

cent level) and even this result is not particularly robust to changes in the specification of the gravity equation.

Earlier research by Grunfeld and Moxnes (2003) employed the same OECD services trade database and a similar NTB variable (also based on the same TRI). The NTB variable is found to be significant at the 1 per cent level in most of their models. They use pooled OLS with exporting country fixed effects (the authors do not state how they specify their fixed effects model). Applying this approach to the dataset used in this chapter, similar results to Grunfeld and Moxnes (2003) are found, with the NTB variable significant at the 5 per cent level for total services imports. However, as discussed above, the HTM has been found to be the most appropriate estimator in this case and use of the pooled OLS does not allow for the richness of the panel data database to be fully exploited.

4.5.2 Tariff Equivalents

The model predictions from the previous section are used to calculate tariff equivalents of the impact of NTBs on services trade. As the inclusion of the various NTB variables is only found to be statistically significant in the case of total services, this methodology cannot be applied to the four disaggregated service sectors.

Several approaches to estimating tariff equivalents using gravity models exist. This research follows the approach of Park (2002). Tariff equivalents are calculated using equation (11).

$$T = \left[M_P / M_{FT} - B_P / B_{FT} \right]^{1/-e} \qquad (11)$$

T is the power of the tariff equivalent (1+t). M_P and M_{FT} are the predicted and free trade levels of imports of services respectively. The former is based on the gravity model prediction of imports and the latter is calculated as the predicted level of trade if all barriers to services trade were abolished. As is standard in the literature (e.g., Francois, 2001), the import ratio is measured relative to a free trade benchmark ratio (B_P and B_{FT}). The benchmark is taken to be the country with the lowest level of restrictions, reflected in the closeness of predicted and free trade levels of imports, which is the Netherlands in this case.

The elasticity of substitution e is assumed to be 1.95. A wide range of estimates for e exist in the literature, the figure used here is from the GTAP database. It is a trade weighted elasticity of substitution for the services sector as a whole. The elasticities in the current version of the GTAP database are based on estimates by Hertel *et al.* (2004). The resulting tariff equivalents are sensitive to the elasticity used. Park (2002) uses a figure of 5.6 for all sectors, Francois *et al.* (2003) use elasticities between 1.26 and 1.68 for different service sectors. Earlier research by Francois (2001) used an elasticity of 4 for overall services trade.

From equation (11), the tariff equivalents of the barriers to trade flows between each bilateral trading pair of countries are calculated. As it is not feasible to report the full set of tariff equivalents between each country and all of its trading partners, the average import tariff equivalents for each country are shown in table 4.9.

The average tariff equivalents range from 0 to 125 per cent, with a mean of 72 per cent. For a number of countries no figure is reported, these are countries that appear in the services trade database but for which no measure of NTBs is available.

In general, the highest tariff equivalents are found in developing countries (such as Brazil, Morocco or Indonesia). Barriers to trade in Asian countries appear to be particularly large, with the exception of Japan and Hong Kong. Even countries that are traditionally open to trade (e.g., Singapore) are found to have high tariff equivalents.

The average for the EU15 countries is 48 per cent (this rises to 57 per cent with the inclusion of the ten new member states). Amongst the EU members, the figures vary widely. The Netherlands, Belgium-Luxembourg and the UK have low or zero tariff equivalents, while Austria, Italy and Greece have relatively high barriers (74, 75 and 84 per cent respectively).

The relative level of protection in each country is closely correlated with its TRI (shown in table 4.8). In some cases the use of the average of the sectoral TRIs to calculate the total TRI can hide variation within a country. For example, Portugal and Singapore are estimated to have similar levels of tariff equivalents but in the case of Singapore there is considerably more variation across the seven sectoral TRIs than Portugal.

Direct comparisons with earlier research by Hoekman (1995), Francois *et al.* (2003) and Park (2002) are difficult. Hoekman's tariff equivalents are relative to a "guess-estimate" of the tariff in the most protectionist country. Francois *et al.* and Park employ similar methodologies, but both use different elasticity parameters. In addition, all three provide tariff equivalents at the sectoral level, rather than for total services trade and the country

coverage differs. However, some similarities and differences in the relative levels of protection between countries are notable.

Francois *et al.* (2003) calculate the tariff equivalent of the Netherlands to be zero across all sectors, as found for total services in this research (Park, 2002, also finds relatively low barriers for the Netherlands). Similarly, low levels of protection are also found for other EU countries such as Germany and Belgium in all three studies. In contrast to the results in this chapter, the UK is found to have relatively higher levels of protection in many sectors in Park. For the United States and Canada, Park also finds relatively high levels of protection but Francois *et al.* calculate low tariff equivalents for North America. Similar patterns exist for Asian countries in this chapter and in Park, both find them to be relatively protectionist. Francois *et al.* estimate very low tariff equivalents for their aggregate high-income and other Asia regions.

4.6 Conclusion

This chapter employs a gravity model approach to analyse the determinants of services trade and to measure the importance of non-tariff barriers on trade in services. Using an OECD database providing total services imports as well as imports for four sub-sectors (travel, transport, government and other commercial) a variety of panel data estimators are applied and tested.

The Hausman-Taylor model is used to estimate the gravity equation for services for the first time. It is found to be superior to the random effects model, which typically suffers from heterogeneity bias in the gravity model, and avoids the problems associated with dealing with time-invariant variables using a fixed-effects model.

The standard gravity framework explains the determinants of services well. The GDP per capita of the importing and exporting countries and a common language are found to be the most important determinants of trade between two countries. Unlike trade in goods, adjacency and membership of the European Union are not found to increase services trade. The results also confirm some earlier research suggesting that distance is not a significant determinant of services trade flows.

A variable measuring the NTBs to trade in each importing country, primarily based on trade restrictiveness indexes of the APC, is added to the gravity equation to calculate a set of tariff equivalents of the restrictions to services trade. The NTB variable is only found to be weakly significant (at the 15 per cent level) in the case of total services and not at all for the four sub-sectors.

Rather than contradicting the established view that barriers to services trade are important, this highlights the problem of collecting accurate data on such barriers. Data on services flows have only recently become available but they are still limited. Barriers to services trade are wide ranging and reflect the heterogeneous nature of services products. Compiling and categorising restrictions is difficult and their quantification even more so, but progress needs to be made in this area for the effects of restrictions to be properly understood. This issue has wider implications. With the share of services in world trade increasing, it becomes ever more important to be able to accurately model services trade and estimate the impact of changes in restrictions on trade flows.

4.7 Tables

Table 4.1: Summary Statistics

Variable	Mean	Standard Deviation	Minimum	Maximum
Distance	5,512	4,586	57	19,564
GDP pc – importer [a]	17,198	11,131	326	37,992
Population – importer	66,700,000	180,000,000	266,080	1,270,000,000
GDP pc – exporter [a]	16,970	11,229	326	37,992
Population – exporter	69,300,000	185,000,000	266,080	1,270,000,000
Adjacency	0.057	0.233	0	1
Language	0.080	0.271	0	1
EU	0.128	0.334	0	1

[a] In US dollars.

Source: own calculations.

Table 4.2: Spearman Rank Correlation Coefficients

	Distance	GDP pc – importer	Pop – importer	GDP pc – exporter	Pop – exporter	Adjacency	Language	EU
Distance	1.00							
GDP pc – importer	-0.05	1.00						
	(0.00)							
Population – importer	0.21	-0.19	1.00					
	(0.00)	(0.00)						
GDP pc - exporter	-0.06	-0.23	-0.01	1.00				
	(0.00)	(0.00)	(0.41)					
Population – exporter	0.22	-0.04	0.03	-0.21	1.00			
	(0.00)	(0.02)	(0.11)	(0.00)				
Adjacency	-0.35	0.03	-0.03	0.04	-0.03	1.00		
	(0.00)	(0.07)	(0.12)	(0.03)	(0.07)			
Language	0.06	0.06	0.02	0.07	0.02	0.22	1.00	
	(0.00)	(0.00)	(0.15)	(0.00)	(0.35)	(0.00)		
EU	-0.37	0.17	-0.06	0.17	-0.07	0.17	0.02	1.00
	(0.00)	(0.00)	(0.01)	(0.00)	(0.00)	(0.00)	(0.56)	

Significance levels in brackets

Source: own calculations.

Table 4.3: Total Services

	I	II	III	IV	V
Estimator	Pooled OLS	REM	FEM[a]	HTM	HTM
Dependent Variable	Total Services Imports				
GDP per capita – importer	1.110***	1.113***	1.111**	1.257***	1.114***
	[0.019]	[0.030]	[0.459]	[0.412]	[0.418]
GDP per capita – exporter	1.037***	1.044***	0.722	0.841**	0.037
	[0.019]	[0.029]	[0.452]	[0.411]	[0.456]
Population – importer	0.826***	0.829***	0.117	1.058	0.649
	[0.014]	[0.022]	[1.178]	[0.809]	[0.804]
Population – exporter	0.789***	0.790***	-1.146	-0.371	1.23
	[0.014]	[0.023]	[1.154]	[0.885]	[0.944]
Distance	-0.694***	-0.710***	0.339***	0.386	-0.525
	[0.022]	[0.035]	[0.052]	[1.191]	[0.873]
Adjacency	0.427***	0.442***	2.080***	-0.06	0.281
	[0.091]	[0.147]	[0.232]	[2.326]	[0.740]
Language	1.311***	1.317***	1.199***	1.135***	1.424***
	[0.069]	[0.111]	[0.179]	[0.435]	[0.255]
EU	0.238***	0.226**	0.820***	10.654	2.182
	[0.065]	[0.107]	[0.155]	[17.211]	[4.383]
NTB - Total					-1.136
					[0.790]
Constant	-37.200***	-37.265***	4.925	-30.972***	-38.907***
	[0.508]	[0.794]	[32.348]	[10.521]	[12.148]
Observations	3820	3820	3820	3820	3312
Country pairs	1456	1456	1456	1456	1253
Adjusted R^2	0.7356	0.7359			
Hausman Test: χ^2 (6)			14.61**		
Over-Identification Test:χ^2 (6)				1.39	

All continuous variables are expressed in logs. Results for year dummies are not reported.
Standard errors in brackets
* significant at 10%; ** significant at 5%; *** significant at 1%
a Time invariant variables estimated in second step: R^2 = 0.05; Observations = 3820

Source: own calculations.

Table 4.4: Travel Services

	I	II	III
Estimator	HTM	HTM	HTM
Dependent Variable	Travel Services Imports		
GDP per capita – importer	1.659***	1.489***	1.452***
	[0.356]	[0.369]	[0.387]
GDP per capita – exporter	0.111	0.206	0.316
	[0.331]	[0.348]	[0.334]
Population – importer	2.55***	2.453***	1.781*
	[0.965]	[0.838]	[0.928]
Population – exporter	-2.796***	-2.682***	-2.907***
	[0.871]	[0.876]	[0.822]
Distance	0.96	0.577	2.573*
	[1.156]	[0.909]	[1.398]
Adjacency	1.917	1.071	2.756
	[1.445]	[1.583]	[2.238]
Language	1.099*	1.195	1.324
	[0.657]	[0.779]	[1.066]
EU	6.464	7.6	15.408
	[4.561]	[7.238]	[11.784]
Temperature – importer		-0.511	-0.043
		[0.655]	[0.879]
Temperature – exporter		2.078***	2.581***
		[0.599]	[0.685]
NTB - Total			3.787
			[3.796]
Constant	-17.625	-17.82	-15.693
	[15.482]	[13.54]	[16.494]
Observations	3044	2726	2446
Country pairs	1167	1029	907

All continuous variables are expressed in logs. Results for year dummies are not reported.
Standard errors in brackets
* significant at 10%; ** significant at 5%; *** significant at 1%

Source: own calculations.

Table 4.5: Transport Services

	I	III
Estimator	HTM	HTM
Dependent Variable	Transport Services Imports	
GDP per capita – importer	1.008***	0.863*
	[0.391]	[0.513]
GDP per capita – exporter	0.985***	0.739*
	[0.376]	[0.394]
Population – importer	-1.611	-0.301
	[0.985]	[1.073]
Population – exporter	-1.916**	-1.713*
	[0.969]	[1.023]
Distance	3.763***	3.670**
	[1.318]	[1.737]
Adjacency	4.537***	3.782**
	[1.478]	[1.685]
Language	0.524	1.12
	[0.797]	[0.708]
EU	14.944***	14.075**
	[5.003]	[6.306]
NTB - Transport		2.326
		[1.961]
Constant	11.918	-5.987
	[16.93]	[22.070]
Observations	3055	2399
Country pairs	1198	903

All continuous variables are expressed in logs. Results for year dummies are not reported.
Standard errors in brackets
* significant at 10%; ** significant at 5%;
*** significant at 1%

Source: own calculations.

Table 4.6: Government Services

	I	II	III
Estimator	HTM	HTM	HTM
Dependent Variable	Government Services Imports		
GDP per capita – importer	0.988	1.147	0.344
	[0.769]	[0.944]	[1.057]
GDP per capita – exporter	1.936***	1.69**	1.765**
	[0.732]	[0.837]	[0.765]
Population – importer	0.033	1.731	0.849
	[1.621]	[2.297]	[2.268]
Population – exporter	0.971	-0.493	0.525
	[1.114]	[1.406]	[0.823]
Distance	-0.613	-0.405	-1.837
	[1.182]	[2.932]	[2.680]
Adjacency	-1.361	-0.222	-0.563
	[1.130]	[2.841]	[0.893]
Language	0.446	0.842	0.263
	[0.558]	[0.973]	[0.691]
EU	-1.281	-1.092	-9.009
	[5.377]	[10.576]	[12.222]
Economic Freedom – importer		-0.633	
		[0.436]	
Economic Freedom – exporter		-0.345	
		[0.411]	
Government Effectiveness – importer		-0.014	
		[1.507]	
Government Effectiveness – exporter		0.944	
		[1.138]	
NTB - Total			-3.842
			[4.454]
Constant	-37.727***	-42.764*	-33.581*
	[14.241]	[23.918]	[19.955]
Observations	1496	1106	1374
Country pairs	596	432	544

All continuous variables are expressed in logs. Results for year dummies are not reported.
Standard errors in brackets
* significant at 10%; ** significant at 5%; *** significant at 1%

Source: own calculations.

Table 4.7: Commercial Services

	I	II	III
Estimator	HTM	HTM	HTM
Dependent Variable	Commercial Services Imports		
GDP per capita – importer	1.556**	1.702***	1.254*
	[0.62]	[0.602]	[0.739]
GDP per capita – exporter	1.119*	1.15*	1.203*
	[0.613]	[0.599]	[0.654]
Population – importer	0.57	0.713	0.385
	[0.794]	[0.793]	[0.608]
Population – exporter	0.718	0.504	0.322
	[1.424]	[1.418]	[1.667]
Distance	-0.306	-0.23	0.597
	[0.708]	[0.728]	[2.183]
Adjacency	0.487	0.541	1.142
	[0.709]	[0.735]	[1.999]
Language	0.928***	0.998***	0.970**
	[0.310]	[0.323]	[0.436]
EU	1.631	1.769	4.979
	[3.001]	[3.041]	[8.462]
Economic Freedom – importer		0.385	0.095
		[0.33]	[0.361]
Economic Freedom – exporter		0.579*	0.439
		[0.334]	[0.353]
NTB - Commercial			0.804
			[1.344]
Constant	-40.896	-42.819***	-35.733*
	[11.574]	[11.634]	[18.315]
Observations	3077	3065	2736
Country pairs	1209	1204	1062

All continuous variables are expressed in logs. Results for year dummies are not reported.
Standard errors in brackets
* significant at 10%; ** significant at 5%; *** significant at 1%

Source: own calculations.

Table 4.8: Trade Restrictiveness Index

Country	Accounting			Banking			Wholesale and Retail			Maritime		
	Domestic	Foreign	Difference	Domestic	Foreign	Difference	Domestic	Foreign	Difference	Domestic	Foreign	Difference
Argentina	0.11	0.29	0.13	0.00	0.07	0.07	0.05	0.09	0.03	0.10	0.33	0.18
Australia	0.16	0.41	0.18	0.00	0.12	0.12	0.03	0.10	0.06	0.13	0.42	0.22
Austria	0.27	0.57	0.21	0.00	0.07	0.07	0.05	0.19	0.11	0.13	0.35	0.16
Belgium-Lux	0.20	0.35	0.11	0.00	0.07	0.07	0.11	0.25	0.09	0.13	0.30	0.12
Brazil	0.20	0.39	0.13	0.01	0.51	0.49	0.01	0.23	0.20	0.23	0.52	0.20
Canada	0.22	0.42	0.13	0.00	0.07	0.07	0.05	0.19	0.11	0.09	0.32	0.18
Chile	0.10	0.35	0.19	0.29	0.40	0.07	0.06	0.13	0.05	0.12	0.50	0.30
China												
Colombia				0.05	0.23	0.15	0.12	0.19	0.04	0.18	0.47	0.21
Czech Republic												
Denmark	0.20	0.41	0.14	0.00	0.07	0.07	0.09	0.27	0.13	0.08	0.28	0.16
Egypt												
Finland	0.10	0.14	0.03	0.00	0.07	0.07	0.05	0.24	0.16	0.11	0.32	0.15
France	0.24	0.31	0.04	0.00	0.07	0.07	0.18	0.33	0.09	0.13	0.33	0.15
Germany	0.22	0.39	0.11	0.00	0.07	0.07	0.10	0.24	0.10	0.19	0.39	0.13
Greece	0.18	0.32	0.09	0.00	0.07	0.07	0.05	0.27	0.19	0.13	0.28	0.10
Hong Kong	0.20	0.32	0.07	0.04	0.09	0.04	0.03	0.05	0.02	0.09	0.40	0.26

Table 4.8 Trade Restrictiveness Index - Continued

Country	Telecommunications			Engineering			Legal			Average		
	Domestic	Foreign	Difference	Domestic	Foreign	Difference	Domestic	Foreign	Difference	Domestic	Foreign	Difference
Argentina	0.29	0.29	0.00	0.01	0.15	0.12				0.09	0.20	0.09
Australia	0.04	0.04	0.00	0.04	0.08	0.03	0.27	0.42	0.10	0.09	0.23	0.10
Austria	0.13	0.13	0.00	0.20	0.39	0.12	0.33	0.57	0.15	0.16	0.32	0.12
Belgium-Lux	0.13	0.18	0.03	0.05	0.06	0.01	0.21	0.31	0.06	0.11	0.21	0.07
Brazil	0.21	0.31	0.06	0.04	0.23	0.16				0.12	0.37	0.21
Canada	0.14	0.44	0.23	0.11	0.16	0.03	0.31	0.52	0.13	0.13	0.30	0.13
Chile	0.09	0.09	0.00	0.00	0.24	0.24				0.11	0.28	0.14
China	0.41	0.81	0.27							0.41	0.81	0.27
Colombia	0.20	0.46	0.18							0.14	0.34	0.15
Czech Republic	0.27	0.47	0.13							0.27	0.47	0.13
Denmark	0.03	0.03	0.00	0.01	0.04	0.02	0.15	0.43	0.21	0.08	0.22	0.10
Egypt	0.43	0.63	0.12							0.43	0.63	0.12
Finland				0.01	0.06	0.04	0.03	0.14	0.10	0.05	0.16	0.09
France	0.05	0.21	0.13	0.03	0.03	0.00	0.22	0.58	0.27	0.12	0.27	0.11
Germany	0.05	0.05	0.00	0.20	0.28	0.05	0.29	0.49	0.12	0.15	0.27	0.08
Greece	0.26	0.46	0.13	0.05	0.20	0.12	0.10	0.37	0.21	0.11	0.28	0.13
Hong Kong	0.21	0.21	0.00	0.08	0.13	0.03	0.08	0.27	0.15	0.10	0.21	0.08

Table 4.8: Trade Restrictiveness Index - Continued

Country	Accounting			Banking			Wholesale and Retail			Maritime		
	Domestic	Foreign	Difference	Domestic	Foreign	Difference	Domestic	Foreign	Difference	Domestic	Foreign	Difference
Hungary												
India	0.31	0.44	0.08	0.05	0.60	0.51	0.15	0.32	0.12	0.25	0.61	0.25
Indonesia	0.00	0.56	0.56	0.07	0.55	0.42	0.09	0.32	0.17	0.21	0.56	0.25
Ireland				0.00	0.07	0.07	0.05	0.19	0.11	0.15	0.35	0.14
Italy	0.13	0.43	0.23	0.00	0.07	0.07	0.14	0.29	0.11	0.18	0.38	0.14
Israel												
Ivory Coast												
Japan	0.28	0.43	0.09	0.13	0.19	0.04	0.20	0.25	0.03	0.15	0.41	0.19
Malaysia	0.09	0.51	0.36	0.27	0.65	0.26	0.09	0.40	0.26	0.25	0.52	0.18
Mexico	0.14	0.36	0.16	0.00	0.17	0.17	0.00	0.11	0.11	0.17	0.48	0.23
Morocco												
Netherlands	0.19	0.22	0.02	0.00	0.07	0.07	0.09	0.24	0.10	0.15	0.35	0.14
New Zealand	0.21	0.39	0.13	0.00	0.06	0.06	0.00	0.06	0.06	0.10	0.35	0.19
Norway												
Pakistan												
Philippines	0.29	0.63	0.23	0.14	0.53	0.30	0.06	0.37	0.27	0.17	0.64	0.37
Poland												

Table 4.8: Trade Restrictiveness Index - Continued

Country	Telecommunications			Engineering			Legal			Average		
	Domestic	Foreign	Difference	Domestic	Foreign	Difference	Domestic	Foreign	Difference	Domestic	Foreign	Difference
Hungary	0.28	0.53	0.16							0.28	0.53	0.16
India	0.39	0.69	0.19	0.00	0.10	0.10	0.09	0.40	0.26	0.18	0.45	0.22
Indonesia	0.34	0.67	0.22	0.05	0.24	0.15	0.17	0.57	0.31	0.13	0.50	0.30
Ireland	0.19	0.35	0.10							0.10	0.24	0.11
Italy	0.14	0.14	0.00	0.16	0.17	0.01	0.18	0.54	0.27	0.13	0.29	0.12
Israel	0.29	0.53	0.16							0.29	0.53	0.16
Ivory Coast	0.21	0.41	0.13							0.21	0.41	0.13
Japan	0.04	0.04	0.00	0.14	0.18	0.02	0.33	0.52	0.12	0.18	0.29	0.07
Malaysia	0.24	0.58	0.24	0.08	0.26	0.13	0.13	0.54	0.33	0.17	0.50	0.25
Mexico	0.23	0.53	0.21	0.04	0.33	0.26	0.22	0.49	0.19	0.11	0.35	0.19
Morocco	0.50	0.90	0.26							0.50	0.90	0.26
Netherlands	0.03	0.03	0.00	0.09	0.10	0.00	0.10	0.25	0.11	0.09	0.18	0.06
New Zealand	0.03	0.03	0.00	0.00	0.19	0.19	0.13	0.47	0.27	0.07	0.22	0.13
Norway	0.17	0.17	0.00							0.17	0.17	0.00
Pakistan	0.35	0.55	0.12							0.35	0.55	0.12
Philippines	0.13	0.45	0.25	0.00	0.15	0.15	0.10	0.54	0.36	0.13	0.47	0.28
Poland	0.36	0.66	0.20							0.36	0.66	0.20

Table 4.8: Trade Restrictiveness Index - Continued

Country	Accounting			Banking			Wholesale and Retail			Maritime		
	Domestic	Foreign	Difference	Domestic	Foreign	Difference	Domestic	Foreign	Difference	Domestic	Foreign	Difference
Portugal	0.26	0.41	0.10	0.00	0.07	0.07	0.05	0.21	0.13	0.08	0.26	0.13
Singapore	0.18	0.41	0.16	0.11	0.37	0.21	0.03	0.07	0.03	0.10	0.21	0.07
South Africa	0.10	0.44	0.28	0.00	0.19	0.19	0.03	0.07	0.03			
South Korea	0.24	0.48	0.16	0.19	0.43	0.16	0.26	0.33	0.04	0.28	0.58	0.20
Spain	0.20	0.31	0.06	0.00	0.07	0.07	0.08	0.22	0.11	0.19	0.39	0.14
Sweden	0.18	0.44	0.19	0.00	0.07	0.07	0.07	0.21	0.11	0.17	0.42	0.18
Switzerland	0.08	0.27	0.15	0.00	0.08	0.08	0.16	0.33	0.11	0.10	0.35	0.20
Thailand	0.19	0.49	0.21	0.00	0.39	0.39	0.06	0.39	0.29	0.13	0.60	0.38
Trinidad & Tobago												
Turkey	0.09	0.41	0.27	0.05	0.37	0.29	0.06	0.13	0.04	0.08	0.49	0.36
United Kingdom	0.18	0.19	0.01	0.00	0.07	0.07	0.05	0.19	0.11	0.06	0.24	0.14
United States	0.20	0.33	0.08	0.00	0.06	0.06	0.00	0.16	0.16	0.17	0.60	0.33
Uruguay				0.14	0.46	0.24	0.02	0.06	0.03			
Venezuela				0.00	0.17	0.17	0.11	0.26	0.11			
Yugoslavia												

Table 4.8: Trade Restrictiveness Index - Continued

Country	Telecommunications			Engineering			Legal			Average		
	Domestic	Foreign	Difference	Domestic	Foreign	Difference	Domestic	Foreign	Difference	Domestic	Foreign	Difference
Portugal	0.31	0.51	0.12	0.18	0.33	0.10	0.21	0.41	0.13	0.16	0.31	0.11
Singapore	0.34	0.44	0.06	0.01	0.11	0.09	0.08	0.42	0.29	0.12	0.29	0.13
South Africa	0.39	0.59	0.12	0.01	0.10	0.07				0.10	0.28	0.14
South Korea	0.35	0.68	0.22	0.00	0.12	0.12	0.11	0.44	0.27	0.20	0.44	0.17
Spain	0.21	0.41	0.13	0.17	0.24	0.04	0.31	0.45	0.09	0.16	0.30	0.09
Sweden	0.10	0.10	0.00	0.01	0.17	0.14	0.12	0.27	0.10	0.09	0.24	0.11
Switzerland	0.20	0.20	0.00	0.05	0.15	0.07	0.24	0.50	0.17	0.12	0.27	0.11
Thailand	0.43	0.79	0.23	0.04	0.11	0.05	0.10	0.44	0.27	0.14	0.46	0.26
Trinidad & Tobago	0.39	0.69	0.19							0.39	0.69	0.19
Turkey	0.47	0.80	0.21	0.18	0.37	0.13	0.26	0.58	0.23	0.17	0.45	0.22
United Kingdom				0.03	0.07	0.03	0.18	0.31	0.09	0.08	0.18	0.08
United States	0.03	0.03	0.00	0.12	0.19	0.05	0.24	0.48	0.16	0.11	0.27	0.12
Uruguay	0.35	0.55	0.12							0.17	0.36	0.13
Venezuela	0.36	0.56	0.12							0.15	0.33	0.14
Yugoslavia	0.40	0.80	0.27							0.40	0.80	0.27

Source: Findlay and Warren (2000)

Notes: the domestic index measures non-discriminatory barriers only; the foreign index measures both discriminatory and non-discriminatory barriers; the difference between the two is taken to indicate the level of discrimination against foreign service providers. Average is the un-weighted mean of the seven sectoral measures.

Table 4.9: Average Import Tariff Equivalent by Country

Importer	Tariff Equivalent (%)	Importer	Tariff Equivalent (%)
Albania	-	Japan	0.0
Argentina	39.2	Latvia	-
Australia	56.3	Lithuania	-
Austria	74.3	Malaysia	119.6
Bahamas	-	Malta	-
Barbados	-	Mexico	108.0
Belarus	-	Morocco	120.2
Belgium-Luxembourg	0.0	Netherlands	0.0
Brazil	112.3	New Zealand	82.8
Bulgaria	-	Nicaragua	-
Canada	81.7	Nigeria	-
Chile	90.8	Norway	0.0
China	121.3	Pakistan	78.3
Colombia	92.3	Philippines	122.7
Costa Rica	-	Poland	109.5
Croatia	-	Portugal	69.1
Cyprus	-	Romania	-
Czech Republic	81.8	Russia	-
Denmark	60.2	Saudi Arabia	-
Egypt	75.5	Senegal	-
El Salvador	-	Singapore	83.5
Estonia	-	Slovak Republic	-
Finland	41.0	Slovenia	-
France	64.0	South Africa	89.2
Germany	26.0	South Korea	101.2
Greece	83.9	Spain	42.8
Guatemala	-	Sweden	70.1
Honduras	-	Switzerland	69.5
Hong Kong	18.3	Thailand	120.9
Hungary	100.1	Trinidad & Tobago	109.0
Iceland	-	Turkey	114.3
India	113.7	Ukraine	-
Indonesia	124.8	United Arab Emirates	-
Iran	-	United Kingdom	3.9
Ireland	63.9	United States	77.0
Israel	96.7	Uruguay	85.6
Italy	75.0	Venezuela	87.2
Ivory Coast	85.4	Vietnam	-
Jamaica	-	Yugoslavia	121.4

Source: own calculations.

CHAPTER 5

THE ECONOMIC CONSEQUENCES OF THE DOHA ROUND FOR IRELAND

5.1 Introduction

This chapter provides a quantitative study of the economic effects of a simulation of trade liberalisation for Ireland using the Global Trade Analysis Project (GTAP) model and database. The experiment incorporates the liberalisation of agricultural, industrial and services trade, as well as measures to improve trade facilitation. The simulation is implemented against a baseline projection of the Irish and world economy over the next decade. It is a stylised simulation, designed to illustrate the broad effects of further trade liberalisation.

The context for the trade liberalisation simulation in this chapter is the Doha Round of World Trade Organisation (WTO) trade negotiations. A successful outcome to this Round would have long-term effects for all countries involved. This chapter examines the consequences of further trade liberalisation on the Irish economy. The nature of the GTAP model means that Ireland is not seen in isolation, rather as an interdependent part of the world economy.

This chapter is structured as follows. The next section outlines the development of the Doha Round and its implications for the Irish economy. Section 5.3 summarises the

GTAP model and database and the process of projecting the world and Irish economy forward to 2014 to create a baseline against which to compare the results of the trade liberalisation simulation. Sections 5.4 and 5.5 outline the trade liberalisation scenario simulated in this chapter and the results of the simulation. Section 5.6 presents the conclusions.

5.2 The Doha Round and the Contribution of this Research

The WTO launched the Doha Round of trade negotiations in the Qatari capital in November 2001. The Doha negotiations are comprehensive both in terms of their country coverage (there are now one hundred and fifty member countries of the WTO) and sector coverage (they cover liberalisation of agricultural, industrial and services trade as well as the clarification of WTO rules).

Progress in the negotiations has been slow. The Seattle Ministerial in December 1999 was originally intended to launch the new Round. Following the Doha Declaration, the initial deadline for completion of negotiations was set for 2005. The failure of the Cancun Ministerial in September 2003 caused a further delay. In July 2004 a framework for further negotiations was established, with the aim of achieving substantial progress on the modalities of the Round by the Hong Kong Ministerial Council in December 2005. However, this target was also missed and at the time of writing the negotiations have been suspended indefinitely.

Due to the lack of progress on addressing the details of the modalities, the trade liberalisation simulation modelled in this chapter is a stylised scenario. It examines the implications of broad measures to further liberalise and facilitate trade on the Irish

economy. However, like the simulations in chapter 3, it does incorporate some elements of the July 2004 Framework.

The aim of this chapter is to quantify the effects of the potential outcomes of Doha. The Round has been termed the Doha Development Agenda, as one the principal ambitions set out in the Doha Declaration is that this Round should consider the needs of developing countries and that its outcome should be beneficial to them. This chapter focuses on the specific outcomes of the trade liberalisation scenarios for Ireland, chapter 6 then analyses the implications for developing countries.

Although the Doha Round is just under five years old, much analysis has already been undertaken by both international agencies and other bodies. However, there has been no full-scale study of the impact of further trade liberalisation on the Irish economy to date. Matthews and O'Toole (2003) employ the results of a global study carried out by the Dutch research institute LEI (Francois *et al.*, 2003) to generate shocks simulating the effects of further trade liberalisation for the EU. These shocks were then subsequently used with a national computable general equilibrium (CGE) model of the Irish economy to generate indirect estimates of the impact on Ireland. The effectiveness of this indirect approach is limited. In particular, it does not allow for a detailed decomposition of results nor an understanding of what is driving them, as is the case when shocks are applied directly to a model in which Ireland is individually distinguished. Matthews and O'Toole also highlight the potential for error in assuming that the shocks experienced by the rest of the EU would be relevant to the Irish economy.

This chapter examines specifically the effects of further trade liberalisation on Ireland. As a small open economy with numerous export oriented sectors, quantification of likely

outcomes of the Doha Round for Ireland is particularly important. Given the preferential access which Ireland enjoys to other EU country markets as a member of the EU, the effects of further liberalisation of world trade are ambiguous. Liberalisation leads to an erosion of these preferential benefits which are particularly important in the case of agricultural trade. This research quantifies directly for the first time the relative importance of the various effects.

5.3 Methodology

The empirical work undertaken in this chapter employs the GTAP CGE model and database. The structure of the model and database are fully documented in chapter 2. GTAP is a powerful tool enabling quantitative analysis of trade issues. Because CGE models emphasise the impact of reallocating resources across sectors of an economy, they are useful tools for identifying winners and losers under a policy change. GTAP in particular, with its wide country coverage and extensive database, is designed for precisely this task.

5.3.1 Model Closure and Aggregation

A standard general equilibrium closure is used in all simulations in this research. This implies all prices (except the numeraire), regional incomes and quantities of producible commodities are determined endogenously.[80] Tax (or subsidy) rates, technology and factor endowments are exogenously fixed. A medium-term closure is assumed. Labour and capital are assumed to be perfectly mobile between sectors. Land and natural resources are imperfectly mobile (or sluggish) between sectors. No factor endowments are mobile

[80] Because all prices are endogenous in a CGE model, one price (or price index) must be chosen as a numeraire in which to express relative price changes. In this closure, the numeraire is a composite world price index of primary factors.

between regions and all are assumed to be fully employed within regions (there is no unemployment of labour or capital). In terms of macroeconomic closure, investment is savings driven and the current balance is assumed to be exogenous.

In this chapter, Ireland is distinguished as a separate region, allowing for the discussion of scenario outcomes at both national and global levels. The three largest EU economies as well as the US, Canada, China and India are also individually represented. Nine agrifood sectors have been distinguished, consisting both of primary agriculture and processed products. There are also nine manufacturing industries (including electronics, textiles and chemical products sectors separately distinguished) and five service sectors. Table 5.1 shows the regional and sector aggregation and tables 5.2.1 and 5.2.1 shows the mapping of the eighty-seven regions and fifty-seven sectors distinguished in the GTAP database to the aggregation employed here.

5.3.2 Construction of the Baseline 2001 to 2014

The base year of the current version of the GTAP database is 2001. Since then, a number of important trade policy developments have taken place. Furthermore, even if WTO negotiations reach a successful conclusion in the near future, the time-span for the implementation and impact of reforms will stretch over a number of years. With this in mind, the base data is projected forward until 2014 to allow more realistic modelling of the effects of any agreement.

The construction of this baseline is undertaken by running a pre-simulation experiment, the outcome of which is used as a baseline against which to compare the results of the trade liberalisation scenarios implemented in the study. The construction of the baseline is divided into two components. Firstly, policy changes, both events that have already

occurred since 2001 and those that are expected to occur in the future, are implemented to create a more realistic policy landscape. Secondly, macroeconomic projections are used to simulate the expected changes to the world economy between the dates in question. This pre-experiment is described in detail in the thesis appendix II, but a summary is provided in this section.

The structural changes to the world economy included in this baseline are: the accession of the People's Republic of China to the WTO; the Agenda 2000 and Mid-term Review (MTR) reforms of the Common Agricultural Policy (CAP) of the EU; the accession of twelve central and eastern European countries to the EU; the full implementation of the Everything But Arms (EBA) Agreement between the EU and fifty of the world's least developed countries (EC, 2001); and the elimination of Multi-Fibre Agreement textile quotas as foreseen under the WTO Agreement on Textiles and Clothing.[81]

As noted in chapter 3, there is some disagreement regarding the appropriateness of including the CAP MTR and indeed the EU's EBA scheme as part of the baseline in measuring the impact of the Doha Round Agreement. Arguably, the starting point for a new Agreement is the Uruguay Round baseline of bound tariffs, export subsidy disciplines and ceilings on trade-distorting domestic support. The implication of this is that undertaking the MTR should be considered an element of the EU's offer in the Doha Round negotiations. Similarly, part of the motivation for the introduction of the EBA scheme was to bolster its credentials in supporting a pro-development outcome in these

[81] Russia is also assumed to join the WTO during the baseline period. The terms of accession are not specifically modelled, but Russia is assumed to participate in the liberalisation scenarios based on its tariff structure in 2001.

negotiations (Matthews and Gallezot, 2006). This should be taken into account when analysing the results.[82]

The second phase in constructing the baseline to 2014 is to shock factor endowments in the model following the approach of Walmsley *et al.* (2000). These shocks are based on forecasts of factor growth rates over the baseline period. Gross Domestic Product (GDP), skilled and unskilled labour, population and capital stock in each region are shocked. The main source is Brockmeier and Salamon (2003) with additional data from Jensen and Frandsen (2003). For Ireland, data from the Economic and Social Research Institute (2003) have been used to further augment these forecasts. The details of these factor endowment shocks are shown in the thesis appendix II.

The initial pre-simulation experiment suggested an unrealistically high growth of agricultural production in the EU, evaluated on the basis of expert opinion. In the baseline represented here, the growth of primary agricultural sectors has been constrained to target the growth rates expected (in the absence of policy change) in the most recent European Commission (2004b) forecast of the likely market balance for agricultural products up to 2014. The same growth rates were applied to each of the separate EU countries and regions distinguished in the model database.

5.3.3 The EU Agricultural Budget Module

In the standard GTAP model there is no direct link between tax revenue and government expenditure and there is no explicit representation of the EU budget. Agricultural

[82] The discussion in chapter 3 also notes that this approach does not consider that the quotas which exist as a result of the EU's Common Agricultural Policy and the EBA scheme imply the existence of quota rents. These are likely to have important political economy consequences that are not considered in this analysis.

subsidies (direct payments, input and output subsidies, market price support and export subsidies) in Ireland are assumed entirely financed through national sources, and there are no intra-European revenue or expenditure flows. This underestimates the negative impact of reforms which lower market prices and thus the inflow of CAP funds for a net exporting country in the EU.

To accurately model shocks such as enlargement or, at a later stage, to simulate the effects of trade liberalisation within a regional union such as the EU, the standard GTAP model is extended to incorporate an EU agricultural budget module based on the approach of Brockmeier (2003). This is accomplished via the addition of a new social accounting matrix that moves the EAGGF revenues and expenditures from member countries or regions to the EU budget. The EU collects 75 per cent of import tariff revenues from agents in the model and a GDP tax is levied on the member regions. This tax is determined endogenously to ensure the overall EU agricultural budget is balanced and it thus approximates both the VAT and GDP elements of revenue that accrue to the EU. The difference between revenues and expenditures of each member state is the net transfer to that region arising from the operation of the CAP. The sum of the net transfers of each region is zero to ensure that the overall agricultural budget balances. To avoid misunderstanding, it should be stressed that what is being modelled here is the EU agricultural budget, and not the full EU budget. Structural fund contributions, for example, are excluded. This should be borne in mind when interpreting the budget figures later in this chapter.

5.3.4 The Irish Economy in 2014

This section describes the structure of the Irish economy in 2014 following the updating of the baseline as described in the previous section. The impact of WTO liberalisation will

be determined by both the production and consumption structure of the economy and by the structure of protection assumed in the baseline in that year, rather than the economic and protection structures in 2001. It is a stylised representation of the Irish economy, and is not intended to capture detailed projections of individual sectors.

The growth rate assumed for Ireland over the baseline period is greater than the other EU countries. Between 2001 and 2014, GDP increases by eighty per cent, capital more than doubles, and the population and labour force increase by between seven and ten per cent.

Table 5.3 shows the structure of the Irish economy, including trade flows, output and domestic consumption, before and after the changes described in the section above are implemented. This provides a baseline against which to compare the results of the simulation to follow. The importance of intra-EU trade to Ireland is a key factor underlying many of these results, hence the value for Ireland of intra-EU and extra-EU trade are indicated.[83]

All non-agricultural sectors expand in line with the projected overall growth of the economy over the period. As noted in section 5.3.2, the growth in the primary agricultural sectors, apart from sugar and raw milk, is constrained to meet forecasts for output growth in the EU as a whole. Output of sugar and raw milk is assumed constrained by quota. Domestic consumption of all commodities, except for other livestock, increases, in particular chemical and petroleum products and other private services.

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[83] The 2001 figures in table 5.3 reflect those in the GTAP database. These data underestimate the degree of self-sufficiency for some agrifood sectors, for example, beef and sheepmeat and dairy products, and this caveat should be noted in interpreting the results.

At a more aggregated level the growth of output in agriculture trails far behind industry and services (table 5.4). As incomes increase and a region becomes richer, consumption tends to shift from primary commodities to industrial goods and services. In the case of Ireland in 2014, the increase in industrial output compared with 2001 is particularly strong, reflecting the open, export-orientated nature of the economy. The increase in industrial output is driven by an increase in demand for Irish exports.

The levels of trade protection applied to Irish imports and exports in 2001 and 2014 by industry are shown in table 5.5. The data are calculated as the ratio of tariff revenue collected to the value of trade at world prices, and thus represent trade-weighted average applied tariffs by sector.[84] The calculated applied tariffs on 'All Trade' are lower than those shown for 'Extra-EU Trade' as they take into account the zero tariffs that apply on intra-EU trade. The dramatically higher levels of protection for some of the agrifood sectors stand out.

Figure 5.1 shows the applied trade protection for Irish exports and imports by source and destination. The only notable changes are the elimination of barriers to trade between Ireland and the new EU members and of import tariffs levied on commodities exported from the EBA countries entering the EU. This is particularly important in the case of sugar.

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[84] These tariff values may be sensitive to very small volumes of trade in some sectors. Also, the method of calculating average tariffs may underestimate the degree of protection provided to Irish agriculture, to the extent that the volume of imports at world prices may represent preferential import prices rather than the 'true' world price. This is likely to be important in the case of sugar, for example, where EU import values reflect the price paid to ACP exporters that is linked to the EU producer price rather than the world price.

5.4 Trade Liberalisation: Negotiation and Simulation

5.4.1 What's Under Negotiation in the Doha Round?

The Doha negotiations are comprehensive both in terms of their country coverage and sectoral coverage. They cover liberalisation of agricultural, industrial and services trade as well as clarification of WTO rules. This section outlines some the main issues under discussion in the Doha negotiations. The actual trade liberalisation simulation implemented is then described in section 5.4.2.

As noted previously, the negotiations are currently suspended. The Framework agreed in July 2004 (WTO, 2004) provides a structure for negotiations towards a final agreement. The description in the following section also provides some indications of the state of play in the negotiations at the time of the suspension of the Round. However, as there are few specific figures or targets, the scenario constructed is a stylised simulation of further liberalisation. This does not seek to approximate any particular negotiation modalities likely to emerge from WTO talks. Rather, it examines the effects of broad liberalisation measures.

Agricultural Trade Liberalisation

The draft modalities on agricultural products agreed in July 2004 do not include specific targets for the cuts in two of the pillars of the Agreement on Agriculture: market access and domestic support.[85] On market access, import tariffs are to be reduced on a tiered basis such that those members with higher tariff levels will implement the largest cuts.

[85] See http://www.wto.org/english/thewto_e/whatis_e/tif_e/agrm3_e.htm for an explanation of technical terms and an overview of agricultural trade negotiations in the WTO.

The number of tiers, the depth of the reduction, the placement of commodities and regions in tiers and the treatment of sensitive products have not yet been agreed.

The proposal by the G20, a group of developing countries with a special interest in agriculture, suggested by WTO Director-General Pascal Lamy as a potential compromise, would imply average tariff cuts of 54 per cent by industrialised countries and 36 per cent by developing countries. This reduction exceeds the current offer by the EU to reduce its tariffs by 46 per cent, which was rejected by the US as being insufficient.

As discussed in chapter 3, on domestic support, the only firm commitment contained in the Framework is the agreement that overall trade distorting support will not exceed 80 per cent of its current level by the end of the first year. This includes final bound total AMS (aggregate measure of support, the most trade-distorting form of support), the permitted *de minimis* levels and permitted blue box levels, with future reductions to be based on a tiered formula implying greater reductions for those countries that maintain the highest levels of support.

The inability of WTO members to agree a deal on domestic support was one of the key reasons for the lack of progress in negotiations in July 2006. In particular, the US came under pressure to offer greater reductions. Prior to the suspension of the Round, Pascal Lamy suggested that a compromise would be to limit US trade distorting domestic support to $20 billion. Although this would imply a substantial cut in bound levels of support, current expenditure by the US is already below this level, therefore it could be achieved with no further reductions. However, it would prevent the US from increasing its levels of domestic support in the future and this may satisfy the demands of other members.

For the third pillar of the Agreement on Agriculture, export competition, the July Framework contains a commitment to fully phase out the use of export subsidies for agricultural products.

Manufacturing Trade Liberalisation

The July Framework text on non-agricultural market access (NAMA) contains few details. WTO members have agreed that improvements in non-agricultural market access in the Doha Round are to be based on a formula approach, with the precise details, and other issues such as the treatment of tariff escalation and tariff peaks, still the subject of negotiation.

Progress towards an agreement on NAMA has been limited. It appears that members were reluctant to make commitments in this area until they could judge the level of ambition with respect to market-opening in agriculture.

There is some consensus that tariff reductions will be based on a Swiss formula (implying steeper cuts on commodities with higher tariffs). In June 2006, Pascal Lamy suggested a Swiss formula approach, with a coefficient of 20. This would be a compromise between the EU and US proposals (coefficients of 10 and 15 for industrialised and developing countries respectively) and the proposals of developing countries. While the applied industrial tariffs of the EU and US are generally close to their bound ceilings, many developing countries impose relatively high industrial tariffs and favour a higher coefficient (implying lower cuts). In particular, developing countries are reluctant to agree to reductions in bound rates that are higher than the cuts being implemented by industrialised nations.

Services Trade Liberalisation

Progress towards liberalising services trade has been slow. Negotiations in this area are complex. Members first submit bilateral requests and offers, plurilateral negotiations only began in February 2006. Whilst there has been progress in some areas, negotiations have stalled pending the outcome of agricultural and non-agricultural market access (ICTSD, 2006).

In addition to the slow pace of negotiation, many members currently provide market access beyond their current GATS (General Agreement on Trade in Services) commitment levels, similar to the concept of tariff overhang (see chapter 4 for full discussion of GATS and the barriers to services trade). An agreement to liberalise services trade may result in binding the *status quo*, rather than lead to further opening of markets. As a consequence the impact of an agreement on services liberalisation may be less than anticipated.

Given the large share of trade in services that is accounted for by FDI in services and, in particular, its importance to the Irish economy, the outcome of any agreement on services will have significant consequences for Ireland.

GTAP is lacking on two fronts in terms of trade in services. The standard model structure does not allow for foreign direct investment which is an important mode for delivery of services abroad, and the database includes no import barriers (tariff equivalents to the qualitative barriers) for service sectors. To model services liberalisation requires quantitative estimates of trade barriers. However, unlike the case of agriculture and manufacturing, in services these barriers tend be qualitative rather than quantitative in

nature. The difficulties in measuring non-tariff barriers and modelling trade in services are fully documented in chapter 4.

This study employs estimates based on research by Francois *et al.* (2005) to calculate the tariff equivalents to barriers to trade in services. The tariff equivalents of Francois *et al.* are preferred to those estimated in chapter 4 due to their broader sector coverage. They are tariff equivalents for services imported by a country or region. In the case of the EU regions, they apply to both intra-EU and extra-EU trade. The full set of tariff equivalents employed in this analysis is shown in table 5.6.

Trade Facilitation

Trade facilitation is now the only one of the four so-called Singapore issues still under negotiation in the Doha Round. Bagai *et al.* (2004, p2) define trade facilitation as encompassing "the domestic policies, institutions and infrastructure associated with the movement of goods across borders". Its importance and sensitivity were clearly illustrated in Cancún with the break-down of negotiations due to the refusal of developing countries to accept EU proposals over the Singapore issues.

In the context of the WTO, the definition of trade facilitation is less broad. The Doha Declaration text cites fees and formalities, transit and transparency. Trade facilitation refers to the reduction in administrative barriers to the importation of goods as opposed to barriers to trade in services as discussed in the section above which fall under the auspices of the GATS.

Wilson (2003) estimates that, with increased liberalisation of world trade and reductions in import tariffs, the cost of moving goods across borders is now as important as the costs

of tariffs. An Organisation for Economic Cooperation and Development (OECD, 2002c) survey finds that trade transactions costs vary between 2 per cent and 15 per cent of total trade costs.

An agreement on trade facilitation will have to balance the desire for reductions in transactions costs with the political will and physical capacity of developing countries to achieve trade facilitation programmes. Walkenhorst and Yasui (2003) and Djankov *et al.* (2006) suggest that developing countries have the most scope to gain from trade facilitation as they have less efficient border procedures and because of the nature of their trade patterns (importance of primary goods and the pre-dominance of small and medium-sized firms).

5.4.2 Simulation Design

The trade liberalisation simulation is implemented using the updated database created from the baseline experiments described in the previous section. The shocks required to implement the scenarios are thus implemented against this baseline featuring the Irish and global economy as projected in 2014.

The simulation is summarised in box 5.1. For import tariffs, a linear cut of 50 per cent across all agricultural and manufacturing sectors is imposed, with special and differential treatment reflected in lower cuts for developing countries (two-thirds of the reductions implemented by industrialised countries) and the exemption of least developed countries.[86]

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[86] Industrialised countries or regions in this chapter are: EU, USA, Canada, High Income Asian countries, Rest of EFTA and the Former Soviet Union. Developing countries or regions are: Mediterranean, China,

The tariff rates in the GTAP model and database are applied rates. WTO negotiations are based on bound tariff levels. In many cases, there will be a degree of tariff overhang whereby the bound ceiling exceeds the applied rate by a considerable amount. A 50 per cent reduction in the bound rate may not translate into an equal reduction in applied rates. Implementing reductions in applied rates by 50 per cent may overestimate the gains from trade liberalisation unless the average cut in bound rates agreed in the Doha Round negotiations is substantially greater. In other words, cutting applied tariffs by 50 per cent implies agreement on a substantially larger cut in bound tariffs once the tariff overhang impact is factored in.

The liberalisation of domestic support and export subsidies follow the structure of the July Framework. Export subsidies on agricultural products are fully phased out in the simulation. As discussed in chapter 3, domestic support as represented in the standard GTAP model does not allow for a full analysis of overall distorting support as defined in the July Framework. Reductions in domestic support are simulated as cuts to direct payments linked to production, intermediate input subsidies and output subsidies. The levels of domestic support in the EU in 2014 prior to the simulation are shown in table 5.7. The reductions reflect the tiered formula approach whereby those with higher levels of trade distorting support are expected to implement the most substantial cuts.[87] The market price support component of AMS is not explicitly modelled, but the reduction in applied tariffs may imply some reduction in this component in any case.

India, Rest of Asia, Rest of the ACP countries, Mercosur, Rest of Latin America and Rest of the World. Least developed countries are approximated by the EBA group of countries.

[87] The same caveat, regarding differences in bound and applied tariff rates and the degree of overhang as discussed above, applies to domestic support also. Applied domestic support is cut by 20 per cent, the bound level of support and the degree of overhang is not considered.

Services trade liberalisation is modelled as a reduction in the estimated tariff equivalents discussed in section 5.4.1. This is modelled as a positive productivity shock to imports of service commodities entering a region, implemented by exogenously shocking the appropriate technology variable in each of the service sectors. For EU regions, it is applied only to imports from third countries. Whilst barriers to trade in services within the single market remain, they are not subject to WTO negotiations but rather they fall within the competence of the European Community. Service trade imports from the USA to Ireland are also exempted from this shock. The Irish economic landscape is dominated by multinational firms, primarily from the US, who in the main produce goods. The Irish services trade balance is distorted as a result of this with very large license and royalty payments that are not really imports *per se*. As these are effectively paper transactions, it is assumed that they do not face any trade barriers. While most countries will have this effect to a degree, the unusual feature of Ireland's economy justifies taking explicit account of this fact.

The simulation of an agreement on trade facilitation follows the approach of Francois *et al.* (2005). Improved trade facilitation is modelled as a positive technology shock to imports entering into a county or region. Based on a survey of the estimates of the benefits of trade facilitation, Francois *et al.* simulate a conservative saving of 1.5 per cent in the cost of importing agricultural and manufacturing commodities. In this chapter, the shock is tiered to reflect that developing countries have the greatest potential to gain from trade facilitation. In the case of the EU countries, this shock is only applied to extra-EU imports on the assumption that membership of the single market has already eliminated customs formalities between members and hence reduces the scope of possible gains from trade facilitation.

5.5 Results

The results of the simulation are presented in this section. The analysis focuses on the interpretation and implications of the simulation for the Irish economy, but begins with an overview of the implications for the world economy.

5.5.1 Global Welfare Effects

The global changes in welfare of the trade liberalisation experiment, as measured by the equivalent variation in millions of US$ and as a percentage of Gross Domestic Product in 2014, are presented in table 5.8. The contribution of liberalisation by industrialised countries (ICs) alone to the global total is also shown (table 5.8.1). In table 5.8.2 the total welfare change is decomposed into the effects of liberalisation of agriculture, manufacturing, and services and trade facilitation.[88]

The net result is a gain for the world economy as a whole of 0.30 per cent of gross domestic product (GDP). All regions gain overall. In GDP terms, the largest gains are for the Rest of the Africa, Caribbean and Pacific (ACP) group, China, India, the Rest of EFTA, the Mercosur region and the Rest of Asia.

An alternative view of these welfare effects is presented in table 5.8.3, which compares the contribution to global gains by regions implementing reform to those that capture the benefits. At a world level, approximately 54 per cent of the welfare gains are due to the liberalisation of ICs compared to 46 per cent from developing countries (DCs). Clearly

[88] A feature in the software package used to implement the GTAP model allows for the results of any particular shock in a simulation to be decomposed into parts known as "subtotals". The result of a shock specified as a subtotal as part of larger simulation is equivalent to the result of implementing the same shock individually. See Harrison *et al.* (1999) for a more detailed discussion of the decomposition of results and the subtotal feature.

indicated in table 5.8.3 is that the main source of gains, both for industrialised and developing countries, derives from liberalisation within their own group of countries. Overall, this accounts for over 80 per cent of the gains each group of countries achieves The gains to ICs from reductions in manufacturing tariffs in DCs are an exception in that ICs benefit more in this case from DC liberalisation than IC liberalisation.

The component of the simulation that adds most to the welfare change of the world economy, almost half the total global gains, is the improvement in trade facilitation (table 5.8.3). It should be noted that the results of any such experiment depend on the magnitude of the shock implemented. If the cost saving assumed due to trade facilitation (between 0.5 and 1.5 per cent of the cost in this simulation) were less, then the welfare impact achieved would be reduced.

Most regions are winners overall from measures to improve trade facilitation, with the US and Asian countries accounting for a substantial share of the gains in value terms. In GDP terms, the Rest of ACP group and the Rest of Asia perform exceptionally well. The results for the EU are more mixed, perhaps due to the large share of intra-EU trade in their exports, which are excluded from the trade facilitation shock.

The second most significant contribution to welfare is industrial tariff liberalisation (table 5.8.3). The results of this simulation are dominated by the large gains to Asian countries. The gains from liberalisation by DCs account for over 80 per cent of the total gains to the global economy in this simulation. By contrast, tariff reductions by ICs have a negative impact on many regions, in particular industrialised regions themselves. The aggregate figure (table 5.8.3) of 2.6 per cent of global gains achieved by ICs resulting from IC

liberalisation disguises the fact that at a disaggregated level many ICs experience a welfare loss from liberalisation.

This loss arises from a negative terms of trade effect for these countries. As countries reduce import tariffs, they must export more to maintain their trade balance in the face of increased imports due to liberalisation. To realise this increase, the exports of the region must become more competitive. This is achieved by reduced factor prices relative to world factor prices.[89] This depreciation implies lower export prices relative to the composite world price, generating the negative terms of trade effect and the welfare loss observed for many ICs

The results from services trade liberalisation are the most uniform (table 5.8.2). All regions gain overall. The Mediterranean region receives the largest gain in GDP terms. Developing regions such as Rest of ACP and Rest of Asia achieve higher than average gains. Positive welfare gains are to be expected in a simulation such as this, where liberalisation has been modelled as a positive productivity shock to reduce non-tariff barriers. The price of services falls across all regions due to lower cost imports and through the use of services as intermediate inputs, and this effect feeds into the rest of the regions' economies.

Services liberalisation by the ICs provides the bigger share of the welfare effect. Given that richer regions consume more services it implies that they are the ones to gain the most. In addition, service barriers in ICs were reduced by more than in DCs allowing for

[89] Statements about price changes arising from a simulation must be interpreted in the context of the model closure. The numeraire is a composite world price index of primary factors. Thus, a reduction in world import prices relative to this fixed basket of factor prices implies a real increase in wages (factor returns).

greater gains in allocative efficiency. However, the existing tariff equivalent barriers were on average considerably higher in the DCs. The 34 per cent reduction applied to such barriers helps to generate the relatively large gains in those countries seen to result from their own liberalisation.

The agricultural liberalisation component of the simulation contributes the least to the overall change in welfare (table 5.8.3). This may be partly explained by the modest nature of the assumed shocks to domestic support and targeting of coupled-support only for reductions. The major winners are the EU15, the USA and the high-income Asian countries. These are the countries that impose the most significant distortions on agricultural trade and it is typical in such simulations to observe welfare gains due to improved allocative efficiency when these distortions are reduced. Net exporters of agricultural commodities, such as Mercosur, also perform strongly. The EU gains from the export subsidy elimination at the expense of net-food importing regions.

The effect of the reduction in agricultural tariffs is considerably greater in magnitude than the cuts in domestic support and the elimination of agricultural export subsidies. This result is similar to those found in chapter 3 on the relative importance of the three pillars in liberalisation. The interaction of these results with the EU budgetary effect is discussed in more detail in the following section.

5.5.2 Overall Welfare Effects for Ireland

Ireland's welfare will increase as a result of further trade liberalisation in this simulation. The total welfare effect amounts to 0.08 per cent of GDP. The decomposition of the welfare results for Ireland is shown in table 5.9. Allocative efficiency effects and technological improvements drive the positive welfare result. The latter are due to the

exogenous shocks introduced to the model in order to simulate trade liberalisation in services and trade facilitation. The investment and savings price effect is a terms of trade effect for the capital account.

Allocative efficiency gains arise when distortions such as domestic support and import tariffs are reduced or eliminated, as this allows the market to move closer to its competitive equilibrium and reduces the efficiency losses associated with any tax or subsidy. The allocative effects stem mainly from agriculture, reflecting the high levels of protection for agricultural sectors in the 2014 baseline.

The terms of trade effect is negative for Ireland. The reduction of export subsidies in agriculture and increased trade facilitation both contribute to a fall in export prices relative to import prices. For a small, export oriented economy like Ireland this results in a loss as Irish producers receive a lower price for their goods on the world market relative to the cost of what they import. In addition, given the high degree of Irish trade destined for EU markets, the erosion of preferential access to EU markets leads to some welfare losses for Irish producers.

Table 5.9 also shows the welfare effects for Ireland decomposed by liberalisation in agriculture, manufacturing, services and trade facilitation. The results indicate that reductions in barriers to services trade will generate particularly strong gains from services liberalisation. The industrial liberalisation scenario also generates positive gains to Ireland, while agricultural liberalisation and trade facilitation have slightly negative welfare effects.

The decomposition for agricultural trade liberalisation needs to be interpreted in the light of the way the model is designed. Overall, Ireland experiences a slight negative loss in

terms of GDP. The largest impact is the effect on Ireland's contribution to the EU budget. This result arises because the gain from improved allocative efficiency is offset by the reduction in net transfers from the EU agricultural budget, as well as a negative terms of trade effect.[90]

As noted above, in the GTAP model Common Agricultural Policy (CAP) support instruments are assumed to be financed domestically, rather than by the EU, hence all allocative efficiency gains are captured by the country in question. The integration of the EU agricultural budget module described in section 5.3.2 allows the calculation of the effect of changes in budgetary flows resulting from the liberalisation scenario. Table 5.11 shows the breakdown and changes in EU budgetary flows to Ireland as a result of the agricultural component of the simulation only. Prior to the simulation in 2014 Ireland is a net recipient of EU funds. The effect of liberalising agricultural trade alone (not considering liberalisation in manufacturing and services or trade facilitation) is to reduce the size of the net transfer to Ireland by $190 million. The elimination of export subsidies implies that Irish producers no longer receive support to sell exports to third countries. However, as the majority of domestic support in the EU is decoupled in 2014, there is little change in budget revenues and expenditure related to direct payments.

Table 5.9 shows the Irish economy gains by $85 million (0.05 per cent of GDP) from further trade liberalisation in industrial goods. This is close to the overall gain for the world economy from industrial liberalisation and it is much greater in relative size compared to other EU regions. The gain arises mostly from liberalisation among ICs. The

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[90] While the EU budgetary effect for any member state or region distinguished in this aggregation may be positive or negative, the sum of the net transfers across EU is zero to ensure that the overall budget balances

result for Ireland is not typical of those for ICs. In general, ICs benefit more from liberalisation by the developing countries (DCs), as this allows them access to markets in regions previously protected by high tariffs and they do not incur the terms of trade losses they suffer in the case of IC liberalisation.

Table 5.10.2 presents an alternative decomposition of the welfare effects on Ireland of liberalising tariffs on manufacturing commodities. Liberalisation of tariffs on trade between Ireland and the rest of the EU has zero effect as these tariffs are already set to zero (subtotals 1 and 3 in table 5.10.2). The welfare gains to Ireland from this simulation are generated by the reduction of barriers to imports goods from third country regions to Ireland and opening of those markets to Irish exporters (subtotals 2 and 4). Subtotal 2 is the main source of the gains in allocative efficiency reported in table 5.10.2. Ireland suffers a welfare loss from the liberalisation of trade between the rest of the EU and third countries as indicated in the final three subtotals. This is driven by lower cost goods from third countries replacing some Irish exports to the rest of the EU and to other third countries. Irish exports to the EU fall across all manufacturing sectors. However, overall industrial exports from Ireland increase in value terms by approximately $200 million.

The reduction of import tariffs in this component of the simulation causes a fall in world prices that impacts negatively on net-exporters of manufacturing commodities. As noted above, as expenditure on imports increases, countries must export more to pay for these imports and this drives down the price of export goods. Whilst this result is consistent across all countries, there is a second terms of trade effect at work. Due to the large share of Irish exports destined for EU markets, the fall in Irish export prices is lower than the fall for other EU countries. As much of Ireland's trade is with other EU countries, the reduction of import tariffs following WTO liberalisation does not lead to as substantial an

increase in imports into Ireland as faced by other countries. The pressure on Irish exporters to lower prices and so increase exports is therefore also less relative to other countries that must raise the level of their exports to maintain their trade balance. EU members that trade more with third countries, usually ICs, face a greater terms of trade loss because a larger share of their exports face lower world prices in this simulation. However, as table 5.10.2 shows, there are strong benefits to Ireland from third country liberalisation as it allows Irish exporters to find new markets for goods pushed out of EU markets.

The Irish economy gains strongly from further liberalisation of services trade. As table 5.9 indicates, the welfare gains for Ireland arise almost entirely from trade liberalisation by ICs. Due to the nature of the shock (a productivity increase to imports of service sectors to reflect a reduction in non-tariff barriers) it is to be expected that imports of services would increase. There are also gains to Irish exporters who, despite being pushed out of some EU markets by imports from third countries, are able to increase exports to other ICs and DCs.

The change in imports of services by source shows a consistent pattern of increased imports into Ireland from all non-EU regions in most sectors. As intra-EU trade was exempt from this liberalisation, imports of services from other EU regions are less competitive due to the shock. The growth in imports from DCs slightly exceeds those from the other ICs. On average, the tariff equivalents of barriers to trade in services were higher for DCs, therefore allowing for a larger relative impact on this group of countries and their exports. The dominance of the gains from IC liberalisation is due to efficiency gains achieved from replacing imports from the rest of the EU with relatively cheaper services from other sources.

Measures to further trade facilitation generate a negative welfare change for Ireland when implemented overall (table 5.9). This result is in line with most other EU regions. The welfare change arising from IC or DC trade facilitation is markedly different.

Trade facilitation is modelled as a cost saving on imports into a region. It is a productivity shock and this generates positive welfare effects for Ireland when implemented in the IC region (including by Ireland itself). When DC liberalisation occurs there is a terms of trade loss, due to lower export prices received by Irish producers. This arises because of greater competition in export markets as DCs strive to increase their exports to balance the increase in imports from the trade facilitation shock.

Measures to improve trade facilitation when implemented by Ireland generate welfare gains due to the allocative efficiency gains from reducing the costs of imports into Ireland. In the case of the IC trade facilitation, this gain counters the terms of trade loss. In the DC subtotal, however, the terms of trade loss is not compensated by increased trade efficiency at home, thus Ireland experiences a negative welfare effect. That intra-EU trade, and thus a large share of Irish trade, is excluded from the positive productivity shock exacerbates the impact of the adverse terms of trade effect for Ireland.

5.5.3 Sectoral Effects on the Irish Economy

The changes at a sectoral level in Ireland arising from the trade liberalisation simulation can be seen in table 5.12.1.[91] In agriculture, whilst the market price of all commodities

[91] The change in market prices in table 5.12.1 is shown relative to the change in the consumer price index (CPI), rather than the numeraire of a composite of world factor prices, to give a more intuitive view of the results at the sectoral level in Ireland. Table 5.12.1 shows the total effect and the discussion of the results

falls, the effects on agricultural sectors in Ireland are varied. There are large drops in production of cattle and sheep (-9.6 per cent) and in the output of the beef and sheepmeat processing sector (-15.3 per cent). Imports of beef and sheepmeat, as well as sugar, increase as tariffs on imports are reduced. Exports of beef and sheepmeat, other meat products and dairy products fall. There is a strong switch in export destinations from non-EU to EU markets (or, in the case of beef and sheepmeat, a much greater fall in exports to non-EU markets than to EU markets).

The effect of liberalisation on industrial goods is mixed. Overall, the changes in output in manufacturing sectors are quite small. In value terms, the largest reductions are in transport equipment and electronic equipment although they are small in percentage terms (1.56 per cent and 0.62 per cent falls). There is a sharper percentage fall in the output of the textiles and clothing sector. However, output increases in the chemicals and petroleum products (0.46 per cent) and mineral and metal products sectors (0.44 per cent).

In all of the industrial sectors in which output expands, the additional output is to supply increased demand for Irish exports from other ICs and DCs. However, there are some decreases in exports to the rest of the EU. The change in imports of manufacturing goods into Ireland shows a similar picture with large increases from other ICs and DCs reflecting lower barriers to imports from these countries, although it should be noted in value terms these changes are lower than those for exports.

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focuses on this. In tables 5.12.2 to 5.12.5 the results are decomposed into agricultural, industrial, services and trade facilitation.

Chemical and petroleum products and electronic equipment account for approximately 50 per cent and 25 per cent of Irish exports of industrial goods in the 2014 pre-liberalisation baseline. The domestic output of the former increases 0.46 per cent as a result of industrial trade liberalisation whereas production of the latter falls 0.62 per cent. How to explain these disparate trends? Domestic demand for both falls, as Irish producers substitute towards imported intermediates because their price decreases due to lower import tariffs. The differences in the output changes are explained by changes in export demand.

Export demand for chemical and petroleum products rises. While exports of these products to many EU markets fall, exports from this sector to the USA increase. The decrease in demand for Irish exports in the EU is due to tariff cuts on imports from third countries into the EU, resulting in Irish exports to other EU countries being displaced from some markets. However, consumers and firms in the USA are substituting towards Irish exports. This arises because the price of Irish exports into the US fall by more than the decrease in composite import prices for the US (i.e., the price of Irish exports to the US falls by more than the average for exports from other regions). This results from the applied tariff on Irish exports of chemical and petroleum products being higher initially than for many other ICs, hence a 50 per cent cut in tariffs implies a greater reduction in the price of Irish goods.

For electronic equipment, the demand for Irish exports falls. Exports to the rest of the EU decrease for the same reason as chemical and petroleum products (increased competition from third country exporters). In addition, in terms of export market shares, EU destinations are more important for electronic equipment than for chemical and petroleum products. Exports of electronic equipment to the USA also decrease. In this

sector, the applied tariff rate is zero for Irish exports to the USA; there is therefore no gain from a reduction in US tariffs.

Driven by relatively strong increases in the export of services commodities, domestic production increases in trade, transport, business and financial services and utilities and public services. As table 5.12.1 shows, imports also increase in all service sectors except trade services. The increase in output of most manufacturing sectors further increases demand for services. Those sectors that consume service commodities as intermediate inputs benefit from lower cost imports due to the liberalisation of services trade. This contributes to the overall positive effect for the Irish economy from services trade liberalisation.

Trade facilitation measures lead to increased domestic output in most sectors. Whilst the trade facilitation shock only applies to agricultural and manufacturing sectors, services also benefit from lower prices and costs. They can increase production in response to higher demand for services. In addition, the reduction in resource use in agriculture, due to the cuts in support provided to agricultural producers, facilitates the expansion in output of most non-agricultural sectors.

Irish exports to non-EU regions increase for nearly all sectors as a result of improved trade facilitation measures (only extra-EU trade was subject to the facilitation shock in this scenario). Whilst in agricultural and manufacturing sectors there is some substitution among imports from EU regions to non-EU regions due to the decrease in their price. In services there is an expansion of EU imports into Ireland and Irish exports to the EU.

5.5.4 Sensitivity Analysis

The results of any CGE analysis are dependent of the parameters and assumptions of the model and database. In this section, the robustness of several such assumptions underlying the model is tested.

Armington Elasticities

The GTAP model assumes that products are differentiated by source following the Armington assumption (Armington, 1969). Imports and domestic production, as well as imports from different sources, are treated as imperfect substitutes. The Armington assumption is described in more detail in chapter 2.

Given the role of the Armington elasticities in determining substitution between domestic and foreign produced goods in the model, the results of trade liberalisation scenarios are sensitivity to the values assumed for these elasticities. Recent research (Hummels, 1999, and Hertel *et al.*, 2003) suggests that the values of the Armington elasticities in the GTAP version 5 database were too low. Their estimates suggest that the values should be approximately doubled and these changes were adopted in the construction of the version 6 database and used in this chapter. Table 5.16 shows the values assumed here for the sectoral aggregation chosen (the elasticities for the full GTAP aggregation are shown in chapter 2).

The GTAP model includes a programme to analysis the sensitivity of the outcomes of simulation to the parameter values chosen. An example of this sensitivity analysis, applied to the results of the trade facilitation component of the simulation, is shown in table 5.17. The first column shows the welfare change due of the measures to improve trade facilitation (less the EU budgetary effect). The second and third columns indicate the

mean and variance of this result when this experiment is repeated and a probability distribution is created for the parameter in question. In this case, the parameter is the Armington elasticity and the distribution is specified such that the elasticity varies between 50 per cent above and below its currently calibrated value. In the final column, Chebyshev's inequality (Hogg and Craig, 1970) is used to create a 95 per cent confidence interval for each result.

Only one variable (change in welfare measured as equivalent variation) is reported here, however the results for each endogenous variable in the model may be calculated. It is clear from table 5.17 that the outcome of the simulation is extremely sensitive to the parameter values chosen. This underlines the importance of selection of such values. As noted above, the values used in this analysis are based on the most recent and detailed research currently available (Hertel *et al.*, 2003).

To further illustrate the sensitivity of the results to the Armington elasticities, the agricultural trade liberalisation component of the simulation is re-run with the values for the Armington elasticities for all agricultural commodities increased by 50 per cent. The results of this alternative simulation are compared to the standard simulation in table 5.18. It shows that the welfare change has approximately doubled for most regions, with some exceptions.

Sensitivity of the Baseline

As described in section 5.3, the construction of the baseline requires a number of assumptions and in some cases the use of secondary data sources. An additional experiment is implemented to assess the sensitivity of the model results to changes in this baseline.

Two new, simplified versions of the baseline (2001 to 2014) are created, consisting only of macro-economic projections and accession of China into the WTO. Baseline 1 uses the same macro-economic projections as before. Baseline 2 is based on the same projections, however the growth rate for the Chinese economy is reduced by half. A 50 per cent tariff cut is then applied to both baselines. The resulting overall welfare effects are reported in table 5.19. The sensitivity of the results is low. For example, the welfare gain to Ireland decreases by 0.5 per cent with the use of the lower growth rate for China.

5.6 Conclusion

This chapter provides a quantitative study of the economic effects of further trade liberalisation for Ireland. The GTAP model is used to estimate the potential effects on the Irish economy of a successful conclusion to the Doha Round.

Trade liberalisation, as simulated in this chapter, focuses on agriculture, industry, services and trade facilitation. This is implemented against a baseline projection of the Irish and world economy over the next decade.

The simulation implemented is illustrative, the shocks do not represent attempts to model specific modalities of the ongoing WTO negotiations, rather they are broad measures designed to generate results that will be indicative of future changes. The cuts in import tariffs and domestic supports are implemented as reductions in the applied rates, while the bound rates and the degree of overhang are not considered.

Agricultural trade liberalisation has a slightly negative effect on the overall economy as does improved trade facilitation. The negative effect from agricultural trade liberalisation arises because gains in allocative efficiency from lower agricultural protection are offset by the loss of net transfers from the EU agricultural budget as export subsidies are eliminated, and by the reduction in the value of the preferential access to the EU market. The loss in welfare due to trade facilitation is driven by terms of trade effects from improvements in trade facilitation in other countries. Trade facilitation by Ireland itself has a positive impact on welfare.

Ireland receives strong gains from the liberalisation of services trade, in particular from liberalisation by industrialised countries. This and the increased liberalisation of industrial trade produce unambiguous gains for Irish welfare that combined are more than double the losses from agricultural liberalisation and trade facilitation. The overall economic effects for Ireland from further liberalisation are strongly positive.

These results are important in giving a fuller perspective to the WTO Doha Round negotiations from an Irish point of view. The Irish debate has concentrated on the losses from agricultural trade liberalisation, and to farmers in particular. However, there are wider interests at stake, not only in terms of potential gains from a substantial reduction in remaining manufacturing trade barriers and from liberalising services trade, but also in terms of strengthening the rules and disciplines governing trade policy actions by WTO members. Recent unilateral actions by the US in the case of steel and by many industrial countries with respect to Chinese apparel exports, as well as simmering disputes around environmental issues and food safety standards, testify to the continuing strength of protectionist forces and to the value of strong multilateral rules which protect smaller and more vulnerable countries. As a small, export-oriented economy, Ireland has benefited

from the increased opening up of the world economy and the system of world trade regulated by the WTO. A successful conclusion to the Doha Round would continue this process and underpin further growth of the Irish economy.

5.5 Tables

Table 5.1: Regional and Sectoral Aggregation

Label	Region	Label	Sector
IRE	Ireland	CROP	Cereals, other crops and horticulture
UK	United Kingdom	SUGA	Sugar, plants and processed
GER	Germany	CATTLE	Cattle and sheep
FRA	France	OTHLIV	Other livestock (swine, poultry...)
EU11	Rest of EU15	MILK	Raw milk
CEEC	New Members / Accession countries	BEEF	Beef & sheepmeat (+wool)
USA	USA	OTHMEAT	Other meat products
CAN	Canada	DAIRY	Dairy
CHINA	China	BEV	Beverages and tobacco
INDIA	India	PROCF	Other processed food products
EBA	Everything-But-Arms group of countries	OTHPRIM	Other primary products (extraction industries, fishing & forestry)
MERC	Mercosur	TEXT	Textiles, leather and clothing
XACP	Rest of African Caribbean Pacific countries	CHEMPET	Chemical and petroleum products
FSU	Former Soviet Union countries	MINMET	Mineral and metal products
HIAC	High Income Asian Countries	TSPEQ	Transport equipment
XEFTA	Rest of European Free Trade Area	ELEC	Electronic equipment
XASIA	Rest of Asia	OTHIND	Other industries
XLAT	Rest of Latin America	TRADE	Trade services
MED	Turkey, Middle-East and North Africa	TSPORT	Transport services
ROW	Rest of the World	BFSVC	Business and financial services
		SVCPRIV	Other private services
		UTILPUB	Utilities and public services

Table 5.2.1: Mapping of GTAP Sectors

Label	Sector
CROP	Paddy rice
CROP	Wheat
CROP	Cereal grains nec
CROP	Vegetables, fruit, nuts
CROP	Oil seeds
SUGA	Sugar cane, sugar beet
CROP	Plant-based fibers
CROP	Crops nec
CATTLE	Cattle,sheep,goats,horses
OTHLIV	Animal products nec
MILK	Raw milk
BEEF	Wool, silk-worm cocoons
OTHPRIM	Forestry
OTHPRIM	Fishing
OTHPRIM	Coal
OTHPRIM	Oil
OTHPRIM	Gas
OTHPRIM	Minerals nec
BEEF	Meat: cattle,sheep,goats,horse
OTHMEAT	Meat products nec
PROCF	Vegetable oils and fats
DAIRY	Dairy products
PROCF	Processed rice
SUGA	Sugar
PROCF	Food products nec
BEV	Beverages and tobacco products
TEXT	Textiles
TEXT	Wearing apparel
TEXT	Leather products
OTHIND	Wood products
OTHIND	Paper products, publishing
CHEMPET	Petroleum, coal products
CHEMPET	Chemical,rubber,plastic prods
MINMET	Mineral products nec
MINMET	Ferrous metals
MINMET	Metals nec
MINMET	Metal products
TSPEQ	Motor vehicles and parts
TSPEQ	Transport equipment nec
ELEC	Electronic equipment
OTHIND	Machinery and equipment nec
OTHIND	Manufactures nec
UTILPUB	Electricity
UTILPUB	Gas manufacture, distribution
UTILPUB	Water
SVCPRIV	Construction
TRADE	Trade
TSPORT	Transport nec
TSPORT	Sea transport
TSPORT	Air transport
UTILPUB	Communication
BFSVC	Financial services nec
BFSVC	Insurance
BFSVC	Business services nec
SVCPRIV	Recreation and other services
UTILPUB	PubAdmin/Defence/Health/Education
SVCPRIV	Dwellings

Note: sector acronyms shown in table 5.1

Table 5.2.2: Mapping of GTAP Regions

Label	Region	Label	Region
ROW	Australia	IRE	Ireland
ROW	New Zealand	EU11	Italy
ROW	Rest of Oceania	EU11	Luxembourg
CHINA	China	EU11	Netherlands
HIAC	Hong Kong	EU11	Portugal
HIAC	Japan	EU11	Spain
HIAC	Korea	EU11	Sweden
HIAC	Taiwan	XEFTA	Switzerland
XASIA	Rest of East Asia	XEFTA	Rest of EFTA
XASIA	Indonesia	ROW	Rest of Europe
XASIA	Malaysia	ROW	Albania
XASIA	Philippines	CEEC	Cyprus
HIAC	Singapore	CEEC	Czech Republic
XASIA	Thailand	CEEC	Hungary
XASIA	Vietnam	CEEC	Malta
EBA	Rest of Southeast Asia	CEEC	Poland
EBA	Bangladesh	CEEC	Romania
INDIA	India	CEEC	Slovakia
XASIA	Sri Lanka	CEEC	Slovenia
EBA	Rest of South Asia	CEEC	Estonia
CAN	Canada	CEEC	Latvia
USA	United States	CEEC	Lithuania
XLAT	Mexico	CEEC	Bulgaria
ROW	Rest of North America	ROW	Croatia
XLAT	Colombia	FSU	Russian Federation
XLAT	Peru	FSU	Rest of Former Soviet Union
XLAT	Venezuela	MED	Turkey
XLAT	Rest of Andean Pact	MED	Rest of Middle East
MERC	Argentina	MED	Morocco
MERC	Brazil	MED	Tunisia
XLAT	Chile	MED	Rest of North Africa
MERC	Uruguay	XACP	Botswana
XLAT	Rest of South America	ROW	South Africa
XACP	Central America	ROW	Rest of South African CU
XLAT	Rest of FTAA	EBA	Malawi
XACP	Rest of the Caribbean	EBA	Mozambique
EU11	Austria	EBA	Tanzania
EU11	Belgium	EBA	Zambia
EU11	Denmark	XACP	Zimbabwe
EU11	Finland	EBA	Rest of SADC
FRA	France	EBA	Madagascar
GER	Germany	EBA	Uganda
UK	United Kingdom	EBA	Rest of Sub-Saharan Africa
EU11	Greece		

Note: region acronyms shown in table 5.1

Table 5.3: Structure of the Irish Economy in 2001 and 2014

(2001 US$ Millions)

Sector	Value of Exports				Value of Imports			
	Intra-EU		Extra-EU		Intra-EU		Extra-EU	
	2001	2014	2001	2014	2001	2014	2001	2014
Crops	261	160	40	23	410	486	285	499
Sugar	7	1	5	3	48	73	19	37
Cattle and sheep	93	176	86	69	110	17	64	96
Other livestock	123	105	22	20	31	27	9	12
Raw milk	0	0	1	0	0	0	1	3
Beef & sheepmeat	839	425	74	28	46	61	40	99
Other meat products	371	341	37	35	343	428	25	60
Dairy products	849	519	255	124	242	263	6	26
Beverages and tobacco	524	620	348	440	406	563	113	166
Other processed food products	1,578	2,046	981	1,882	1,222	1,655	341	513
Other primary products	329	212	39	51	495	825	614	917
Textiles, leather and clothing	824	303	209	117	1,863	1,552	659	2,412
Chemical & petroleum products	13,645	43,540	15,384	54,388	5,341	14,130	2,458	5,880
Mineral & metal products	2,029	2,428	624	927	2,518	4,610	490	983
Transport equipment	747	549	129	95	2,639	5,305	1,386	3,221
Electronic equipment	11,384	15,275	6,557	7,910	9,863	11,266	7,344	13,550
Other industries	6,947	8,979	4,481	5,020	7,231	9,948	3,974	7,576
Trade services	350	410	388	513	3,252	5,487	3,790	8,144
Transport services	870	964	1,320	1,495	563	897	872	1,582
Business & financial services	7,913	7,509	6,794	6,795	6,621	12,568	7,056	14,453
Other private services	531	662	538	685	279	524	279	559
Utilities & public services	745	626	919	761	322	600	633	1,373

Table 5.3: Structure of the Irish Economy in 2001 and 2014 – Continued

(2001 US$ Millions)

Sector	Output		Domestic Consumption		Self Sufficiency[1]	
	2001	2014	2001	2014	2001	2014
Crops	1,069	1,127	1,462	1,930	0.73	0.58
Sugar	152	152	208	257	0.73	0.59
Cattle and sheep	1,303	1,249	1,298	1,117	1.00	1.12
Other livestock	391	413	287	327	1.36	1.26
Raw milk	1,361	1,392	1,362	1,396	1.00	1.00
Beef & sheepmeat	2,033	1,724	1,207	1,431	1.68	1.20
Other meat products	953	1,017	914	1,130	1.04	0.90
Dairy products	3,139	3,043	2,282	2,689	1.38	1.13
Beverages and tobacco	1,909	2,526	1,556	2,194	1.23	1.15
Other processed food products	4,299	5,907	3,302	4,146	1.30	1.42
Other primary products	884	1,202	1,624	2,681	0.54	0.45
Textiles, leather and clothing	1,490	867	2,978	4,410	0.50	0.20
Chemical & petroleum products	31,629	105,027	10,399	27,108	3.04	3.87
Mineral & metal products	7,006	11,211	7,362	13,449	0.95	0.83
Transport equipment	7,889	13,085	11,038	20,967	0.71	0.62
Electronic equipment	18,503	24,481	17,770	26,112	1.04	0.94
Other industries	17,140	23,927	16,916	27,451	1.01	0.87
Trade services	11,631	21,058	17,934	33,766	0.65	0.62
Transport services	5,432	8,146	4,677	8,165	1.16	1.00
Business & financial services	27,415	37,179	26,385	49,896	1.04	0.75
Other private services	34,030	62,605	33,519	62,343	1.02	1.00
Utilities & public services	26,242	41,647	25,532	42,233	1.03	0.99

Note 1: self-sufficiency calculated as sum of value of domestic production divided by value of domestic consumption.
Source: GTAP version 6.0 database and model simulation results.

Table 5.4: Change in the Irish Economy in 2001 to 2014

Aggregate Changes

	Output ($M)			Share of GDP		Share of Value of Returns to Labour by Sector					
						Unskilled Labour		Skilled Labour		Total Labour Force	
	2001	2014	Growth Rate	2001	2014	2001	2014	2001	2014	2001	2014
Agriculture	10,402	10,118	-3%	3%	2%	5%	4%	1%	1%	3%	3%
Manufacturing	90,748	188,231	107%	47%	48%	44%	44%	32%	32%	39%	39%
Services	104,750	170,635	63%	51%	50%	51%	52%	67%	67%	58%	58%
Total	205,900	368,985	79%	100%	100%	100%	100%	100%	100%	100%	100%

Source: GTAP model simulation results.

Table 5.5: Applied Trade Protection for Ireland in 2001 and 2014

(Trade-weighted Averages in %)

Sector	Average Import Protection				Average Export Protection			
	All Trade		Extra-EU Trade		All Trade		Extra-EU Trade	
	2001	2014	2001	2014	2001	2014	2001	2014
Crops	5.3	6.3	13.0	12.4	0.8	0.9	6.0	6.8
Sugar	7.7	6.0	24.5	17.9	24.4	49.4	53.2	63.6
Cattle and sheep	0.4	0.8	1.0	0.9	0.2	0.2	0.4	0.6
Other livestock	0.2	0.2	0.8	0.8	0.3	0.3	1.2	1.6
Raw milk	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Beef & sheepmeat	46.0	56.3	99.1	90.7	1.4	0.7	10.8	11.3
Other meat products	1.4	2.4	19.6	19.2	3.6	3.0	37.1	32.1
Dairy products	0.7	2.5	28.1	28.5	2.2	2.1	9.3	11.1
Beverages and tobacco	1.1	1.2	5.1	5.1	1.8	2.1	3.5	5.1
Other processed food products	4.9	5.2	22.2	22.1	5.1	6.0	12.4	12.5
Other primary products	0.0	0.0	0.0	0.0	0.4	0.8	3.8	3.9
Textiles, leather and clothing	1.8	5.5	6.8	9.1	2.2	3.1	9.9	10.9
Chemical & petroleum products	0.7	0.6	2.1	2.1	1.5	1.8	2.9	3.3
Mineral & metal products	0.5	0.4	2.5	2.4	2.2	2.6	9.2	9.5
Transport equipment	1.1	1.1	3.2	2.9	0.4	0.4	2.9	3.0
Electronic equipment	0.0	0.1	0.1	0.1	0.4	0.6	1.1	1.6
Other industries	0.3	0.4	0.9	0.9	0.7	0.8	1.8	2.2
Trade services	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Transport services	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Business & financial services	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Other private services	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Utilities & public services	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

Source: GTAP version 6.0 database and model simulation results.

Table 5.6: Estimated Tariff Equivalents of Service Trade Barriers (%)

Sector	European Union	Other Industrialised Countries	Developing Countries
Trade services	2.62	0.00	7.05
Transport services	2.57	4.15	6.16
Business and financial services	2.77	2.84	5.58
Other private services	1.92	5.19	5.78
Utilities and public services	1.92	5.19	5.78

Source: Own calculations based on Francois *et al.* (2003).

Table 5.7: Domestic Support in the EU in 2014 Baseline

(expressed as *ad valorem* subsidies on the use of land and capital as a percentage of value of production)

Region	Crops		Sugar		Cattle and Sheep		Other Livestock		Raw Milk	
	Land	Capital	Land	Capital	Land	Capital	Land	Capital	Land	Capital
Ireland	-69.7	0.0	-27.4	-4.9	-88.2	0.0	-27.6	-37.4	-22.3	-24.3
UK	-55.5	0.0	-8.4	-0.5	-93.8	0.0	-8.6	-18.0	-10.8	-28.5
Germany	-51.0	0.0	-3.6	-0.4	-86.3	0.0	-7.3	-19.4	-7.8	-44.2
France	-46.3	0.0	-12.9	-1.3	-83.2	0.0	-20.2	-28.6	-22.9	-55.5
Rest EU15	-35.7	0.0	-14.7	-3.4	-87.3	0.0	-8.3	-13.9	-18.6	-33.8
CEEC	-92.2	0.0	-48.6	0.0	-98.2	0.0	15.8	0.0	-65.8	0.0
EU27	-71.7	0.0	-26.2	-1.2	-92.2	0.0	0.0	-15.0	-37.5	-37.6

Source: GTAP Database and model simulation results.

Table 5.8.1: Global Welfare Effects

(Measured as Equivalent Variation in 2001 US$ Millions and % of GDP)

Region	Global Liberalisation		Industrialised Country Liberalisation Only	
	$M	% of GDP	$M	% of GDP
Ireland	137	0.08	210	0.13
UK	1,644	0.09	1,641	0.09
Germany	1,203	0.05	1,228	0.06
France	568	0.04	585	0.04
Rest EU15	5,977	0.16	5,271	0.14
New EU member	1,744	0.30	1,817	0.31
USA	8,906	0.07	11,100	0.09
Canada	2,073	0.25	1,933	0.24
China	22,909	1.08	10,149	0.48
India	6,055	0.87	1,157	0.17
EBA	1,068	0.16	-1,430	-0.22
Mercosur	6,164	0.59	2,277	0.22
Rest of ACP	1,890	1.28	1,002	0.68
Former Soviet Union	2,244	0.33	2,039	0.30
High Income Asian	24,182	0.40	20,805	0.35
Rest EFTA	6,311	1.15	6,238	1.14
Rest Asia	10,740	1.49	2,119	0.29
Rest Latin America	5,242	0.34	-910	-0.06
Mediterranean	5,193	0.31	-3,247	-0.20
Rest of World	5,411	0.63	1,020	0.12
Total	119,660	0.30	65,004	0.16

Source: GTAP model simulation results.

Table 5.8.2: Global Welfare Effects

(Measured as Equivalent Variation in 2001 US$ Millions and % of GDP)

Region	Total ($M)	% of GDP	Agriculture	Industry	Service Trade	Trade Facilitation
Ireland	**137**	**0.08**	-0.03	0.05	0.12	-0.06
UK	**1,644**	**0.09**	0.10	-0.06	0.04	0.02
Germany	**1,203**	**0.05**	0.03	-0.06	0.05	0.04
France	**568**	**0.04**	0.03	-0.05	0.02	0.04
Rest EU15	**5,977**	**0.16**	0.06	-0.03	0.05	0.08
CEEC	**1,744**	**0.30**	0.01	0.13	0.02	0.14
USA	**8,906**	**0.07**	0.03	-0.04	0.03	0.06
Canada	**2,073**	**0.25**	0.10	-0.09	0.08	0.16
China	**22,909**	**1.08**	-0.03	0.54	0.05	0.52
India	**6,055**	**0.87**	0.02	0.46	0.04	0.34
EBA	**1,068**	**0.16**	-0.08	-0.08	0.02	0.30
Mercosur	**6,164**	**0.59**	0.18	0.15	0.07	0.20
Rest ACP	**1,890**	**1.28**	0.40	0.02	0.13	0.74
Former Soviet Union	**2,244**	**0.33**	0.04	0.20	0.12	-0.03
High Income Asian	**24,182**	**0.40**	0.09	0.13	0.05	0.14
Rest EFTA	**6,311**	**1.15**	0.20	0.74	0.13	0.08
Rest Asia	**10,740**	**1.49**	0.06	0.53	0.19	0.71
Rest Latin America	**5,242**	**0.34**	0.00	0.04	0.06	0.24
Mediterranean	**5,193**	**0.31**	-0.01	0.08	0.13	0.12
Rest of World	**5,411**	**0.63**	0.15	0.09	0.11	0.29
Total	**119,660**	**0.30**	0.05	0.07	0.05	0.14

Source: GTAP model simulation results.

Table 5.8.3: Global Welfare Effects

(% of global gains)

Liberalising Region / *Benefiting Region*	Agriculture: Domestic Support	Agriculture: Tariffs and Export Subsidies	Industry	Services	Trade Facilitation	Total
IC						
IC	0.3	11.8	2.6	10.0	19.6	44.2
DC	0.0	1.3	6.2	0.9	1.7	10.1
Total	*0.3*	*13.1*	*8.8*	*10.9*	*21.3*	*54.3*
DC						
IC	0.0	1.2	0.6	0.6	-0.6	1.8
DC	0.0	1.2	12.4	5.6	24.8	43.9
Total	*0.0*	*2.4*	*13.0*	*6.2*	*24.1*	*45.7*
All Regions						
IC	0.3	13.0	3.2	10.6	19.0	46.0
DC	0.0	2.4	18.6	6.5	26.5	54.0
Total	***0.3***	***15.4***	***21.8***	***17.1***	***45.4***	***100.0***

Source: GTAP model simulation results.

Table 5.9: Welfare Effects for Ireland

(Measured as Equivalent Variation in 2001 US$ Millions)

Welfare Change	US$ Millions
Total	**132**
Allocative Efficiency Effect	306
Technology Effect	360
Terms of Trade Effect	-511
Investment and Savings Price Effect	154
EU Budgetary Effect	-177
Agriculture	**-44**
Domestic support reductions – EU and USA	2
Domestic support reductions – Rest of World	1
Tariff Reductions – Industrialised Countries	90
Tariff Reductions – Developing Countries	19
Export Subsidies Abolished	34
EU Budgetary Effect	-190
Manufacturing	**85**
Tariff Reductions – Industrialised Countries	58
Tariff Reductions – Developing Countries	9
EU Budgetary Effect	18
Services	**196**
Tariff Reductions – Industrialised Countries	179
Tariff Reductions – Developing Countries	17
EU Budgetary Effect	0
Trade Facilitation	**-100**
Trade Facilitation – Industrialised Countries	23
Trade Facilitation – Developing Countries	-118
EU Budgetary Effect	-5

Source: GTAP model simulation results.

Table 5.10.1: Alternative Decomposition of Welfare Effects on Ireland

Agricultural Liberalisation –Tariff Liberalisation Only

(2001 US$ Millions)

Breakdown of Tariff Reductions	Welfare
Reduction of tariffs on agricultural goods from Rest of EU to Ireland	0
Reduction of tariffs on agricultural goods from Third Countries to Ireland	143
Reduction of tariffs on agricultural goods from Ireland to Rest of EU	0
Reduction of tariffs on agricultural goods from Ireland to Third Countries	1
Reduction of tariffs on agricultural goods from Rest of EU to Third Countries	12
Reduction of tariffs on agricultural goods from Third Countries to Rest of EU	-54
Reduction of tariffs on agricultural goods from Third Countries to Third Countries	7
Total	109

Note: the numbers are interpreted as the gain to Ireland on the assumption that agricultural imports and exports to non-EU countries are traded at world prices. In practice, they are traded at EU prices due to the operation of the common financing of the CAP. To obtain the overall impact of tariff liberalisation the change in net transfers from the EU budget must also be taken into account.
Source: GTAP model simulation results.

Table 5.10.2: Alternative Decomposition of Welfare Effects on Ireland

Manufacturing Liberalisation –Tariff Liberalisation Only

(2001 US$ Millions)

Breakdown of Tariff Reductions	Welfare
Reduction of tariffs on manufacturing goods from Rest of EU to Ireland	0
Reduction of tariffs on manufacturing goods from Third Countries to Ireland	88
Reduction of tariffs on manufacturing goods from Ireland to Rest of EU	0
Reduction of tariffs on manufacturing goods from Ireland to Third Countries	676
Reduction of tariffs on manufacturing goods from Rest of EU to Third Countries	-269
Reduction of tariffs on manufacturing goods from Third Countries to Rest of EU	-138
Reduction of tariffs on manufacturing goods from Third Countries to Third Countries	-290
Total	67

Source: GTAP model simulation results.

Table 5.11: Overall of EU Budgetary Effect on Ireland

Agricultural Liberalisation Only

(2001 US$Millions)

	2001	2014 Pre-Simulation	2014 Post-Simulation
Net contribution[1]	-718	-474	-284
Decomposition of net contribution			
GDP tax	298	204	169
Revenues and subsidies	-1,016	-678	-453
Decomposition of revenues and subsidies			
Exports subsidies			
Crops	-3	-3	0
Sugar	-3	-2	0
Cattle and sheep	0	0	0
Other livestock	0	0	0
Raw milk	0	0	0
Beef & sheepmeat	-62	-21	0
Other meat products	-2	-2	0
Dairy products	-80	-42	0
	-150	***-70***	***0***
Tariff revenues collected and domestic support			
Crops	-449	-442	-387
Sugar	0	28	26
Cattle and sheep	-675	-711	-632
Other livestock	-19	-22	-16
Raw milk	-7	-12	-7
	-1,151	***-1,158***	***-1,016***
Tariff duties on other products			
	286	***550***	***563***

Note 1: a positive figure represents a net contribution from Ireland to the EU; a negative figure a net transfer from the EU to Ireland.
Source: GTAP model simulation results.

Table 5.12.1: Resource Allocation Effects for Ireland

Sector	Market Price Relative to CPI	Value of Imports	Value of Domestic Output	Value of Exports	Quantity of Imports	Quantity of Domestic Output	Quantity of Exports	Change in Trade Balance
	%	$M	$M	$M	%	%	%	$M
Crops	-1.20	14.18	-26.10	-9.18	1.10	-1.64	-3.11	-7.40
Sugar	-0.27	6.58	-12.76	-2.90	5.87	-7.60	-70.28	-0.24
Cattle and sheep	-1.93	-32.45	-152.24	25.76	-17.09	-9.64	7.82	47.10
Other livestock	-0.95	-3.08	-19.55	-0.35	-4.79	-3.38	-0.17	-0.74
Raw milk	-11.94	-1.52	0.00	0.86	-33.61	0.00	102.21	2.21
Beef & sheepmeat	-1.39	162.89	-304.65	-134.58	98.22	-15.28	-25.36	-197.00
Other meat products	-0.41	14.01	-60.69	-36.10	2.67	-5.46	-9.05	-37.94
Dairy products	-6.57	-18.78	16.38	-34.24	-5.34	0.47	-4.39	-35.30
Beverages and tobacco	-0.29	3.04	13.37	7.89	0.47	0.59	0.86	-2.86
Other processed food products	-0.54	58.42	86.09	124.06	2.88	1.55	3.67	58.48
Other primary products	-0.48	19.69	-1.20	-3.43	0.41	-0.06	-0.37	49.51
Textiles, leather and clothing	-0.38	37.67	-19.75	-7.09	1.14	-2.53	-1.93	-26.97
Chemical & petroleum products	0.40	162.91	411.44	484.12	0.84	0.46	0.59	-165.81
Mineral & metal products	0.48	38.90	44.72	82.01	0.78	0.44	2.85	71.00
Transport equipment	0.52	55.18	-194.62	-20.22	0.74	-1.57	-3.35	3.22
Electronic equipment	0.47	-62.77	-124.33	-117.43	-0.30	-0.62	-0.61	-22.25
Other industries	0.40	27.74	49.13	95.45	0.18	0.24	0.80	91.74
Trade services	0.60	-91.59	64.87	27.67	-0.83	0.37	3.50	112.33
Transport services	0.31	10.02	68.54	63.63	0.47	0.95	2.36	51.09
Business & financial services	0.64	19.97	213.71	192.40	0.09	0.65	1.51	235.93
Other private services	0.60	1.76	-101.51	12.94	0.19	-0.19	1.11	10.94
Utilities & public services	0.59	4.98	26.72	20.74	0.29	0.07	1.54	20.68

Source: GTAP model simulation results.

The change in market prices is relative to the change in the consumer price index in Ireland. Note that all prices are initially equal one; changes are shown relative to the numeraire.

Table 5.12.2: Resource Allocation Effects for Ireland – Agricultural Liberalisation Only

Sector	Market Price Relative to CPI	Value of Imports	Value of Domestic Output	Value of Exports	Quantity of Imports	Quantity of Domestic Output	Quantity of Exports	Change in Trade Balance
	%	$M	$M	$M	%	%	%	$M
Crops	-1.71	16.72	-30.96	-11.32	1.29	-1.94	-3.84	-13.11
Sugar	-0.41	6.32	-13.16	-3.07	5.64	-7.83	-74.28	-1.03
Cattle and sheep	-2.24	-32.71	-158.09	22.83	-17.23	-10.01	6.93	45.39
Other livestock	-1.35	-3.08	-21.76	-1.84	-4.79	-3.76	-0.89	-1.39
Raw milk	-12.72	-1.62	0.00	0.87	-35.81	0.00	103.38	2.29
Beef & sheepmeat	-1.67	162.38	-309.25	-139.12	97.91	-15.51	-26.21	-199.03
Other meat products	-0.71	12.68	-62.59	-38.73	2.42	-5.63	-9.71	-39.88
Dairy products	-7.08	-20.58	17.12	-34.36	-5.85	0.49	-4.41	-32.70
Beverages and tobacco	-0.54	-0.28	22.48	15.33	-0.04	1.00	1.67	8.51
Other processed food products	-0.57	-2.44	72.34	74.78	-0.12	1.30	2.21	50.53
Other primary products	0.48	8.74	0.30	-1.86	0.18	0.01	-0.20	-11.68
Textiles, leather and clothing	0.02	4.19	8.88	5.85	0.13	1.14	1.59	6.77
Chemical & petroleum products	0.34	37.15	194.82	191.79	0.19	0.22	0.23	109.51
Mineral & metal products	0.31	4.03	30.92	17.88	0.08	0.31	0.62	13.41
Transport equipment	0.32	-11.13	11.64	2.40	-0.15	0.09	0.40	11.86
Electronic equipment	0.38	48.68	70.45	68.94	0.23	0.35	0.36	14.63
Other industries	0.33	20.90	77.06	62.71	0.14	0.38	0.53	35.70
Trade services	0.33	3.32	-3.02	0.61	0.03	-0.02	0.08	4.65
Transport services	0.30	-2.08	17.38	12.96	-0.10	0.24	0.48	11.93
Business & financial services	0.34	-9.56	54.53	35.94	-0.04	0.17	0.28	37.85
Other private services	0.34	-1.16	11.92	3.30	-0.13	0.02	0.28	3.58
Utilities & public services	0.32	-2.99	13.75	5.94	-0.18	0.03	0.44	7.11

Source: GTAP model simulation results.

The change in market prices is relative to the change in the consumer price index in Ireland. Note that all prices are initially equal one; changes are shown relative to the numeraire.

Table 5.12.3: Resource Allocation Effects for Ireland – Industrial Liberalisation Only

Sector	Market Price Relative to CPI	Value of Imports	Value of Domestic Output	Value of Exports	Quantity of Imports	Quantity of Domestic Output	Quantity of Exports	Change in Trade Balance
	%	$M	$M	$M	%	%	%	$M
Crops	0.10	-7.36	1.20	2.06	-0.57	0.08	0.70	7.37
Sugar	-0.03	-0.29	-0.50	0.04	-0.26	-0.30	0.97	0.70
Cattle and sheep	-0.02	-0.69	0.59	1.28	-0.36	0.04	0.39	1.23
Other livestock	0.01	-0.32	-0.17	1.01	-0.50	-0.03	0.49	0.86
Raw milk	-0.12	0.01	0.00	0.00	0.18	0.00	0.58	0.01
Beef & sheepmeat	0.00	0.10	-1.96	-0.11	0.06	-0.10	-0.02	-1.20
Other meat products	0.02	1.19	-4.03	-1.57	0.23	-0.36	-0.39	-2.34
Dairy products	-0.07	0.44	0.51	1.62	0.13	0.01	0.21	-0.05
Beverages and tobacco	0.00	3.27	-12.97	-11.02	0.51	-0.57	-1.20	-13.57
Other processed food products	-0.15	58.11	-30.56	9.50	2.87	-0.55	0.28	-22.32
Other primary products	-0.16	20.00	-0.26	2.06	0.42	-0.01	0.22	0.87
Textiles, leather and clothing	-0.66	34.36	-35.07	-18.46	1.04	-4.49	-5.02	-47.57
Chemical & petroleum products	-0.05	145.78	492.27	537.21	0.75	0.56	0.65	250.11
Mineral & metal products	-0.02	34.04	13.98	54.32	0.68	0.14	1.89	37.76
Transport equipment	-0.02	77.27	-144.68	-22.95	1.04	-1.16	-3.80	-55.34
Electronic equipment	-0.03	-179.78	-298.19	-292.71	-0.85	-1.48	-1.51	-99.90
Other industries	-0.09	-36.30	-176.49	-126.96	-0.24	-0.86	-1.07	-78.67
Trade services	0.08	-83.97	53.64	10.54	-0.76	0.31	1.33	45.63
Transport services	-0.08	1.07	28.56	21.85	0.05	0.39	0.81	16.42
Business & financial services	0.08	-6.02	38.53	17.47	-0.03	0.12	0.14	30.98
Other private services	0.06	1.60	-48.55	-4.36	0.18	-0.09	-0.38	-5.26
Utilities & public services	0.05	1.35	-18.54	-4.91	0.08	-0.05	-0.36	-4.49

Source: GTAP model simulation results.

The change in market prices is relative to the change in the consumer price index in Ireland. Note that all prices are initially equal one; changes are shown relative to the numeraire.

Table 5.12.4: Resource Allocation Effects for Ireland – Services Liberalisation Only

Sector	Market Price Relative to CPI	Value of Imports	Value of Domestic Output	Value of Exports	Quantity of Imports	Quantity of Domestic Output	Quantity of Exports	Change in Trade Balance
	%	$M	$M	$M	%	%	%	$M
Crops	0.19	1.03	0.50	0.04	0.08	0.03	0.01	-1.03
Sugar	0.10	0.07	0.21	0.02	0.07	0.12	0.40	0.00
Cattle and sheep	0.17	0.03	0.60	0.17	0.02	0.04	0.05	0.10
Other livestock	0.17	0.07	0.35	0.02	0.11	0.06	0.01	-0.05
Raw milk	0.25	0.01	0.00	0.00	0.25	0.00	-0.32	-0.01
Beef & sheepmeat	0.14	0.02	0.64	0.07	0.01	0.03	0.01	-0.18
Other meat products	0.12	0.21	1.05	0.57	0.04	0.09	0.14	0.35
Dairy products	0.18	0.29	-0.21	-0.62	0.08	-0.01	-0.08	-0.86
Beverages and tobacco	0.12	0.34	0.60	0.24	0.05	0.03	0.03	-0.18
Other processed food products	0.11	1.05	7.06	5.76	0.05	0.13	0.17	3.47
Other primary products	0.22	5.44	0.08	-0.04	0.11	0.00	0.00	-6.36
Textiles, leather and clothing	0.13	1.35	0.70	0.41	0.04	0.09	0.11	0.16
Chemical & petroleum products	0.13	21.54	122.17	116.62	0.11	0.14	0.14	58.79
Mineral & metal products	0.13	4.16	1.28	0.38	0.08	0.01	0.01	-1.60
Transport equipment	0.14	7.82	5.21	-0.85	0.11	0.04	-0.14	-4.17
Electronic equipment	0.13	12.53	14.47	13.98	0.06	0.07	0.07	2.86
Other industries	0.12	10.63	20.63	15.30	0.07	0.10	0.13	6.04
Trade services	0.12	71.91	-25.77	1.45	0.65	-0.15	0.18	-11.86
Transport services	0.03	13.70	-13.61	-1.75	0.65	-0.19	-0.07	-1.00
Business & financial services	0.10	126.89	-101.20	-39.52	0.57	-0.31	-0.31	-54.06
Other private services	0.13	7.66	7.55	-0.97	0.84	0.01	-0.08	-4.78
Utilities & public services	0.14	15.52	1.27	0.81	0.91	0.00	0.06	-5.24

Source: GTAP model simulation results.

The change in market prices is relative to the change in the consumer price index in Ireland. Note that all prices are initially equal one; changes are shown relative to the numeraire.

Table 5.12.5: Resource Allocation Effects for Ireland – Trade Facilitation Only

Sector	Market Price Relative to CPI	Value of Imports	Value of Domestic Output	Value of Exports	Quantity of Imports	Quantity of Domestic Output	Quantity of Exports	Change in Trade Balance
	%	$M	$M	$M	%	%	%	$M
Crops	0.22	3.79	3.16	0.05	0.29	0.20	0.02	-0.63
Sugar	0.07	0.48	0.69	0.11	0.42	0.41	2.63	0.10
Cattle and sheep	0.16	0.91	4.67	1.48	0.48	0.30	0.45	0.38
Other livestock	0.21	0.25	2.03	0.46	0.39	0.35	0.22	-0.15
Raw milk	0.64	0.08	0.00	-0.01	1.77	0.00	-1.43	-0.07
Beef & sheepmeat	0.14	0.39	5.92	4.59	0.23	0.30	0.86	3.41
Other meat products	0.17	-0.06	4.89	3.63	-0.01	0.44	0.91	3.93
Dairy products	0.41	1.07	-1.04	-0.88	0.31	-0.03	-0.11	-1.70
Beverages and tobacco	0.12	-0.29	3.26	3.34	-0.04	0.14	0.36	2.38
Other processed food products	0.08	1.69	37.24	34.03	0.08	0.67	1.01	26.80
Other primary products	-1.02	-14.48	-1.33	-3.59	-0.30	-0.06	-0.39	66.69
Textiles, leather and clothing	0.13	-2.23	5.75	5.10	-0.07	0.74	1.39	13.67
Chemical & petroleum products	-0.02	-41.55	-397.83	-361.50	-0.21	-0.45	-0.44	-584.22
Mineral & metal products	0.06	-3.33	-1.47	9.43	-0.07	-0.01	0.33	21.43
Transport equipment	0.09	-18.79	-66.80	1.18	-0.25	-0.54	0.20	50.87
Electronic equipment	-0.01	55.80	88.94	92.36	0.26	0.44	0.48	60.16
Other industries	0.04	32.51	127.92	144.40	0.21	0.62	1.21	128.67
Trade services	0.08	-82.85	40.02	15.09	-0.75	0.23	1.91	73.90
Transport services	0.06	-2.67	36.21	30.58	-0.13	0.50	1.14	23.74
Business & financial services	0.12	-91.33	221.85	178.51	-0.41	0.68	1.40	221.16
Other private services	0.06	-6.33	-72.43	14.97	-0.70	-0.14	1.29	17.40
Utilities & public services	0.08	-8.91	30.24	18.90	-0.52	0.07	1.40	23.30

Source: GTAP model simulation results.

The change in market prices is relative to the change in the consumer price index in Ireland. Note that all prices are initially equal one; changes are shown relative to the numeraire.

Table 5.13: Changes in Consumer Price Index (%)

Region	Agricultural Liberalisation	Industrial Liberalisation	Services Liberalisation	Trade Facilitation	Total
Ireland	-0.41	-0.31	-0.20	-0.26	-1.17
UK	-0.30	-0.54	-0.12	-0.28	-1.24
Germany	-0.28	-0.52	-0.10	-0.27	-1.17
France	-0.36	-0.55	-0.09	-0.30	-1.29
Rest EU15	-0.32	-0.46	-0.08	-0.23	-1.09
CEEC	-0.46	-0.42	-0.10	-0.18	-1.16
USA	0.10	-0.61	-0.03	-0.22	-0.76
Canada	0.04	-0.78	-0.02	0.05	-0.72
China	-0.14	1.14	-0.07	0.09	1.03
India	-0.35	-0.18	0.03	0.23	-0.27
EBA	-0.25	-0.27	0.03	-0.34	-0.83
Mercosur	0.88	-0.09	-0.08	0.10	0.82
Rest ACP	0.63	-0.46	-0.03	0.09	0.23
Former Soviet Union	-0.29	-1.61	-0.15	-0.15	-2.20
High Income Asian	-0.49	0.37	-0.04	-0.04	-0.20
Rest EFTA	-0.50	-0.32	-0.04	-0.17	-1.03
Rest Asia	-0.11	0.34	-0.05	0.11	0.30
Rest Latin America	0.10	-0.59	-0.05	-0.01	-0.55
Mediterranean	-0.12	-1.01	-0.14	-0.34	-1.61
Rest of World	0.40	-0.36	-0.10	0.05	-0.01

CPI = price index for private consumption expenditure in region (variable *ppriv*)
Source: GTAP model simulation results.

Table 5.14: Price Changes in Ireland (%)

AGRICULTURAL LIBERALISATION	piw	pim	pxw	pp
Crops	49.7	19.8	6.1	10.6
Sugar	72.0	118.7	24.4	36.3
Cattle and sheep	3.6	0.0	0.5	0.9
Other livestock	24.4	0.7	3.1	1.5
Raw milk	0.0	0.0	0.0	0.0
Beef & sheepmeat	47.2	73.4	5.5	33.1
Other meat products	48.2	6.4	13.5	6.2
Dairy products	23.4	5.8	15.7	7.7
Beverages and tobacco	27.2	8.7	19.8	8.8
Other processed food products	32.7	5.8	7.9	3.5
Other primary products	5.2	0.4	0.3	1.8
Textiles, leather and clothing	162.6	1.2	13.8	11.4
Chemical & petroleum products	11.5	0.2	4.2	2.5
Mineral & metal products	10.3	0.1	5.4	1.9
Transport equipment	9.4	1.0	10.5	2.1
Electronic equipment	9.7	0.1	4.7	1.8
Other industries	12.8	0.0	5.8	1.3
Trade services	0.0	0.0	0.0	0.0
Transport services	0.0	0.0	0.0	0.0
Business & financial services	0.0	0.0	0.0	0.0
Other private services	0.0	0.0	0.0	0.0
Utilities & public services	0.0	0.0	0.0	0.0

INDUSTRIAL LIBERALISATION	piw	pim	pxw	pp
Crops	3.5	20.2	6.1	11.2
Sugar	13.1	117.1	24.6	33.5
Cattle and sheep	3.2	0.0	0.4	1.1
Other livestock	4.9	0.8	3.3	1.8
Raw milk	0.0	0.0	0.0	0.0
Beef & sheepmeat	7.3	73.9	6.1	37.9
Other meat products	14.0	6.8	14.1	6.0
Dairy products	20.3	5.7	15.3	7.3
Beverages and tobacco	25.1	8.7	19.7	9.5
Other processed food products	9.6	5.7	8.0	3.8
Other primary products	2.0	0.7	0.3	2.6
Textiles, leather and clothing	14.9	1.4	13.5	11.5
Chemical & petroleum products	5.8	0.4	4.3	2.8
Mineral & metal products	8.2	0.3	5.5	2.0
Transport equipment	7.9	1.2	10.3	2.0
Electronic equipment	6.9	0.9	6.0	2.4
Other industries	7.6	0.1	6.0	1.4
Trade services	0.0	0.0	0.0	0.0
Transport services	0.0	0.0	0.0	0.0
Business & financial services	0.0	0.0	0.0	0.0
Other private services	0.0	0.0	0.0	0.0
Utilities & public services	0.0	0.0	0.0	0.0

Table 5.14: Price Changes in Ireland (%) - Continued

SERVICES LIBERALISATION	piw	pim	pxw	pp
Crops	49.7	19.8	6.1	10.6
Sugar	72.0	118.7	24.4	36.3
Cattle and sheep	3.6	0.0	0.5	0.9
Other livestock	24.4	0.7	3.1	1.5
Raw milk	0.0	0.0	0.0	0.0
Beef & sheepmeat	47.2	73.4	5.5	33.1
Other meat products	48.2	6.4	13.5	6.2
Dairy products	23.4	5.8	15.7	7.7
Beverages and tobacco	27.2	8.7	19.8	8.8
Other processed food products	32.7	5.8	7.9	3.5
Other primary products	5.2	0.4	0.3	1.8
Textiles, leather and clothing	162.6	1.2	13.8	11.4
Chemical & petroleum products	11.5	0.2	4.2	2.5
Mineral & metal products	10.3	0.1	5.4	1.9
Transport equipment	9.4	1.0	10.5	2.1
Electronic equipment	9.7	0.1	4.7	1.8
Other industries	12.8	0.0	5.8	1.3
Trade services	0.0	0.0	0.0	0.0
Transport services	0.0	0.0	0.0	0.0
Business & financial services	0.0	0.0	0.0	0.0
Other private services	0.0	0.0	0.0	0.0
Utilities & public services	0.0	0.0	0.0	0.0

TRADE FACILITATION	piw	pim	pxw	pp
Crops	3.5	20.2	6.1	11.2
Sugar	13.1	117.1	24.6	33.5
Cattle and sheep	3.2	0.0	0.4	1.1
Other livestock	4.9	0.8	3.3	1.8
Raw milk	0.0	0.0	0.0	0.0
Beef & sheepmeat	7.3	73.9	6.1	37.9
Other meat products	14.0	6.8	14.1	6.0
Dairy products	20.3	5.7	15.3	7.3
Beverages and tobacco	25.1	8.7	19.7	9.5
Other processed food products	9.6	5.7	8.0	3.8
Other primary products	2.0	0.7	0.3	2.6
Textiles, leather and clothing	14.9	1.4	13.5	11.5
Chemical & petroleum products	5.8	0.4	4.3	2.8
Mineral & metal products	8.2	0.3	5.5	2.0
Transport equipment	7.9	1.2	10.3	2.0
Electronic equipment	6.9	0.9	6.0	2.4
Other industries	7.6	0.1	6.0	1.4
Trade services	0.0	0.0	0.0	0.0
Transport services	0.0	0.0	0.0	0.0
Business & financial services	0.0	0.0	0.0	0.0
Other private services	0.0	0.0	0.0	0.0
Utilities & public services	0.0	0.0	0.0	0.0

piw = world price of composite import in Ireland.

pim = market price of composite import in Ireland.

pm = market price in Ireland.

pxw = aggregate price of exports from Ireland.

pp = private consumption price for commodity in Ireland.

Source: GTAP model simulation results.

Table 5.15: Changes in Wages (%)

Region	Agricultural Liberalisation		Industrial Liberalisation		Services Liberalisation		Trade Facilitation	
	Unskilled	Skilled	Unskilled	Skilled	Unskilled	Skilled	Unskilled	Skilled
Ireland	0.28	0.41	0.10	0.14	0.20	0.17	-0.13	-0.07
UK	0.21	0.23	0.08	0.08	0.05	0.03	0.06	0.07
Germany	0.22	0.24	0.11	0.07	0.08	0.07	0.05	0.05
France	0.29	0.34	0.10	0.06	0.04	0.03	0.08	0.08
Rest EU15	0.23	0.29	0.12	0.11	0.07	0.05	0.15	0.16
CEEC	0.68	0.83	0.52	0.66	0.01	-0.01	0.27	0.34
USA	0.02	-0.01	0.05	0.07	0.03	0.03	0.08	0.08
Canada	0.10	0.09	0.08	0.11	0.10	0.11	0.43	0.41
China	0.25	0.26	2.74	2.92	0.03	0.04	1.57	1.87
India	0.40	0.42	2.00	2.02	0.04	0.06	0.62	0.68
EBA	-0.20	-0.09	-0.08	-0.13	0.03	0.08	0.67	0.75
Mercosur	-0.23	-0.24	0.39	0.36	0.06	0.05	0.33	0.36
Rest ACP	-0.03	-0.11	1.24	1.05	0.15	0.17	1.05	1.15
Former Soviet Union	0.14	0.16	0.12	0.06	-0.02	-0.04	1.25	1.30
High Income Asian	0.48	0.57	0.45	0.43	0.06	0.06	0.20	0.20
Rest EFTA	0.48	0.53	0.73	0.71	0.16	0.16	0.26	0.26
Rest Asia	0.29	0.25	2.42	1.97	0.22	0.23	1.50	1.47
Rest Latin America	-0.02	-0.08	0.41	0.39	0.07	0.06	0.48	0.52
Mediterranean	0.11	0.11	0.65	0.58	0.07	0.01	0.46	0.48
Rest of World	0.14	0.10	0.60	0.56	0.11	0.10	0.58	0.63

Source: GTAP model simulation results.

Table 5.16: Armington Elasticities in Current Aggregation

Sector	*ESUBD*	*ESUBM*
Crops	2.66	5.17
Sugar	2.7	5.4
Cattle and sheep	2	4
Other livestock	1.3	2.6
Raw milk	3.65	7.3
Beef & sheepmeat	4.01	8.23
Other meat products	4.4	8.8
Dairy products	3.65	7.3
Beverages and tobacco	1.15	2.3
Other processed food products	2.18	4.34
Other primary products	4.47	12.22
Textiles, leather and clothing	3.78	7.58
Chemical & petroleum products	2.96	6.05
Mineral & metal products	3.39	6.94
Transport equipment	3.15	6.43
Electronic equipment	4.4	8.8
Other industries	3.67	7.69
Trade services	1.9	3.8
Transport services	1.9	3.8
Business & financial services	1.9	3.8
Other private services	1.9	3.8
Utilities & public services	2.03	4.08

Note: for an explanation of *ESUBM* and *ESUBD* see chapter 2.
Source: GTAP Database.

Table 5.17: Sensitivity Analysis of ESUBD in Trade Facilitation Simulation

(in 2001 US$ Millions)

Region	Welfare	Mean	Standard Deviation	95% Confidence Interval	
				lower	upper
Ireland	-95	-98	16.5	-172	-25
UK	270	242	127.4	-327	811
Germany	976	947	139.9	322	1573
France	697	681	113.2	175	1187
Rest EU15	2,978	2,956	178.0	2160	3751
CEEC	839	849	5.8	823	874
USA	7,340	7,239	432.4	5306	9171
Canada	1,278	1,286	27.4	1164	1408
China	10,925	10,990	26.7	10870	11109
India	2,367	2,379	54.8	2135	2624
EBA	1,976	1,986	69.8	1674	2298
Mercosur	2,072	2,098	37.3	1931	2264
Rest ACP	1,094	1,113	56.0	863	1363
Former Soviet Union	-224	-221	34.1	-374	-69
High Income Asian	8,155	8,134	149.0	7468	8800
Rest EFTA	464	461	22.6	360	561
Rest Asia	5,128	5,149	24.3	5040	5257
Rest Latin America	3,759	3,780	26.9	3659	3900
Mediterranean	1,921	1,920	119.6	1385	2454
Rest of World	2,461	2,493	66.7	2195	2791

Source: GTAP model simulation results.

Table 5.18: Sensitivity of the Agricultural Trade Liberalisation Component

(Welfare Change in 2001 US$ Millions)

Region	Standard Armington Elasticities	Armington Elasticities in Agricultural Sectors increased by 50 per cent
Ireland	-44	62
UK	1,725	3,901
Germany	607	1,868
France	405	113
Rest EU15	2,335	5,967
CEEC	41	1,599
USA	2,986	2,821
Canada	818	1,815
China	-558	514
India	159	334
EBA	-504	-305
Mercosur	1,816	3,356
Rest ACP	582	744
Former Soviet Union	268	246
High Income Asian	5,611	13,771
Rest EFTA	1,089	2,428
Rest Asia	403	836
Rest Latin America	-52	503
Mediterranean	-133	193
Rest of World	1,237	1,417
Total	18,794	42,184

Source: GTAP model simulation results.

Table 5.19: Sensitivity of the Baseline

Region	Baseline 1	Baseline 2	Variation (%)
Ireland	347	345	0.5
UK	1,532	1,532	0.0
Germany	2,220	2,230	-0.4
France	980	992	-1.2
Rest EU15	3,764	3,774	-0.2
CEEC	676	682	-1.0
USA	-3,126	-3,002	4.1
Canada	57	59	-4.0
China	5,719	5,455	4.8
India	1,970	1,962	0.4
EBA	124	130	-5.2
Mercosur	4,136	4,127	0.2
Rest ACP	180	182	-1.1
Former Soviet Union	1,333	1,339	-0.4
High Income Asian	16,971	16,986	-0.1
Rest EFTA	1,089	1,081	0.7
Rest Asia	4,671	4,660	0.2
Rest Latin America	4,026	4,030	-0.1
Mediterranean	255	254	0.3
Rest of World	3,583	3,579	0.1
Total	50,507	50,397	0.2

Source: GTAP model simulation results.

5.6 Boxes

Box 5.1: Summary of the Trade Liberalisation Scenario

Import Tariffs: applied agricultural and manufacturing import tariffs are reduced by 50, 34 and 0 per cent for industrialised, developing and least developed countries respectively.

Export Subsidies: a global elimination of agricultural export subsidies.

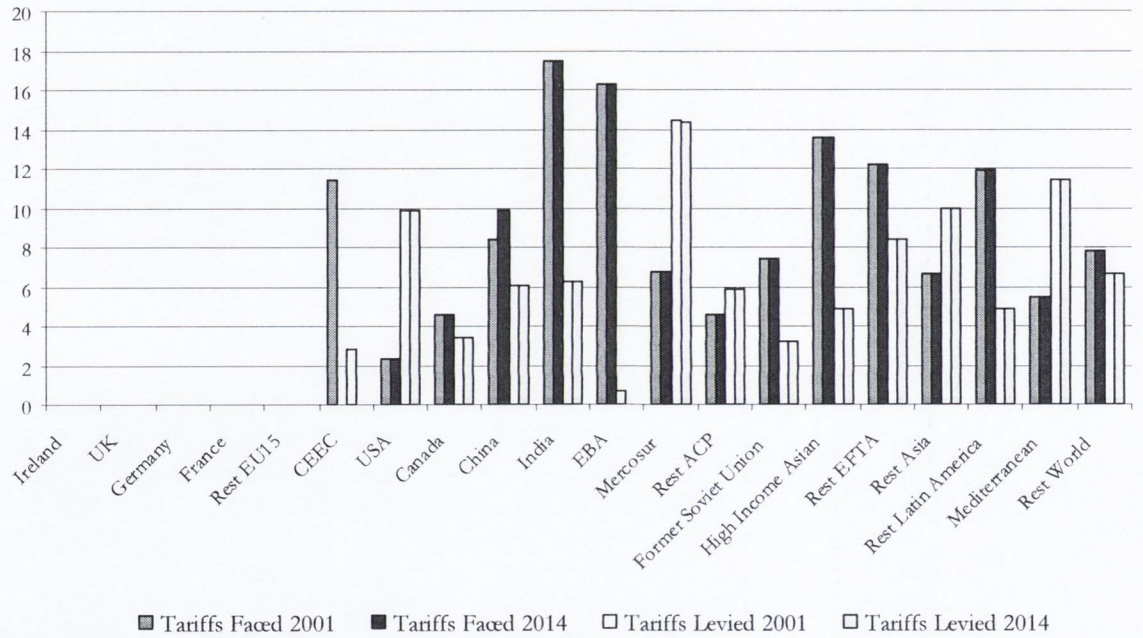
Domestic Support: trade-distorting domestic support is reduced by 20 per cent in the EU and USA and by 5 per cent elsewhere.

Services: a 50 per cent reduction in the tariff equivalents of barriers to trade in services. Special and differential treatment applies to developing regions. This is not applied to intra-EU trade in services or exports from the USA to Ireland.

Trade Facilitation: modelled as a reduction in the cost of importing all agricultural and manufacturing commodities (1.5 per cent cost reduction for least developed, 1 per cent for developing and 0.5 for industrialised countries). In the case of the EU, this applies only to imports from non-member countries.

5.7 Figures

Figure 5.1: Applied Trade Protection for Irish Exports and Imports



Source: GTAP model simulation results.

CHAPTER 6

THE DOHA DEVELOPMENT AGENDA:

MIXED PROSPECTS FOR DEVELOPING COUNTRIES

6.1 Introduction

This chapter examines the potential implications of a Doha Round agreement for developing countries. The approach is similar to chapter 5. The Global Trade Analysis Project (GTAP) model and database are used to quantify the effects of an agreement and the simulation is implemented against the same baseline projecting the world economy forward from 2001 to 2014. The major difference from chapter 5, other than the focus on developing countries, is that only an agricultural trade liberalisation scenario is simulated (as opposed to economy-wide liberalisation). The simulation is stylised, it does not attempt to capture recent modalities in the Doha Round negotiations.

The Doha Round has been termed the "Doha Development Agenda", as one of the principal ambitions set out in the Doha Declaration is that this Round should consider the needs of developing countries and that its outcome should be beneficial to them. Many developing countries felt that the benefits from the previous Uruguay Round were unfairly skewed in favour of the richer nations. The promise of a pro-development round, as a means of redressing some of these imbalances, was a necessary requirement for developing countries to agree to join a new round of trade negotiations.

Agriculture remains a key sector for many developing countries and the outcome of liberalisation of this sector will be an important determinant of whether these countries gain from the Round. Consequently, this paper focuses on modelling agricultural trade liberalisation.

As developing countries are not a homogenous group and therefore their responses to further trade liberalisation are expected to vary, special attention is given to considering the relative outcomes for two of the poorest groups of developing countries, defined as the EBA group and the Rest of ACP group. The former are the least developed countries benefiting from the EU's Everything But Arms (EBA) initiative.[92]. The latter are other African, Caribbean and Pacific (ACP) countries that benefit from preferential access to the EU market under the Cotonou Agreement but have less generous terms than the EBA group.

The focus on developing countries and, in particular, on these two groups of developing countries, reflects the fact that these countries' prospects from Doha are now at the centre of the political debate on the Round. The initial research on the Doha Round suggested that a successful agreement would have the potential to generate substantial benefits to the world economy, in particular for developing countries, and to lift millions out of poverty. The results produced by modellers became increasingly significant in the discourse surrounding the negotiations. The research suggested that the outcome of the Doha Round would indeed be pro-development and beneficial to developing countries, in the spirit of the Doha Declaration.

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[92] The EBA agreement covers trade between the EU and fifty of the world's least developed countries. Simply put, the EU has agreed to the unilateral elimination of tariffs and quotas on imports from these countries, on all commodities except those related to the arms trade. Effective from 2001 for most products, the EBA agreement was fully phased in by beginning of 2004. Full market access will be delayed for some sensitive products: bananas (January 2006), sugar (July 2009) and rice (September 2009).

However, in recent years the projected effects of a Doha Round agreement have been revised downward. This has largely been driven by the availability of better data and improved modelling techniques, further details of which are discussed in the next section. As this issue has become widely recognised within the political discourse on the Doha Round, it has highlighted attention on the methodologies employed. Increasingly the focus of research on this topic has been to understand the differences between the early, optimistic research and the revised, more pessimistic research.

This chapter considers two topics: the role of liberalisation by developing countries themselves and the erosion of preferential access to industrialised country markets. The contribution of this chapter is to show the importance of accurately modelling these two issues. This is done by illustrating their different effects on the two groups of developing countries mentioned above (the EBA region and the Rest of ACP region) and the significant role they play in the determining whether these regions are to benefit from further liberalisation.

The chapter is structured as follows. The next section describes the issues facing developing countries in the Doha Round and outlines the contribution of this chapter to the existing body of research. Section 6.3 describes the methodology. Section 6.4 presents the trade liberalisation scenario simulated in this chapter and discusses the results of this simulation. Section 6.5 concludes.

6.2 What's at Stake for Developing Countries in the Doha Round?

Even prior to the launch of the Doha Development Agenda in 2001, research on the potential effects of further trade liberalisation from a new Round had begun. As a primary aim of the Doha Round is the promotion of the development needs of less developed countries, a considerable body of literature on the subject has already been undertaken. Ackerman (2005), Charlton and Stiglitz (2005) and Bouet (2006) provide surveys of a range of computable general equilibrium (CGE) based estimates of the welfare gains to the world economy.[93] The magnitude of the results varies between studies, with the majority indicating that industrialised countries expect to achieve the largest share of the gains from liberalisation. This effect is particular strong in the areas of agricultural and service liberalisation but holds for other sectors also.

The effects for developing countries are generally found to be smaller, however most studies conclude that they will benefit in welfare terms from further liberalisation. When the welfare gains are measured as a percentage of Gross Domestic Product (GDP) rather than in absolute terms, in many cases the relative gains to developing countries will be greater than those achieved by the industrialised nations. Anderson *et al.* (2006) calculate the gains from the complete removal of protection on agricultural and manufacturing goods to be worth 1.2 per cent and 0.6 per cent of GDP for developing and industrialised countries respectively.

The results of Hertel and Keeney (2006) illustrate the contribution of reducing protection in agricultural sectors to the welfare effects of overall trade liberalisation. Although the

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[93] In addition, Bouet (2006) provides a detailed analysis of why CGE estimates of the impact of trade liberalisation on developing countries vary.

economic importance of agriculture has declined in recent decades, it remains a heavily protected sector in many countries. Hertel and Keeney estimate the global welfare gains from trade liberalisation to be $84 billion, of which $55 billion arise from agricultural trade liberalisation (reductions in import tariff, domestic support and export subsidies). As noted above, the largest share of these gains (in US dollar terms) accrues to industrialised countries (those that impose the highest levels of protection and make the largest cuts). However, the total welfare gain for developing countries from liberalisation is estimated as $22 billion, 55 per cent of which is due to agricultural liberalisation.

As noted above, developing countries are not heterogeneous. For example, they vary in terms of their level of economic development, their comparative advantage in different commodities and in their trading relationship with other countries and regions. This heterogeneity is further analysed in Diao *et al.* (2005), who examine in detail the agricultural production and trade patterns of developing countries.

From a CGE modelling perspective, Bouet *et al.* (2004) highlight the importance of accurately accounting for three factors: the choice of disaggregation of the developing countries, the degree of overhang (in tariffs and domestic support) and the existence of preferential agreements. Their estimates of the global welfare gains, and the gains to developing countries, are considerably lower than much of the previous literature. More recent research has begun to account for these factors. In particular, addressing the role of preferential trade agreements has been aided by the release of the version 6 GTAP database which incorporates such schemes.

The trade liberalisation scenario implemented in this chapter incorporates the three pillars of the Uruguay Round Agreement on Agriculture: market access, domestic support and

export competition. This chapter specifically examines the effects of further agricultural trade liberalisation on the global economy as well as looking in detail at two issues that will affect the outcomes for the poorest developing countries.

First, the trade liberalisation scenario simulated is broken down between the impact of liberalisation by industrialised and developing countries. As noted in earlier chapters, the GTAP model allows for the shocks applied to the various regions to be altered, allowing the simulation of special and differential treatment of developing countries and gives specific attention to analysing the impacts upon them.

Second, by comparing the outcomes for two similar groups of developing countries that enjoy different preferential trading arrangements with the European Union, the effects of the erosion of this advantage can be demonstrated as further liberalisation forces the EU to reduce the margin of preference accorded to these regions. These two groups are also different in that they will be asked to undertake different levels of commitments with respect to their own liberalisation under a Doha Round Agreement. The importance of these differences is underlined by the following analysis.

6.3 Methodology

6.3.1 Model and Database

The empirical research undertaken in this chapter follows closely that of the previous chapter. The GTAP model and database are employed to simulate further agricultural trade liberalisation. The details of the simulation are described in section 6.4.

The aggregation used is the same as chapter 5 and is reproduced in table 6.1. China, India, the Mercosur region, the Mediterranean rim countries and the remaining Asian and Latin American countries are all considered to be developing countries.[94] The two developing country regions that are the focus of this chapter are the EBA region and the Rest of ACP region. The EBA group of least developed countries is represented, although the GTAP aggregation does not permit the inclusion of all fifty EBA countries in this region, as many are not individually represented in the database.[95] The Rest of ACP region encompasses the remaining ACP countries that do not qualify for the EBA.[96]

This chapter employs a baseline pre-experiment that projects the world economy from 2001 (the base year of the current version of the GTAP database) to 2014. The construction of this baseline is described in chapter 5 and in the thesis appendix II. The macro-projections and policy events included in the baseline are the same in both chapters. The structural changes to the world economy included in this baseline are: the accession of the People's Republic of China to the World Trade Organisation (WTO); the Agenda 2000 and Mid-term Review reforms of the Common Agricultural Policy; the accession of twelve central and eastern European Countries to the EU; the full implementation of the EBA Agreement; and the elimination of Multi-Fibre Agreement textile quotas as foreseen under the Agreement on Textiles and Clothes.

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[94] The Rest of the World region is assumed to be a developing region also.

[95] EBA countries individually represented in the GTAP database are: Malawi, Mozambique, Tanzania, Zambia, Madagascar, Uganda and Bangladesh. The Rest of SADC and the Rest of Sub-Saharan Africa are also included in the EBA region.

[96] The same caveat applies the aggregated Rest of ACP region. Separately disaggregated in this region are Zimbabwe, Botswana, Rest of Caribbean and Central America.

6.3.2 Changes to Developing Countries over the Baseline 2001-2014

This section describes the changes in the structures of developing country economies over the period of the baseline 2001 to 2014. In particular, the focus is on the changes for the EBA group of the world's poorest countries and the Rest of the ACP region countries (tables 6.2.1 to 6.2.4 and 6.3.1 to 6.3.4 respectively). It is the structure of the world economy in 2014 that will determine the impact of WTO liberalisation, rather than economic and protection structures in 2001.

In the baseline period the average GDP growth rate is 62 per cent, with most developing countries regions growing at a rate close to the average. The EBA region grows slightly faster than average in GDP terms, however in capital accumulation and skilled labour terms, the region is projected to perform less well.

The dependence of EBA countries on exports of primary products (primarily minerals and oil) as well as textiles is highlighted by the self-sufficiency indicators in table 6.2. Domestic output in the EBA region increases across all sectors with particularly strong growth projected in sugar (among primary commodities), the transport and electronic sectors (in industry) and public services. This is driven by higher domestic consumption and by increased exports in these sectors. The changes reflect a shift from consumption of agricultural products to industrial goods as the region grows and becomes richer over the period of the baseline. Exports to EU and non-EU markets both increase, by approximately 30 per cent and 50 per cent respectively, encouraged in part by the implementation of the EU's EBA scheme.

Unlike the EBA region, the export surplus of the Rest of the ACP region is driven by high ratios of output to domestic consumption in the crops, sugar and transport services

sectors (table 6.3). Changes for the Rest of ACP region are broadly similar, if less pronounced, than for the EBA region. Output in the textiles and clothing sector increases by less than the average in both regions, and indeed exports from the Rest of ACP in this sector are projected to fall, reflecting the more intense competition from Asia, and in particular China, following the removal of MFA quotas.

6.4 Trade Liberalisation: Simulation and Results

This section describes the agricultural trade liberalisation scenario implemented in this chapter and presents the results. The scenario incorporates reductions in agricultural import tariffs, domestic support and export subsidies. This simulation is stylised because there is as yet no agreement on the modalities of a final agreement. The simulation is based on the Framework Agreement reached in July 2004.[97] As the Framework Agreement contains few specific figures or targets, certain assumptions have been made.

Special and differential treatment (SDT) of developing countries (DCs) is incorporated in the scenario where appropriate. As noted in section 6.3.1, the aggregation chosen in this chapter features eleven industrialised country (IC) regions and nine developing country regions. The EBA group of developing countries are assumed to be the world's poorest or least developed countries (LDC). Unless otherwise noted, SDT is assumed to imply that DCs implement two-thirds of the level of commitments (e.g., a tariff cut) undertaken by ICs and that LDCs are exempted from any reduction commitments.

The trade liberalisation shocks are implemented using the updated database created from the baseline pre-experiment. The shocks required to implement the trade liberalisation

[97] Details of July 2004 agreement available at www.wto.org.

scenario are thus implemented against this baseline featuring the global economy as projected in 2014.

To aid the analysis of the outcomes, the results of each shock are decomposed into the effects due to liberalisation of ICs and effects due to liberalisation of DCs. As noted in chapter 5, the results of any particular shock in a simulation can be decomposed into components known as "subtotals". Subtotals may be decomposed by region (in the example above) or by commodity.

6.4.1 Simulation Design

The simulation implemented is based on the agricultural trade liberalisation component of the stylised scenario in chapter 5 and is summarised in box 6.1. The same caveat discussed in chapter 5, regarding differences in bound and applied tariff rates and domestic support, applies in this simulation also. The reductions in tariffs and domestic support are implemented on applied rates, rather than on the bound rates on which WTO negotiations are based. This should be considered when analysing the results.

Market Access

Applied agricultural import tariffs are cut by 50 per cent in this simulation. The cut is linear across all agricultural sectors. To reflect the special and differential treatment of DCs, the import tariffs of these regions are subjected to a 34 per cent reduction, and LDCs are exempted from any reduction commitment.

Export Competition

The July 2004 Framework contains a commitment to fully phase out the use of export subsidies for agricultural products and therefore their complete elimination has been implemented in the simulation.

Domestic Support

On domestic support, the only firm commitment contained in the Framework is the agreement that overall trade distorting support will not exceed 80 per cent of its current level by the end of the first year. This includes final bound AMS (aggregate measure of support), the permitted *de minimis* levels and permitted blue box levels, with future reductions to be based on a tiered formula implying greater reductions for those countries that maintain the highest levels of support.

As discussed in chapter 3, domestic support as currently represented in the GTAP model does not allow for a full analysis of overall distorting support as defined in the July Framework. In this simulation, reductions in domestic support are simulated as cuts to direct payments linked to production, intermediate input subsidies and output subsidies. The scenario implemented is a modest reduction of 20 per cent for non-exempt support in the EU and USA and 5 per cent for all other regions reflecting the tiered formula approach whereby those with higher levels of trade distorting support are expected to implement the most substantial cuts. As in the case of market access, results are decomposed by the source of the reductions.

6.4.2 Results

The results of the experiment outlined above are presented in this section. Although the overall results for the world economy are the same as those in the previous chapter, an

overview is presented and the share of the gains to developing countries are first discussed. This is followed by a more detailed analysis of the impacts on developing countries of further liberalisation as simulated in this study and an explanation of the factors driving these results. All results presented are net of the effect of the macro-economic projections and policy changes built into the baseline, allowing the isolation of the effects due to the various trade liberalisation scenarios. The results are decomposed by liberalisation by IC and DC regions.

Global Effects

The global change in welfare, as measured by the equivalent variation in millions of US dollars and as a percentage of GDP in 2014, are presented in table 6.4. The net result is a gain for the world economy as whole of 0.05 per cent of GDP. The modest nature of the estimated gains reflects, in part, the nature of the model being used (a static, one-period model assuming fixed resources and perfect competition, so the only source of gains from trade liberalisation arise from the reallocation of resources between sectors and any consequential terms of trade effects on individual countries). They also reflect the limited nature of the trade liberalisation scenario which is undertaken (a partial reduction in tariffs and other trade-distorting measures, but only in the agricultural sector). The liberalisation of all three pillars generates positive welfare impacts overall, with the largest contribution from tariff reductions, followed by domestic support and export subsidies, a finding further discussed in chapter 3.

Across the different regions identified in the model, the results are more mixed. The major winners are the countries that impose the most significant distortions on agricultural trade. It is typical in such simulations to observe welfare gains due to improved allocative efficiency when these distortions are reduced. Net exporters of

agricultural commodities, such as the Mercosur region, also perform strongly. The EU gains from the export subsidy elimination at the expense of net-food importing regions.

Overview of Results for Developing Countries

Eight of the twenty regions disaggregated in this study are considered to be DCs. This section presents the results for DCs overall, whilst the following section focuses on two of these groups of countries in more detail.

As table 6.4 shows, in GDP terms, the Rest of ACP, Mercosur and the Rest of World are the biggest winners in welfare terms. Their gains are considerably above the world average. Four DC regions, the EBA group, China, Rest of Latin America and the Mediterranean, suffer a welfare loss from liberalisation. Table 6.4 also confirms the importance of tariff reductions, compared to domestic support cuts and export subsidy elimination, to the total welfare gain for developing countries. The relatively small contribution from domestic support arises from the modest nature of the cuts assumed.

In table 6.5, the distribution of the global welfare gains compares the contribution by regions implementing reform to those that capture the benefits. At the global level, approximately 85 per cent of the welfare gains are due to liberalisation of ICs compared to 15 per cent from DC liberalisation. The main source of gains for ICs is liberalisation by ICs themselves, but the gains for DCs derive almost equally from liberalisation by ICs and liberalisation from within their own group of countries. Whilst DCs gains from increased access to IC markets as a result of lower import tariffs imposed on their exports, they also increase their welfare as a result of allocative efficiency gains from reducing their own tariff protection.

Changes in wages are shown in table 6.10, calculated as the change in the ratio of the returns to skilled and unskilled labour to the CPI in each region, respectively. These results reinforce the welfare change results. Regions that enjoy improved welfare from liberalisation will also see returns to labour increase, with a likely positive impact on poverty.

Factors Underlying the Impacts of Liberalisation on Developing Regions

In this section, the results of the EBA region and the Rest of the ACP region are examined in detail. This comparison is revealing for two reasons. First, between them these regions represent most of the poorest countries in the study. The way in which they are affected by agricultural trade liberalisation is one measure of whether the Doha Round can live up to its promise to be a Development Round. Second, despite their similarities, they experience very different outcomes from further trade liberalisation as simulated in this chapter. Comparison of the two illustrates the challenges and opportunities for DCs in the Doha Development Agenda.

As indicated in table 6.4, the EBA group of countries experiences a decrease in their welfare resulting from trade liberalisation. By contrast, the Rest of ACP region is one of the biggest winners in GDP terms. By comparing the impact of liberalisation on these two regions, the two principal reasons for these differences are identified: (i) the importance of allocative efficiency gains and the impact of special and differential treatment for DCs; and (ii) the impact of the erosion of preferential access to IC markets.

As already noted, for most regions in this study, the major benefits are driven by their own trade liberalisation and the improvements in allocative efficiency that arise from the elimination of their own barriers to trade. The reduction in distortionary tariffs or

subsidies allows resources within a country, which were previously tied up in subsidised sectors, to be reallocated to other sectors of the economy in which they will earn a higher return. Using these resources more efficiently increases the welfare of the region.

The effect of reallocating resources is illustrated by the plight of the EBA region. Special and differential treatment of developing countries implies that this region, composed of the least developed economies in the world, is exempt from commitments to liberalise. Their lack of liberalisation means they do not enjoy the gains in allocative efficiency that other regions achieve. This contrasts sharply with the outcome for the Rest of ACP group. This group also receives special and differential treatment but to a lesser degree. This is confirmed by table 6.6, which shows the decomposition of the welfare change into allocative efficiency, terms of trade and investment-and-savings price effects, for the EBA and Rest of ACP regions. The contribution of allocative efficiency to welfare change for the EBA region is negative, this is due to further resources being drawn into protected sectors. The Rest of ACP by contrast enjoys strong welfare gains from improvements in allocative efficiency.

The second loss from trade liberalisation faced by the EBA region and, to a lesser degree, the Rest of ACP group arises from a loss of preferential access to IC markets, and particularly the EU market.[98] Under the EBA Agreement, implemented in the baseline, all exports from this region receive tariff free access to EU markets. The Rest of ACP also receives preferential access to EU markets, granted under the Cotonou Agreement. However, the preference margin is considerably smaller as tariffs are still imposed on imports of many commodities from this region to the EU (see table 6.3.4).

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[98] The Mediterranean rim countries also suffer a similar welfare loss resulting from the erosion of their preferential access to the EU.

As tariffs on EBA exports to the EU are already abolished, further liberalisation is not possible between regions. However, the Common External Tariff of the EU, imposed on imports of third countries entering the EU, is reduced as part of the liberalisation process and thus third countries can sell their goods more cheaply on the EU market. This erodes the preference margin of the EBA region exporters against third country producers and they also face increased competition on EU markets. The Rest of ACP region's preference margin is also reduced but by a lesser extent.

Table 6.7 shows an alternative decomposition of the welfare effects on the EBA and Rest of ACP regions of EU agricultural tariff liberalisation alone.[99] In table 6.7, the effect of reducing tariffs on agricultural goods from the region in question to the EU (subtotal 3) illustrates the gains achieved by the Rest of ACP region from cuts in the tariffs faced by their exports to the EU ($727 million) compared to same effect for the EBA region ($0 as no such barriers remain to be cut). Whilst it might be expected that the impact of third country exporters gaining increased access to EU markets (subtotal 7) would be negative for both regions, these welfare measures also capture some impacts on each region's terms of trade position from which it may benefit.

This result is further illustrated in tables 6.8 and 6.9. Table 6.8 shows the total changes in exports for both the EBA and Rest of ACP regions. EBA exports of most agricultural commodities fall as a result of trade liberalisation. In table 6.9 each region's share of total

[99] The tariff liberalisation results for EBA and Rest of ACP are decomposed into eight subtotals representing the impact of reducing EBA/ACP import tariffs on goods from the EU (1) and from third countries (2) and the reduction on tariffs on EBA/ACP exports to the EU (3) and to the rest of the world (4). Subtotal (5) shows the impact of the reduction in imports tariffs on trade between EBA/ACP regions themselves. The next two subtotals calculate the impact on EBA/ACP of the reductions in EU tariffs on goods from the rest of the world (6) and of rest of the world tariffs on EU exports (7). Subtotal (8) calculates the residual effect from trade liberalisation between third regions.

EU imports (as a percentage) is shown before and after the trade liberalisation simulation. The percentage of EU imports originating in the EBA region falls in crops, sugar, other livestock, beef and sheepmeat, other meat products and diary products. It should be noted that EU total imports increase as a result of trade liberalisation. Not only is the EBA's import share lower, the volume of imports (in US dollars) from this region to the EU is also decreasing in all these commodities. For the Rest of ACP, the results vary across commodities. The Rest of ACP's import share increases significantly in crops, sugar and beef and sheepmeat. All three are important export sectors for this region.

6.4 Conclusion

The GTAP model is used to estimate the potential effects on the global economy of a successful conclusion to the Doha Round. Initial research suggested that a successful outcome to the Round would have the potential to generate substantial benefits to the world economy. However, in recent years the projected effects of an agreement have been revised downward. This chapter examines a number of reasons behind this change and their impact on the outcome of the Round for developing countries.

Agricultural trade liberalisation as simulated in this chapter consists of a stylised scenario, incorporating improvements in market access, domestic support and export competition. The shocks do not represent attempts to model specific modalities of the ongoing negotiations, rather they are broad measures designed to generate results that will be indicative of future changes. The simulation is implemented against a baseline projection of the world economy over the next decade.

Particular attention is given to comparing the differences in results of liberalisation by industrialised countries and by developing countries and on the analysis of the outcomes for the latter group. The focus is on the radically different projected outcomes for two of the poorest groups of developing countries, the least developed countries (here called the EBA group) and other, mainly African, countries which are part of the Rest of ACP group.

The study draws important conclusions about the likely impact of further agricultural trade liberalisation for developing countries. Most developing regions can expect strong positive results from a successful conclusion to the Round. However, these gains often depend on developing countries undertaking their own liberalisation, and whether they will happen must be uncertain. One message of this study is that the removal of trade barriers by developing countries not only helps to reduce the costs of their own inappropriate domestic policies but also encourages imports from other developing countries as well.

The more direct impact of the removal of trade barriers by industrialised countries is more ambiguous. The Mercosur group, Rest of ACP countries and the Rest of the World (which includes Australia, New Zealand and South Africa) will benefit significantly. However, EBA countries and Mediterranean countries will lose because of the erosion of their benefits from preferential access to industrialised country markets, particularly the EU. If the poorest developing countries are to benefit from the Doha Round, this issue of preference erosion must be addressed. Development assistance to help these countries to improve their supply-side responses may be more important than further trade liberalisation *per se*.

6.5 Tables

Table 6.1: Regional and Sectoral Aggregation

Regions	Sectors
Ireland	Cereals, other crops and horticulture
United Kingdom	Sugar, plants and processed
Germany	Cattle and sheep
France	Other livestock (swine, poultry…)
Rest of EU15	Raw milk
New Members / Accession countries	Beef & sheepmeat (+wool)
USA	Other meat products
Canada	Dairy
China	Beverages and tobacco
India	Other processed food products
Everything-But-Arms group of countries	Other primary products (extraction, fishing & forestry)
Mercosur	Textiles, leather and clothing
Rest of African Caribbean Pacific countries	Chemical and petroleum products
Former Soviet Union countries	Mineral and metal products
High Income Asian Countries	Transport equipment
Rest of European Free Trade Area	Electronic equipment
Rest of Asia	Other industries
Rest of Latin America	Trade services
Turkey, Middle-East and North Africa	Transport services
Rest of the World	Business and financial services
	Other private services
	Utilities and public services

Table 6.2.1: Structure of the EBA Region Economy in 2001 and 2014

(2001 US$ Millions)

2001	Value of Exports		Value of Imports		Output	Domestic Consumption	Self Sufficiency[1]
	Intra-EU	Extra-EU	Intra-EU	Extra-EU			
Crops	4,020	4,202	663	4,025	69,904	66,370	1.05
Sugar	399	153	60	637	10,411	10,556	0.99
Cattle and sheep	10	84	1	89	10,288	10,284	1.00
Other livestock	112	148	42	87	6,759	6,626	1.02
Raw milk	3	5	1	2	4,447	4,441	1.00
Beef & sheepmeat	12	47	57	227	3,641	3,865	0.94
Other meat products	25	153	292	313	4,838	5,265	0.92
Dairy products	10	29	637	419	1,741	2,759	0.63
Beverages and tobacco	54	168	905	1,082	20,019	21,784	0.92
Other processed food	2,113	1,992	1,941	5,512	41,588	44,936	0.93
Other primary products	6,998	22,207	75	1,868	63,675	36,413	1.75
Textiles, leather and clothing	7,625	12,015	1,080	9,410	49,174	40,024	1.23
Chemical & petroleum	518	1,981	5,657	12,996	27,520	43,674	0.63
Mineral & metal products	2,259	2,209	2,993	7,458	27,571	33,554	0.82
Transport equipment	862	601	4,580	8,265	11,870	23,253	0.51
Electronic equipment	116	162	1,793	2,518	4,016	8,049	0.50
Other industries	3,475	1,823	8,847	11,600	34,414	49,563	0.69
Trade services	565	683	1,110	1,731	71,032	72,626	0.98
Transport services	1,894	3,277	1,727	2,722	48,873	48,150	1.02
Business & financial services	1,427	2,069	3,604	4,415	46,917	51,440	0.91
Other private services	248	365	578	665	90,487	91,116	0.99
Utilities & public services	807	2,838	848	2,261	72,446	71,909	1.01

2014	Value of Exports		Value of Imports		Output	Domestic Consumption	Self Sufficiency[1]
	Intra-EU	Extra-EU	Intra-EU	Extra-EU			
Crops	5,528	4,389	819	7,715	104,676	103,293	1.01
Sugar	3,976	217	72	1,120	21,429	18,428	1.16
Cattle and sheep	24	180	1	181	18,325	18,302	1.00
Other livestock	104	135	67	175	11,626	11,628	1.00
Raw milk	0	0	1	13	7,532	7,546	1.00
Beef & sheepmeat	44	130	34	405	6,876	7,142	0.96
Other meat products	38	213	418	985	8,570	9,721	0.88
Dairy products	25	37	817	1,325	2,943	5,023	0.59
Beverages and tobacco	68	252	1,483	1,856	34,126	37,145	0.92
Other processed food	1,900	2,286	3,272	10,234	62,999	72,318	0.87
Other primary products	2,269	13,296	301	2,397	97,452	84,584	1.15
Textiles, leather and clothing	8,673	12,519	1,059	17,254	69,662	66,783	1.04
Chemical & petroleum	499	2,986	13,400	20,693	46,974	77,582	0.61
Mineral & metal products	4,079	4,475	4,530	13,611	50,776	60,364	0.84
Transport equipment	2,842	1,797	5,464	13,104	26,994	40,924	0.66
Electronic equipment	431	702	1,517	4,336	9,456	14,175	0.67
Other industries	7,648	3,479	9,811	22,010	66,633	87,328	0.76
Trade services	1,016	1,547	1,496	2,606	128,538	130,077	0.99
Transport services	3,722	6,657	2,434	4,399	94,181	90,635	1.04
Business & financial services	2,690	4,304	5,078	7,114	90,656	95,854	0.95
Other private services	398	607	907	1,120	155,924	156,946	0.99
Utilities & public services	1,709	6,120	1,246	3,944	151,863	149,224	1.02

Note 1: self-sufficiency calculated as sum of value of domestic production divided by value of domestic consumption.

Source: GTAP Version 6.0 database.

Table 6.2.2: Change in the EBA Region Economy in 2001-2014 – Sectoral Changes

2001 - 2014	Change in Exports		Change in Imports		Change in Output		Change in Domestic Consumption		Change in Trade Balance ($M)	Change in Self-Sufficiency
	$M	%	$M	%	$M	%	$M	%		
Crops	1,695	21	3,847	82	34,772	50	36,923	56	-2,152	-0.04
Sugar	3,640	659	494	71	11,018	106	7,871	75	3,147	0.18
Cattle and sheep	110	118	91	101	8,037	78	8,018	78	19	0.00
Other livestock	-22	-8	113	89	4,867	72	5,002	75	-135	-0.02
Raw milk	-8	-92	12	573	3,085	69	3,105	70	-20	0.00
Beef & sheepmeat	115	194	156	55	3,235	89	3,276	85	-41	0.02
Other meat products	72	41	798	132	3,731	77	4,457	85	-725	-0.04
Dairy products	23	60	1,085	103	1,202	69	2,264	82	-1,062	-0.05
Beverages and tobacco	97	44	1,351	68	14,107	70	15,361	71	-1,253	0.00
Other processed food products	82	2	6,052	81	21,411	51	27,382	61	-5,971	-0.05
Other primary products	-13,640	-47	754	39	33,777	53	48,171	132	-14,395	-0.60
Textiles, leather and clothing	1,552	8	7,823	75	20,488	42	26,759	67	-6,271	-0.19
Chemical & petroleum products	986	39	15,441	83	19,454	71	33,908	78	-14,454	-0.02
Mineral & metal products	4,085	91	7,690	74	23,205	84	26,810	80	-3,605	0.02
Transport equipment	3,176	217	5,724	45	15,124	127	17,671	76	-2,547	0.15
Electronic equipment	854	307	1,541	36	5,440	135	6,126	76	-687	0.17
Other industries	5,829	110	11,374	56	32,219	94	37,764	76	-5,545	0.07
Trade services	1,315	105	1,261	44	57,506	81	57,452	79	55	0.01
Transport services	5,208	101	2,384	54	45,308	93	42,485	88	2,823	0.02
Business & financial services	3,498	100	4,174	52	43,739	93	44,414	86	-676	0.03
Other private services	391	64	783	63	65,438	72	65,830	72	-392	0.00
Utilities & public services	4,184	115	2,081	67	79,417	110	77,315	108	2,102	0.01

Source: GTAP model simulation results.

Table 6.2.3: Change in the EBA Economy in 2001-2014

Aggregate Changes

	Output ($M)			Share of GDP		Share of Value of Returns to Labour by Sector					
	2001	2014	Growth Rate	2001	2014	Unskilled Labour		Skilled Labour		Total Labour Force	
						2001	2014	2001	2014	2001	2014
Agriculture	112,029	181,977	62%	20%	21%	11%	27%	1%	1%	8%	21%
Manufacturing	279,847	465,073	66%	23%	25%	34%	18%	15%	9%	28%	16%
Services	329,754	621,162	88%	57%	54%	55%	56%	83%	90%	64%	63%
Total	721,631	1,268,212	76%	100%	100%	100%	100%	100%	100%	100%	100%

Source: GTAP model simulation results.

Table 6.2.4: Applied Trade Protection for EBA Region Economy in 2001 and 2014

(Trade-weighted Averages in %)

2001	EU Trade		All Trade	
	Average Import Protection	Average Export Protection	Average Import Protection	Average Export Protection
Crops	17.9	3.5	9.9	8.7
Sugar	22.1	79.0	20.7	60.5
Cattle and sheep	7.8	0.4	14.1	11.3
Other livestock	25.4	0.5	15.3	1.8
Raw milk	0.0	0.0	0.0	0.0
Beef & sheepmeat	13.6	3.1	12.7	2.8
Other meat products	29.6	6.1	22.1	40.2
Dairy products	13.6	9.4	15.0	13.2
Beverages and tobacco	47.8	2.0	44.2	19.2
Other processed food products	26.7	0.7	24.7	4.4
Other primary products	9.5	0.0	12.6	0.4
Textiles, leather and clothing	27.8	0.9	23.6	7.1
Chemical & petroleum products	16.0	0.1	13.7	6.9
Mineral & metal products	20.5	0.3	16.0	2.9
Transport equipment	15.1	1.0	17.1	2.6
Electronic equipment	12.8	0.2	11.9	2.9
Other industries	16.6	0.1	13.3	2.1
Trade services	0.0	0.0	0.0	0.0
Transport services	0.0	0.0	0.0	0.0
Business & financial services	0.0	0.0	0.0	0.0
Other private services	0.0	0.0	0.0	0.0
Utilities & public services	0.0	0.0	0.1	0.1

2014	EU Trade		All Trade	
	Average Import Protection	Average Export Protection	Average Import Protection	Average Export Protection
Crops	9.1	0.0	9.5	5.9
Sugar	21.9	0.0	20.9	0.7
Cattle and sheep	6.1	0.0	14.1	11.3
Other livestock	23.5	0.0	14.9	2.2
Raw milk	0.0	0.0	0.0	0.0
Beef & sheepmeat	10.2	0.0	16.2	2.1
Other meat products	24.0	0.0	21.6	39.1
Dairy products	13.6	0.0	15.7	8.7
Beverages and tobacco	47.3	0.0	44.5	21.0
Other processed food products	23.0	0.0	24.6	4.9
Other primary products	7.4	0.0	11.5	1.8
Textiles, leather and clothing	24.3	0.0	24.8	6.6
Chemical & petroleum products	14.3	0.0	14.1	8.2
Mineral & metal products	18.0	0.0	16.4	3.0
Transport equipment	13.1	0.0	17.7	1.6
Electronic equipment	10.9	0.0	12.9	3.2
Other industries	13.6	0.0	13.4	2.1
Trade services	0.0	0.0	0.0	0.0
Transport services	0.0	0.0	0.0	0.0
Business & financial services	0.0	0.0	0.0	0.0
Other private services	0.0	0.0	0.0	0.0
Utilities & public services	0.0	0.0	0.0	0.0

Source: GTAP Version 6.0 database and model simulation results.

Table 6.3.1: Structure of the Rest of ACP Region Economy in 2001 and 2014

(2001 US$ Millions)

2001	Value of Exports		Value of Imports		Output	Domestic Consumption	Self Sufficiency[1]
	Intra-EU	Extra-EU	Intra-EU	Extra-EU			
Crops	2,010	2,610	136	1,544	11,565	8,626	1.34
Sugar	97	1,133	2	66	2,688	1,526	1.76
Cattle and sheep	5	44	2	47	2,224	2,223	1.00
Other livestock	21	46	6	62	1,834	1,836	1.00
Raw milk	1	1	0	1	1,293	1,292	1.00
Beef & sheepmeat	79	164	12	166	2,775	2,710	1.02
Other meat products	24	46	52	265	2,135	2,383	0.90
Dairy products	23	97	140	444	2,380	2,843	0.84
Beverages and tobacco	143	289	289	326	4,383	4,566	0.96
Other processed food	402	1,516	285	2,241	9,793	10,402	0.94
Other primary products	82	298	26	2,509	3,439	5,594	0.61
Textiles, leather and clothing	260	7,455	349	7,368	14,535	14,538	1.00
Chemical & petroleum	394	2,998	1,421	7,646	11,406	17,080	0.67
Mineral & metal products	368	1,671	887	3,333	8,055	10,235	0.79
Transport equipment	658	844	1,851	10,375	3,418	14,141	0.24
Electronic equipment	488	1,344	495	2,699	2,630	3,992	0.66
Other industries	2,791	2,413	2,525	7,325	13,101	17,747	0.74
Trade services	347	438	235	630	21,868	21,947	1.00
Transport services	1,680	2,511	520	927	15,550	12,806	1.21
Business & financial services	813	1,254	929	1,218	17,336	17,415	1.00
Other private services	246	346	232	276	25,231	25,148	1.00
Utilities & public services	494	903	238	876	32,992	32,710	1.01

2014	Value of Exports		Value of Imports		Output	Domestic Consumption	Self Sufficiency[1]
	Intra-EU	Extra-EU	Intra-EU	Extra-EU			
Crops	3,203	3,589	127	2,259	16,759	12,353	1.36
Sugar	88	1,700	1	94	3,921	2,228	1.76
Cattle and sheep	11	73	1	73	3,086	3,076	1.00
Other livestock	30	59	7	97	2,507	2,522	0.99
Raw milk	4	1	0	1	1,834	1,829	1.00
Beef & sheepmeat	110	163	9	290	3,766	3,792	0.99
Other meat products	27	43	45	587	2,773	3,335	0.83
Dairy products	74	209	88	660	3,901	4,368	0.89
Beverages and tobacco	197	430	379	463	6,553	6,767	0.97
Other processed food	527	1,955	358	3,347	13,645	14,868	0.92
Other primary products	32	346	42	2,176	5,020	6,860	0.73
Textiles, leather and clothing	221	7,243	332	9,656	17,449	19,974	0.87
Chemical & petroleum	322	3,275	2,519	11,813	14,645	25,381	0.58
Mineral & metal products	615	2,893	1,304	5,129	13,521	16,446	0.82
Transport equipment	1,175	1,546	2,761	15,471	6,234	21,745	0.29
Electronic equipment	816	2,567	394	4,250	5,203	6,464	0.80
Other industries	5,961	4,375	2,846	10,932	24,152	27,593	0.88
Trade services	540	821	320	830	34,912	34,701	1.01
Transport services	3,093	4,814	645	1,328	26,712	20,778	1.29
Business & financial services	1,531	2,613	1,108	1,666	29,771	28,400	1.05
Other private services	470	688	284	362	39,100	38,588	1.01
Utilities & public services	1,209	2,199	243	1,150	55,732	53,718	1.04

Note 1: self-sufficiency calculated as sum of value of domestic production divided by value of domestic consumption.

Source: GTAP Version 6.0 database.

Table 6.3.2: Change in the Rest of ACP Region Economy in 2001-2014 – Sectoral Changes

2001 - 2014	Change in Exports		Change in Imports		Change in Output		Change in Domestic Consumption		Change in Trade Balance ($M)	Change in Self-Sufficiency
	$M	%	$M	%	$M	%	$M	%		
Crops	2,173	47	706	42	5,194	45	3,727	43	1,467	0.02
Sugar	558	45	27	40	1,233	46	702	46	531	0.00
Cattle and sheep	35	70	25	51	862	39	852	38	10	0.00
Other livestock	22	34	35	52	673	37	686	37	-13	0.00
Raw milk	3	131	0	50	541	42	538	42	3	0.00
Beef & sheepmeat	30	12	121	68	990	36	1,081	40	-91	-0.03
Other meat products	0	0	314	99	638	30	952	40	-314	-0.06
Dairy products	162	136	165	28	1,522	64	1,524	54	-3	0.06
Beverages and tobacco	195	45	227	37	2,170	50	2,202	48	-32	0.01
Other processed food products	565	29	1,179	47	3,852	39	4,466	43	-614	-0.02
Other primary products	-3	-1	-318	-13	1,581	46	1,266	23	315	0.12
Textiles, leather and clothing	-251	-3	2,271	29	2,914	20	5,436	37	-2,522	-0.13
Chemical & petroleum products	204	6	5,266	58	3,240	28	8,301	49	-5,061	-0.09
Mineral & metal products	1,469	72	2,214	52	5,466	68	6,211	61	-745	0.04
Transport equipment	1,219	81	6,006	49	2,816	82	7,603	54	-4,787	0.05
Electronic equipment	1,551	85	1,449	45	2,573	98	2,471	62	101	0.15
Other industries	5,133	99	3,927	40	11,051	84	9,846	55	1,205	0.14
Trade services	576	73	286	33	13,044	60	12,754	58	290	0.01
Transport services	3,717	89	526	36	11,162	72	7,972	62	3,191	0.07
Business & financial services	2,078	101	627	29	12,435	72	10,984	63	1,451	0.05
Other private services	567	96	137	27	13,869	55	13,440	53	429	0.01
Utilities & public services	2,011	144	279	25	22,740	69	21,008	64	1,732	0.03

Source: GTAP model simulation results.

Table 6.3.3: Change in the Rest of ACP Economy in 2001-2014

Aggregate Changes

	Output ($M)			Share of GDP		Share of Value of Returns to Labour by Sector					
	2001	2014	Growth Rate	2001	2014	Unskilled Labour		Skilled Labour		Total Labour Force	
						2001	2014	2001	2014	2001	2014
Agriculture	26,894	38,546	43%	16%	17%	21%	21%	2%	2%	16%	16%
Manufacturing	70,758	106,422	50%	27%	27%	30%	30%	14%	14%	26%	26%
Services	112,977	186,228	65%	56%	55%	49%	49%	84%	84%	58%	59%
Total	210,629	331,196	57%	100%	100%	100%	100%	100%	100%	100%	100%

Source: GTAP model simulation results.

Table 6.3.4: Applied Trade Protection for Rest of ACP Region in 2001 and 2014

(Trade-weighted Averages in %)

2001	EU Trade		All Trade	
	Average Import Protection	Average Export Protection	Average Import Protection	Average Export Protection
Crops	49.7	19.8	6.1	10.6
Sugar	72.0	118.7	24.4	36.3
Cattle and sheep	3.6	0.0	0.5	0.9
Other livestock	24.4	0.7	3.1	1.5
Raw milk	0.0	0.0	0.0	0.0
Beef & sheepmeat	47.2	73.4	5.5	33.1
Other meat products	48.2	6.4	13.5	6.2
Dairy products	23.4	5.8	15.7	7.7
Beverages and tobacco	27.2	8.7	19.8	8.8
Other processed food products	32.7	5.8	7.9	3.5
Other primary products	5.2	0.4	0.3	1.8
Textiles, leather and clothing	162.6	1.2	13.8	11.4
Chemical & petroleum products	11.5	0.2	4.2	2.5
Mineral & metal products	10.3	0.1	5.4	1.9
Transport equipment	9.4	1.0	10.5	2.1
Electronic equipment	9.7	0.1	4.7	1.8
Other industries	12.8	0.0	5.8	1.3
Trade services	0.0	0.0	0.0	0.0
Transport services	0.0	0.0	0.0	0.0
Business & financial services	0.0	0.0	0.0	0.0
Other private services	0.0	0.0	0.0	0.0
Utilities & public services	0.0	0.0	0.0	0.0

2014	EU Trade		All Trade	
	Average Import Protection	Average Export Protection	Average Import Protection	Average Export Protection
Crops	3.5	20.2	6.1	11.2
Sugar	13.1	117.1	24.6	33.5
Cattle and sheep	3.2	0.0	0.4	1.1
Other livestock	4.9	0.8	3.3	1.8
Raw milk	0.0	0.0	0.0	0.0
Beef & sheepmeat	7.3	73.9	6.1	37.9
Other meat products	14.0	6.8	14.1	6.0
Dairy products	20.3	5.7	15.3	7.3
Beverages and tobacco	25.1	8.7	19.7	9.5
Other processed food products	9.6	5.7	8.0	3.8
Other primary products	2.0	0.7	0.3	2.6
Textiles, leather and clothing	14.9	1.4	13.5	11.5
Chemical & petroleum products	5.8	0.4	4.3	2.8
Mineral & metal products	8.2	0.3	5.5	2.0
Transport equipment	7.9	1.2	10.3	2.0
Electronic equipment	6.9	0.9	6.0	2.4
Other industries	7.6	0.1	6.0	1.4
Trade services	0.0	0.0	0.0	0.0
Transport services	0.0	0.0	0.0	0.0
Business & financial services	0.0	0.0	0.0	0.0
Other private services	0.0	0.0	0.0	0.0
Utilities & public services	0.0	0.0	0.0	0.0

Source: GTAP Version 6.0 database and model simulation results.

Table 6.4: Global Welfare Effects of Trade Liberalisation

(2001 US$ Millions)

Region	Total	% of GDP	Domestic Support Reduction EU & USA	Domestic Support Reduction Rest of World	Tariff Reduction IC	Tariff Reduction DC	Export Subsidy Abolished	EU Budgetary Effect
Ireland	**-44**	**-0.03**	2	1	90	19	34	-190
UK	**1,725**	**0.10**	29	14	1,341	54	-50	338
Germany	**607**	**0.03**	60	11	237	29	218	50
France	**405**	**0.03**	9	3	290	22	308	-227
Rest EU15	**2,335**	**0.06**	52	19	1,668	-93	841	-152
CEEC	**41**	**0.01**	-42	-3	-258	-8	170	181
USA	**2,986**	**0.03**	20	-48	1,670	1,211	133	-
Canada	**818**	**0.10**	-37	8	653	182	12	-
China	**-558**	**-0.03**	-1	18	-264	-290	-21	-
India	**159**	**0.02**	-9	1	42	111	14	-
EBA	**-504**	**-0.08**	3	3	-347	77	-239	-
Mercosur	**1,816**	**0.18**	-34	-15	1,257	501	106	-
Rest ACP	**582**	**0.40**	-5	-4	581	8	3	-
Former Soviet Union	**268**	**0.04**	56	2	271	163	-224	-
High Income Asian	**5,611**	**0.09**	149	-3	5,928	-267	-195	-
Rest EFTA	**1,089**	**0.20**	20	7	944	125	-8	-
Rest Asia	**403**	**0.06**	0	4	212	273	-87	-
Rest Latin America	**-52**	**0.00**	43	11	88	-17	-177	-
Mediterranean	**-133**	**-0.01**	70	36	221	321	-782	-
Rest of World	**1,237**	**0.15**	-85	-18	712	393	235	-
Total	**18,794**	**0.05**	303	48	15,338	2,815	291	0

Source: GTAP model simulation results.

Table 6.5: Distribution of Global Welfare Change (%)

Liberalising Region / *Benefiting Region*		Domestic Support	Tariffs and Export Subsidies	Total
IC				
	IC	1.7	74.9	76.6
	DC	-0.1	8.3	8.2
	Total	*1.6*	*83.2*	*84.8*
DC				
	IC	0.1	7.6	7.7
	DC	0.2	7.3	7.5
	Total	*0.3*	*15.0*	*15.2*
All Regions				
	IC	1.8	82.5	84.3
	DC	0.1	15.6	15.7
	Total	***1.9***	***98.1***	***100.0***

Source: GTAP model simulation results.

Table 6.6: Welfare Decomposition for EBA and Rest of ACP Regions

(2001 US$ Millions)

	EBA Region	Rest of ACP Region
Allocative Efficiency Effects	-118	113
Terms of Trade Effects	-391	415
Investment and Savings Price Effect	6	55
Total Welfare Gain	-504	582

Source: GTAP model simulation results.

Table 6.7: Alternative Welfare Decomposition for EBA and Rest of ACP Regions

Tariff Liberalisation Only

(2001 US$ Millions)

EBA Region	Welfare
Reduction of tariffs on agricultural goods from EU to EBA Countries	0
Reduction of tariffs on agricultural goods from Third Countries to EBA Countries	0
Reduction of tariffs on agricultural goods from EBA Countries to EU	0
Reduction of tariffs on agricultural goods from EBA Countries to Third Countries	228
Reduction of tariffs on agricultural goods from EBA Countries to EBA Countries	0
Reduction of tariffs on agricultural goods from EU to Third Countries	-442
Reduction of tariffs on agricultural goods from Third Countries to EU	22
Reduction of tariffs on agricultural goods from Third Countries to Third Countries	-78
Total	-270

Rest of ACP Region	Welfare
Reduction of tariffs on agricultural goods from EU to Rest of ACP	0
Reduction of tariffs on agricultural goods from Third Countries to Rest of ACP	-33
Reduction of tariffs on agricultural goods from Rest of ACP to EU	727
Reduction of tariffs on agricultural goods from Rest of ACP to Third Countries	305
Reduction of tariffs on agricultural goods from Rest of ACP to Rest of ACP	11
Reduction of tariffs on agricultural goods from EU to Third Countries	-142
Reduction of tariffs on agricultural goods from Third Countries to EU	-16
Reduction of tariffs on agricultural goods from Third Countries to Third Countries	-264
Total	588

Source: GTAP model simulation results.

Table 6.8: Changes in Exports of EBA and Rest of ACP Regions

Sector	EBA		Rest of ACP	
	%	$Millions	%	$Millions
Crops	-0.9	-119	4.3	371
Sugar	-29.5	-1,131	23.2	377
Cattle and sheep	4.9	11	-3.4	-3
Other livestock	-2.4	-9	-7.0	-8
Raw milk	-28.1	-1	-41.2	-3
Beef & sheepmeat	-5.9	-9	102.2	288
Other meat products	6.7	18	-14.4	-11
Dairy products	5.1	3	-1.5	-4
Beverages and tobacco	0.0	0	-2.2	-12
Other processed food products	-0.6	-27	-4.7	-110
Other primary products	0.2	112	0.9	14
Textiles, leather and clothing	0.8	151	-3.6	-226
Chemical & petroleum products	0.6	21	-0.9	-34
Mineral & metal products	1.3	96	-1.6	-49
Transport equipment	1.6	58	-1.0	-22
Electronic equipment	2.5	23	-2.1	-63
Other industries	1.5	138	-2.8	-246
Trade services	1.0	22	-2.1	-24
Transport services	1.1	112	-1.2	-88
Business & financial services	1.3	74	-1.6	-54
Other private services	1.0	9	-1.4	-13
Utilities & public services	1.4	89	-1.6	-44

Source: GTAP model simulation results.

Table 6.9: EBA and Rest of ACP Share of Total EU Imports (%)

Sector	EBA		Rest of ACP	
	Pre-Simulation	Post-Simulation	Pre-Simulation	Post-Simulation
Crops	7.78	7.21	5.04	5.82
Sugar	59.62	38.57	2.79	6.75
Cattle and sheep	0.51	0.52	0.26	0.22
Other livestock	1.54	1.51	0.35	0.32
Raw milk	0.18	0.26	1.07	0.78
Beef & sheepmeat	0.25	0.15	1.18	3.07
Other meat products	0.20	0.17	0.13	0.11
Dairy products	0.10	0.07	0.27	0.21
Beverages and tobacco	0.22	0.22	0.68	0.68
Other processed food products	2.51	2.50	0.67	0.63
Other primary products	3.49	3.50	0.04	0.05
Textiles, leather and clothing	3.85	3.87	0.10	0.09
Chemical & petroleum products	0.11	0.11	0.08	0.08
Mineral & metal products	1.19	1.21	0.18	0.18
Transport equipment	0.59	0.60	0.26	0.26
Electronic equipment	0.11	0.12	0.28	0.28
Other industries	0.90	0.91	0.68	0.66
Trade services	1.01	1.02	0.54	0.53
Transport services	1.93	1.95	1.63	1.62
Business & financial services	0.84	0.85	0.49	0.48
Other private services	0.48	0.49	0.56	0.55
Utilities & public services	1.50	1.52	1.05	1.03
Total	1.46	1.42	0.55	0.58

Source: GTAP model simulation results.

Table 6.10: Percentage Changes in Wages

Region	Unskilled	Skilled
Ireland	0.28	0.41
UK	0.21	0.23
Germany	0.22	0.24
France	0.29	0.34
Rest EU15	0.23	0.29
CEEC	0.68	0.83
USA	0.02	-0.01
Canada	0.10	0.09
China	0.25	0.26
India	0.40	0.42
EBA	-0.20	-0.09
Mercosur	-0.23	-0.24
Rest ACP	-0.03	-0.11
Former Soviet Union	0.14	0.16
High Income Asian	0.48	0.57
Rest EFTA	0.48	0.53
Rest Asia	0.29	0.25
Rest Latin America	-0.02	-0.08
Mediterranean	0.11	0.11
Rest of World	0.14	0.10

Note: change in wages measured as the change in ratio of return of skilled or unskilled labour to CPI in each region (variable *pfactreal*).
Source: GTAP model simulation results.

6.6 Boxes

Box 6.1: Summary of Simulation

Market Access:

Applied agricultural import tariffs are reduced by 50, 34 and 0 per cent for industrialised, developing and least developed countries respectively.

Domestic Support:

Trade-distorting domestic support is reduced by 20 per cent in the EU and USA and by 5 per cent elsewhere.

Export Competition:

A global elimination of agricultural export subsidies.

CHAPTER 7

CONCLUSION

7.1 Overview

This thesis examines a number of topics related to the modelling and implications of trade liberalisation. Early research, following the launch of the World Trade Organisation's (WTO) Doha Round of trade negotiations in 2001, suggested that a successful outcome to the Round would have the potential to generate substantial benefits to the world economy and to lift millions out of poverty. The results produced by modellers became increasingly significant in the political discourse on the Doha Round. However, in recent years the projected effects of a Doha Round agreement have been revised downward largely due to the availability of better databases and improved modelling techniques (Ackerman, 2005 and Bouet, 2006). The contribution of this thesis is to further extend the modelling techniques and data to improve the empirical basis for policy analysis.

As most of the research employs the Global Trade Analysis Project (GTAP) computable general equilibrium (CGE) model and database, chapter 2 describes the model structure and the construction of the database in detail.

The first contribution of this thesis is to improve the measurement and representation of modelling agricultural trade liberalisation, in particular disciplines on domestic support, using an extended version of the GTAP model and database. Chapter 3 highlights the importance of incorporating the degree of overhang in domestic support, the allocation of

subsidies in the GTAP database to the various "boxes" (each subject to different types of disciplines) and the explicit inclusion of the market price support element of the amber box. Analysis of the relative contributions of domestic support disciplines and tariff reductions in agricultural liberalisation and the measurement of the different boxes within domestic support liberalisation is important in the context of WTO negotiations. It provides an indicator of the areas in which negotiators should focus their efforts.

Once these issues are taken into consideration, the effects of domestic support liberalisation are shown to be lower than previously estimated. Global welfare gains are found to be 20 per cent lower overall, with even larger reductions for some regions such as the US and EU. The results confirm the findings of other researchers, that the gains from agricultural liberalisation will be driven by reductions in import tariffs, with the effect of domestic support disciplines and the elimination of export subsidies relatively small in comparison. The contribution of domestic support reductions to global welfare change is reduced from 20 per cent to 3 per cent. These results, although based on illustrative improvements in market access, show that the impact of trade liberalisation from stricter WTO disciplines on domestic support measures is likely to be quite small.

In chapter 4, the focus switches from agriculture to services. Many simulations predict high welfare gains from liberalisation of services trade. For example, in chapter 5 almost 20 per cent of the global welfare gains are achieved from services liberalisation, the figure is even greater for Ireland. However, the empirical basis for the estimates of barriers to services trade (barriers that are reduced to simulate trade liberalisation) is weak. Chapter 4 outlines the difficulties in accurately quantifying barriers to services, which are typically qualitative in nature, and the problems in the existing estimates.

In an attempt to address these deficiencies, and to better analyse the determinants of services trade, a gravity model is constructed. This model is econometrically estimated for total services trade flows and for four disaggregated services sectors. A number of different estimators are tested and the Hausman-Taylor model is found to be the most appropriate.

Overall, the gravity equation is found to fit services trade in a similar way to trade in goods. The wealth (measured as Gross Domestic Product per capita) of the importing country and a common language shared between trading partners are found to be the most important determinants of trade between countries. Some variation to these results is found at the sectoral level. However, the estimation of tariff equivalents of the barriers to services trade was only partially successful. The influence of barriers to trade in services is found to be only weakly statistically significant and this must be borne in mind when assessing the resulting tariff equivalents.

The tariff equivalents estimated range from 0 to 125 per cent. In general, the highest tariff equivalents are found in developing countries (such as Brazil, Morocco or Indonesia). Barriers to trade in Asian countries appear to be particularly large, with the exception of Japan and Hong Kong. The average for the EU15 countries is 48 per cent (this rises to 57 per cent with the inclusion of the ten new member states). Amongst the EU members, the figures vary widely. The Netherlands, Belgium-Luxembourg and the UK have low or zero tariff equivalents, while Austria, Italy and Greece have relatively high barriers.

Chapter 5 presents the results of an economy-wide trade liberalisation scenario for Ireland in the context of the Doha Round of negotiations. This is an important contribution to the policy debate in Ireland, providing the first quantitative assessment of the potential consequences of the Doha Round on the Irish economy. The simulation incorporates

liberalisation of agricultural, industrial and services trade and measures to improve trade facilitation. The discussion of the results focuses on the effects for the Irish economy.

For Ireland, a small open economy whose growth has benefited from the stability provided by the world trading system, the potential consequences of a Doha Round agreement are wide ranging. The current debate in Ireland tends to focus on the expected losses to the agricultural sector and the simulation results confirm these expectations and show that this sector will incur losses. However, the results underline the importance of manufacturing and services trade liberalisation. The combined gains from these sectors are estimated to be more than double the losses from agricultural trade liberalisation.

The final empirical chapter, chapter 6, examines the implications of a Doha Round agreement on agricultural trade liberalisation for developing countries. The Doha Declaration has as a stated objective that this Round (also known as the Doha Development Agenda) should explicitly take into consideration the needs of developing countries.

The simulation results indicate that the outcomes from reducing barriers to agricultural trade for developing countries are likely to be mixed. They depend heavily of the degree of liberalisation implemented by the developing countries themselves and the impact of preference erosion. The Mercosur group, Rest of the Africa, Caribbean and Pacific group of countries and the Rest of the World (which includes Australia, New Zealand and South Africa) will benefit significantly. However, Everything But Arms group of countries and Mediterranean countries will lose because of the erosion of their benefits from preferential access to EU market.

7.2 Areas for Further Research

There are numerous issues arising from this research contained that may merit further attention or refinement. Although not an exhaustive list, this section outlines several potential topics for each chapter of the thesis.

The improved modelling of domestic support disciplines in chapter 3 is achieved by constructing an extensive domestic support dataset and the extension of the GTAP model to explicitly incorporate market price support measures. The extension of the domestic support dataset to separately distinguish all EU member states (currently the EU is represented as a aggregate region) and other countries that use domestic support, in addition to those already included (EU, US, Canada, Japan and Brazil), would allow the analysis of domestic support reductions to be broadened. Another issue that would benefit from further research is the extent to which decoupled payments influence production decisions (they are assumed to be fully decoupled from production in this research), and the consequences for their eligibility to be included in the green box.

The results of the gravity model approach to modelling services trade in chapter 4 illustrate the extent to which research on this topic is still restricted by data limitations. Although data on services trade are now more readily available and its quality improving, it still lags considerably behind what is available for trade in goods. In particular, as emphasised in chapter 4, the available data on services trade barriers is poor, despite the efforts researchers such as those at the Australian Productivity Commission and the Organisation for Economic Cooperation and Development. There is as yet no consensus on the best approach to quantifying non-tariff barriers and the existing methods are not satisfactory.

The analysis of the economy-wide impacts of trade liberalisation on Ireland in chapter 5 focuses on a stylised simulation. Should the Doha negotiations resume in earnest, a more refined simulation incorporating any modalities that emerge or a future agreement would be required in order to accurately measure the implications for the Irish economy.

From an Irish perspective, a topic that merits further work is the representation of Ireland in the GTAP model and database. Submission and incorporation of the most recent set of input-output (IO) tables for Ireland would considerably update the GTAP database on Ireland. The Central Statistics Office has recently produced IO tables for 1998. The tables that currently form the basis of the Irish region in GTAP date from 1990. Another feature of the database, noted in chapter 5, that could be improved is the accuracy of the volume of Irish agricultural exports as currently reported the GTAP. For certain commodities, the reported levels of exports are unrealistically low relative to the level of production in those sectors shown in the GTAP database.

Finally, with regard to the effects of agricultural trade liberalisation on developing countries (chapter 6) there are a number of topics that could be explored further. Similar to the research in the previous chapter, should the details of a Doha Round agreement emerge, a refined scenario needs to be implemented to accurately assess the implications for these countries. From the results in chapter 6, it is clear that the erosion of preferential access will be a key issue for developing countries. A refined scenario could further assess the implications of this issue, but also investigate other topics such as the treatment of sensitive products and the role of intra-developing country trade (south-south trade), both of which are likely to influence the outcomes from further liberalisation.

7.3 Concluding Comments

This thesis extends the existing body of research and literature in several respects. The representation and modelling of domestic support in GTAP is improved. The determinants of services trade are better understood. The trade liberalisation scenarios illustrate the issues faced by Ireland and developing countries in the Doha Round of world trade negotiations.

The effects of trade liberalisation are found to be important for many countries. Overall, the world economy is expected to gain from a Doha Round agreement. However, there will be winners and losers, both at the country level and at a sectoral level within countries. This is illustrated by the Irish case. As an export oriented economy Ireland will gain substantially from further opening of world markets, in particular in manufacturing and services. These gains come at the expense of losses in agriculture. The differences in results across regions and sectors highlight one of the contributions of thesis, the importance of accurately measuring trade liberalisation and the process of continually improving and extending the available data and modelling techniques.

APPENDIX I

THE GTAP MODEL STRUCTURE

A1.1 Introduction

This appendix supplements the description of the Global Trade Analysis Project (GTAP) model in chapter 2. It provides a more technical presentation of key elements of the model structure discussed in that chapter. The material presented in this appendix adheres very closely to the approach of Hertel (1997).

The layout of this appendix follows that of chapter 2. The features of model covered are: the regional household; private household behaviour; government behaviour; production structure; and investment demand.

A1.2 The Regional Household

In the GTAP model all revenues within a region r accrue to the regional household. This income is distributed in equation (1) from the regional household to private households (*PRIVEXP*), government (*GOVEXP*) and savings (*SAVE*). This distribution is based on a per capita Cobb-Douglas utility function, shown in equation (2), where u is the change in per capita utility in region r, p and g are the changes in composite expenditures

of private households and government respectively in each region and *qsave* is the change in expenditure on savings in each region.[100]

$$INCOME(r) = PRIVEXP(r) + GOVEXP(r) + SAVE(r) \tag{1}$$

$$\begin{aligned} INCOME(r) * u(r) \;=\; & PRIVEXP(r) * p(r) \\ & + GOVEXP(r) * [g(r) - pop(r)] \;+\; SAVE(r) * [qsave(r) - pop(r)] \end{aligned} \tag{2}$$

Both government expenditure and savings are homothetic in real income (see equations (3) and (4) respectively), but private consumption is not. Equations (3) and (4) show that the changes in composite government spending (*g*) and spending on savings (*qsave*) are functions of the change in regional income (*y*) and the change in price of the composite government commodity (*pgov* – defined in section A1.4) or the price of savings (*psave*). Private consumption is treated differently. As discussed in chapter 2, a non-homothetic specification allows better modelling of private household behaviour through the use of the constant differences of elasticities (CDE) functional form. As regional income increases there will be a shift towards public and future consumption (savings) away from private consumption.

$$g(r) = y(r) - pgov(r) \tag{3}$$

$$qsave(r) = y(r) - psave \tag{4}$$

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[100] Small letters are used to denote percentage changes in the GTAP model and this notation is employed throughout this appendix unless otherwise indicated. E.g., *g(r)* is the percentage change in government expenditure in region r – *GOVEXP(r)*.

A1.3 Private Households

Equation (5) determines the change in expenditure by private households (*yp*) in region r. It is a function of the change in per capita utility received from consumption (*up*), the price paid by private households (*pp*) and the change in population (*pop*). *CONSHR* is the share of private household expenditure devoted to commodity i and *INCPAR* is an expansion parameter of the CDE elasticity function.

$$yp(r) = \sum_{i \in TRAD} [CONSHR(i,r) * pp(i,r)] + \sum_{i \in TRAD} [CONSHR(i,r) * INCPAR(i,r)] * up(r) + pop(r) \quad (5)$$

The change in per capita household demand (*qp* – *pop*) for commodity i in region r is shown in equation (6). It is a function of the sum of the changes in the composite price paid by private households (*pp*) multiplied by the cross price elasticity (*EP*) and the change in expenditure (*yp*) less the change in population (*pop*) multiplied by the income elasticity (*EY*).

$$qp(i,r) = \sum_{k \in TRAD} EP(i,k,r) * pp(k,r) + EY(i,r) * [yp(r) - pop(r)] + pop(r) \quad (6)$$

If the *EY* was unity, the population terms (*pop*) would cancel out and private household expenditure would be homothetic in income like government expenditure and savings. As noted in the previous section, the CDE functional form is applied to private consumption. The parameters of the CDE function are initially calibrated to selected vector of elasticities. However, these elasticities are not constant, they vary with expenditure shares. In particular, the *EY* elasticity for commodity i in region r is a

function of the share of private household expenditure devoted to the consumption of that commodity (*CONSHR*).

Equation (6) shows the composite demand (*qp*) for commodity i in region r. However, private households may purchase domestically produced commodities or imported commodities. The allocation of private household demand between domestic and foreign commodities in GTAP is based on a two level, constant elasticity of substitution (CES) functional form. This approach follows the Armington assumption (Armington, 1969) in differentiating national varieties of a homogenous commodity by source.

Initially, households decide on the sourcing of their imports as shown in equation (7). Imports (*qxs*) of commodity i from region r into region s are function of the composite import of the commodity from all sources (*qim*), the Armington elasticity (σ_M or *ESUBM* in chapter 2) and the price of imported commodity from each region (*pms*) relative to the composite import price (*pim*).[101] The composite import price is determined by equation (8), where the share of commodity i imported from region k in total imports of region s (*MSHR*) is weighted by the price (*pms*) of that commodity i imported form k into s.

$$qxs(i,r,s) = qim(i,s) - \sigma_M(i) * [pms(i,r,s) - pim(i,s)] \quad (7)$$

$$pim(i,s) = \sum_{k \in R} MSHRS(i,k,s) * pms(i,k,s) \quad (8)$$

[101] The values used in the GTAP model for *ESUBM* and all other elasticity parameters cited in this appendix are shown in chapter 2.

Households' optimal mix of domestically and foreign produced inputs is determined by equations (9) to (11). The composite price paid by private households (*pp*) for the commodity i used in sector j in region r is the weighted average of the imported (*ppm*) and domestic prices (*ppd*). *PMSHR* is the share of imports of commodity i in the total purchases of commodity i by households. The demand for commodity i, both imported (*qpm*) and domestically produced (*qpd*), is a function of the total demand for i in sector j, the second Armington elasticity (σ_D or *ESUBD* in chapter 2) and the relative price of the imported (*ppm*) or domestically produced (*ppd*) commodity compared to the composite price (*pp*).

$$pp(i,s) = PMSHR(i,s) * ppm(i,s) + [1 - PMSHR(i,s)] * ppd(i,s) \quad (9)$$

$$qpd(i,s) = qp(i,s) + \sigma_D(i,) * [pp(i,s) - ppd(i,s)] \quad (10)$$

$$qpm(i,s) = qp(i,s) + \sigma_D(i) * [pp(i,s) - ppm(i,s)] \quad (11)$$

A1.4 Government

The change in composite government expenditure is determined by the change in income received from the regional household. This spending is allocated across commodities based on a Cobb-Douglas utility function shown in equation (12).

$$qg(i,r) = g(r) - [pg(i,r) - pgov(r)] \quad (12)$$

Government demand (*qg*) for a tradable commodity i in region r is a function of composite government expenditure (*g*) and the price paid by the government (*pg*) for commodity i relative to the composite price for all commodities purchased by the government (*pgov*). The composite price, equation (13) is the sum over all commodities of expenditure by the government on each commodity (*VGA*) as a fraction of total government expenditure (*GOVEXP*).

$$pgov(r) = \sum_{i \in TRAD_COMM} (VGA(i,r) / GOVEXP(r)) * pg(i,r) \qquad (13)$$

The next step is to allocate government demand between domestically produced commodities and imported commodities. As with private households this follows the Armington assumption. A price index (*pg*) is calculated in equation (14), where *GMSHR* is the share of imported commodity i in government purchases in region s. Composite government demand is allocated between domestically produced commodities (*qgd*) and imported commodities (*qgm*) are shown in equations (15) and (16) using the Armington elasticity (σ_D).[102] Government demand for domestically produced commodity (*qgd*) i in region s is a function of the price of the domestic commodity (*pgd*) relative to the composite price (*pg*) of all commodities (domestic and imported). Demand for imported commodities (*qgm*) is similar.

$$pg(i,s) = GMSHR(i,s) * pgm(i,s) - [1 - GMSHR(i,s)] * pgd(i,s) \qquad (14)$$

[102] As noted in chapter 2, the same Armington elasticities (*ESUBM* and *ESUBD*) are used for private households, government and firms.

$$qgd(i,s) = qg(i,s) - \sigma_D(i) * [pg(i,s) - pgd(i,s)] \quad (15)$$

$$qgm(i,s) = qg(i,s) - \sigma_D(i) * [pg(i,s) - pgm(i,s)] \quad (16)$$

The second level of this structure determines the sourcing of imported commodities from different regions. Equation (17) shows that the change in price of the composite import (*pim* – composite of imports across all regions) is a function of the change in price (*pms*) of commodity i imported from region k into region s weighted by the share of imports from k in composite imports in s (*MSHRS*). Equation (18) determines the sourcing of imports (*qxs*) of commodity i from region r into region s. This is a function of the composite import (*qim*) of i into region s and the price of the imported commodity (*pms*) relative to the composite import price (*pim*) and the second Armington elasticity (σ_M).

$$pim(i,s) = \sum_{k \in REG} MSHRS(i,k,s) * pms(i,k,s) \quad (17)$$

$$qxs(i,r,s) = qim(i,s) - \sigma_M(i) * [pms(i,r,s) - pim(i,s)] \quad (18)$$

A1.5 Producers

Firms' output in GTAP is produced using a combination of primary factors (endowments) and intermediate inputs purchased from other sectors. In the standard model there is no substitution between intermediate inputs and value-added factors in production as a Leontief functional form is chosen. Demand for intermediate inputs (*qf*)

and factors of production (*qva*) in section j in region are determined by the change in demand for the commodity (*qo*) as shown in equations (19) and (20) respectively. The elasticity of substitution (*ESUBT*) is set to zero, therefore the changes in prices of intermediates (*pf*) and factors of productions (*pva*) relative to the composite price (*ps*) have no effect at this level of the production structure.

$$qf(i,j) = qo(j) - ESUBT(j).(pf(i,j) - ps(j)) \tag{19}$$

$$qva(j) = qo(j) - ESUBT(j).(pva(j) - ps(j)) \tag{20}$$

Within the value added and intermediate input nests in the production tree, substitution is permitted based on constant elasticity of substitution function. Demand for the factor of production (*qfe*) i in sector j in region r is determined by equation (21). It is a function of the change in total factor demand (*qva*) in sector j in region r, the elasticity of substitution between factors of production (σ_{VA} or *ESUBVA* in chapter 2) and the change in the price of factor i relative to change in composite factor prices (*pva*) in the sector. The composite factor price in section j in region r is determined by equation (22), where *SVA* and *pfe* are the share and price of factor k in sector j.

$$qfe(i,j,r) = qva(j,r) - \sigma_{VA}(j) * [pfe(i,j,r) - pva(j,r)] \tag{21}$$

$$pva(j,r) = \sum_{k \in ENDW} SVA(k,j,r) * [pfe(k,j,r) -] \tag{22}$$

Within the intermediate input nest, the Armington assumption is again used to differentiate between domestically produced and imported commodities. Firms decide

on the sourcing of their imports as shown in equation (23). Imports (*qxs*) of the commodity from a specific region are a function of the composite import of the commodity (*qim*), the Armington elasticity (σ_M) and the price of imports (*pms*) from commodity from each region relative to the composite import price (*pim*). The composite import price is determined by equation (24), where *MSHRS* is the share of commodity i imported from region k in total imports.

$$qxs(i,r,s) = qim(i,s) - \sigma_M(i) * [pms(i,r,s) - pim(i,s)] \quad (23)$$

$$pim(i,s) = \sum_{k \in REG} MSHRS(i,k,s) * pms(i,k,s) \quad (24)$$

At the next level of the production structure, firms' optimal mix of domestically and foreign produced inputs is determined by equations (25) to (27). The composite price (*pf*) of the commodity is the weighted average of the imported (*pfm*) and domestic prices (*pfd*). *FMSHR* is the share of imports of commodity i in the total purchases of commodity i in the sector. The demand for commodity i, both imported (*qfm*) and domestically produced (*qfd*), is a function of the total demand for i in sector j, the second Armington elasticity (σ_D) and the relative price of the imported (*pfm*) or domestically produced (*pfd*) commodity compared to the composite price (*pf*).

$$pf(i,j,r) = FMSHR(i,j,r) * pfm(i,j,r) + [1 - FMSHR(i,j,r)] * pfd(i,j,r) \quad (25)$$

$$qfm(i,j,s) = qf(i,j,s) - \sigma_D(i) * [pfm(i,j,s) - pf(i,j,s)] \quad (26)$$

$$qfd(i,j,s) = qf(i,j,s) - \sigma_D(i) * [pfd(i,j,s) - pf(i,j,s)] \quad (27)$$

A1.6 Investment Demand

The regional household in GTAP allocates income to savings in addition to private households and government (based on the utility function of the regional household as discussed in section A1.2). Savings from each region in the GTAP model are collected by a global bank. This revenue is re-distributed to the regions, less depreciation. Global savings (equal to the sum of *SAVE* across all regions r) are equal to global net investment (*GLOBINV*) as shown in equation (28). However, this need not hold for each individual region, i.e., in any one region savings may exceed investment or vice versa, as long as the global constraint holds.

$$\sum_{r \in REG} (REGINV_r - VDEP_r) = GLOBINV = \sum_{r \in REG} SAVE_r \quad (28)$$

Regional investment, the share of global investment allocated to a region, is determined by the expected rate of return, which in turn depends on capital stock accumulation. If, at the end of the period capital stock is higher than it was in the beginning, then the rate of return falls as capital accumulation is assumed to depress expected returns. To remain consistent with the static nature of the GTAP model, the amount of capital used in production is fixed at the level of the beginning of the period (i.e., in the base data) and is not influenced by capital stock accumulation. Investment into a region increases (or decreases) the end of period capital stock, but does this not affect the current productive

capacity. End of period capital stock (*VKE*) in region r is defined as the capital stock (*VKB*) in the beginning of the period plus gross investment (*REGINV*) in the region and minus the value of depreciation (*VDEP*) in the region as shown in equation (29).

$$VKB(r) + REGINV(r) - VDEP(r) = VKE(r) \quad (29)$$

A1.7 Conclusion

This appendix presents a technical overview of the structure of the standard GTAP model employed in three of the four core chapters of this thesis. It supplements the description provided in chapter 2. Further information on the model structure can be found in Hertel (1997). In addition, the GTAP website is a useful resource which also provides extensive documentation of various aspects of the model and database and the model code itself may be downloaded.[103]

[103] See www.gtap.org.

APPENDIX II

CONSTRUCTION OF THE BASELINE 2001 - 2014

A2.1 Introduction

The trade liberalisation scenarios in chapters 3, 5 and 6 are implemented against a baseline in which the Global Trade Analysis Project (GTAP) model and database are projected forward from 2001 (2001 is the base year in the current version of the GTAP database) to 2014 (the year by which all trade liberalisation reforms are assumed to be fully implemented).[104]

This baseline provides a counter-factual scenario in which no further trade liberalisation occurs, to compare against the results of trade liberalisation simulations. Any results generated by a computable general equilibrium (CGE) model depend on the accuracy of its baseline data, therefore a realistic baseline improves the validity of simulations.

The baseline employed in this thesis includes extensions to the standard model structure and the projection forward of the world economy. The baseline is implemented by running a pre-simulation experiment, which has two components: (i) macroeconomic projections are used to simulate the expected changes to the world economy between the dates in question (section A2.3); and (ii) policy changes, both events that have already

[104] The baseline employed in chapter 3 is similar but not identical that in chapters 5 and 6. Any differences between the two are noted in this appendix. The major differences are in aggregation and the fact the in chapter 3 no macro-projections are included.

occurred since 2001 and those that are expected to occur in the future, are implemented to create a more realistic policy landscape (described in section A2.2). The world economy in 2014 then provides the base data for the trade liberalisation simulations in chapters 3, 5 and 6.

A2.2 Macro-Economic Projections

The first phase in constructing the baseline to 2014 is to shock factor endowments in the model following the approach of Walmsley *et al.* (2000).[105] These shocks are implemented at a regional level, based on forecasts of factor growth rates over the baseline period.

Gross Domestic Product (GDP), skilled and unskilled labour, population and capital stock in each region are the variables to be shocked. In the standard general equilibrium closure, all of these variables are exogenous with the exception of GDP. However, in the closure used in this baseline, GDP is swapped with an exogenous technology variable. This means that GDP in each region is exogenously determined and the technology variable fluctuates as a residually determined measure, representing change in total factor productivity (TFP).

The predictions of factor growth rates assumed are shown in table A2.1. The main source is Brockmeier *et al.* (2003), which follows a similar aggregation to that chosen in this thesis, with additional data from Jensen and Frandsen (2003).[106] For Ireland,

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[105] The baseline in chapter 3 does not feature macro-economic projections.

[106] In the case of the both Brockmeier *et al.* (2003) and Jensen and Frandsen (2003), the primary source of data is the World Bank's Global Economic Perspectives' Database and several other sources cited in Walmsley *et al.* (2000).

additional data from the Economic and Social Research Institute (ESRI, 2003) are used to further augment the forecasts.[107]

The initial pre-simulation experiment suggested an unrealistically high growth of agricultural production in the EU, evaluated on the basis of expert opinion. In the baseline represented here, the growth of primary agricultural sectors is constrained to target the growth rates expected (in the absence of policy change) in the most recent EU Commission forecast of the likely market balance for agricultural products up to 2014 (European Commission, 2004b). The same growth rates are applied to each of the separate EU countries and regions distinguished in the selected aggregation.

A2.3 Structural Changes to the World Economy

The choice of events to be included in the baseline needs to strike a balance between accuracy and feasibility. As it is not possible to model all changes over the next decade, the structural adjustments that form the core of the baseline are chosen based on their expected relevance for Ireland. This explains the decision to include the reform of the Common Agricultural Policy (CAP) whilst leaving out similar policy measures that could have been included, for example the US Farm Bill.[108]

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[107] The regional aggregation chosen in chapter 3 is slightly different to that in chapters 5 and 6 (for example the EU15 countries are combined into a composite region and none are separately distinguished). This case appropriately weighted averages of the GDP, population, labour and capital projections shown in table A2.1 are used.

[108] As noted in discussion of the baseline methodology in chapters 3 and 5, there are at least two caveats regarding the application of the baseline. First, there is disagreement about how appropriate it is to include certain events in the baseline depending on which period is assumed to be the starting point for a new Agreement. Second, this approach does not consider that the quotas which exist as a result of the EU's Common Agricultural Policy and the EBA scheme imply the existence of quota rents. These are likely to have important political economy consequences which are not considered in the analysis in this thesis.

The structural changes to the world economy included in this baseline, each of which are discussed further below as is the methodology used to implement them, are: (i) the accession of China to the World Trade Organisation;[109] (ii) the Agenda 2000 and Mid-term Review reforms of the CAP; (iii) the Eastern enlargement of the European Union; (iv) the Everything But Arms Agreement; and (v) the elimination of MFA textile quotas.

A2.3.1 Accession of China to the WTO

In 2001 agreement was reached on the accession of the People's Republic of China to the WTO, thus also paving the way for the accession of the separate customs territory of Taiwan, Penghu, Kinmen and Matsu (Chinese Taipei) in 2002. This is modelled as the implementation of import tariffs based on Francois and Spinanger (2002), Francois *et al.* (2003) and AMAD to reflect China's new trading position since obtaining WTO membership.[110] Additionally, all Chinese export subsidies in the 2001 GTAP database are eliminated as agreed in the accession protocol.

A2.3.2 Agenda 2000 Reform of the CAP

The Agenda 2000 reforms of the CAP were agreed in Berlin in 1999.[111] The reforms were to be phased in over the current EU budget period 2000 to 2006. The Agenda 2000 package is a continuation of the previous MacSharry reforms, including further reductions in intervention prices compensated by increases in compensation payments.

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[109] Russia is also assumed to join the WTO during the baseline period. The terms of accession are not specifically modelled, but Russia is assumed to participate in the liberalisation scenarios based on its tariff structure in 2001.

[110] See http://www.amad.org/ for more information concerning the Agricultural Market Access Database (AMAD), a database operated jointly by USDA-ERS, UNCTAD, European Commission, FAO and the World Bank.

[111] Agenda 2000 is a wide ranging reform of EU finances implemented over the period 2000 to 2006. The elements of relevance to international trade liberalisation, and this thesis in particular, are those related to agricultural reform. See http://europa.eu.int/comm/agenda2000/index_en.htm for more information on the Agenda 2000 reform or Van Tongeren *et al.* (2000) provide a good summary in a CGE context.

Other elements of Agenda 2000 related to agricultural production and trade, including measures to promote rural development and agri-environmental policies, are not considered in the context of this study as their impact on agricultural protection and trade is considered to be negligible.

As the core reforms of Agenda 2000 are to be phased in over the period 2000 to 2006, the current version of the GTAP database (base year 2001), includes some of these measures, such as changes in arable crop intervention prices and support payments, already in the data.[112] However, other measures are only partially implemented (e.g., changes to domestic support in cattle production) or not yet begun in the case of dairy market reforms.

Therefore, those reforms that were not yet fully phased in 2001 have been included in the baseline construction. Changes to intervention prices are modelled implicitly via reduced border protection (import tariffs and export subsidies are altered by the target rate percentage change). Following Bach and Frandsen (1998), variations to the set-aside rate for agricultural land are simulated via productivity shocks to land in the sector in question. Modelling of the raw milk and sugar quotas follows the approach of Brockmeier *et al.* (2001) of fixing output exogenously and allowing the relevant output subsidy to fluctuate endogenously. This change in the subsidy is interpreted as the change in the quota rent.

[112] Domestic support in the database is based on EAGGF-Guarantee expenditures for 2001 for animal premia and 2002 for hectare premia (Jensen 2004). See chapter 2 for more details.

A2.3.3 Mid-Term Review of the CAP

In June 2003, with the CAP facing the twin challenges of EU enlargement and the continuing Doha Round, the European Council agreed a further set of CAP reforms known as the Mid-term Review (MTR) or the Luxembourg Agreement. The MTR maintains the trend of further reducing intervention prices and increased direct payments, strengthening of rural development measures and improved budgetary discipline.

However, the most innovative feature of the MTR is the decision to decouple most direct support payments from production and hence lessen their impact on production decisions and their distortionary effects on agricultural trade.[113] Once decoupled, a range of payments to cereals, cattle, sheep and other products will be unrelated to the current level of production; instead, farmers will receive a "single farm payment" subject to cross-compliance conditions.

The modelling of decoupling in this thesis is based on the approach of Jensen and Frandsen (2003). Direct payments to be decoupled are transformed into uniform (single farm) payments to agricultural land across all sectors in EU countries. The justification for this approach is that land must be kept in good agricultural condition to receive the payment and that land has no use outside of agriculture in GTAP.[114] As modelled in this thesis, decoupling of direct payments is effective only in the cattle and sheep, cereals and dairy sectors.[115] The subsidy instruments representing those payments that have been decoupled are set to zero (e.g., some capital subsidies in the cattle and sheep sector). The

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[113] See http://europa.eu.int/scadplus/leg/en/lvb/l11062.htm for more details.

[114] Fishing and forestry use natural resources rather than land in GTAP.

[115] Representing the suckler cow premium, the male animal premium, the slaughter premia, the ewe premium, the arable aid premium and the dairy cow premium.

new decoupled payment to land is a region-specific payment and, as the subsidies have simply been transferred, the cost is unchanged.

National governments in the EU have been given some discretion concerning the extent of decoupling they decide to implement.[116] With respect to the regions of the EU as represented in the aggregation used chapters 5 and 6, Ireland, the United Kingdom and Germany have decided to implement full (100 per cent) decoupling, albeit with some differences in timing and measurement of payments (Agra Europe, 2004). France has opted for a more limited approach, as have most of the other members represented in the aggregated EU11 region. The European Commission (2004b) suggests an informal estimate of 90 per cent of all payments decoupled by 2011. In this study all EU members are assumed to implement full decoupling of the appropriate sectors, assuming that this will be the case by 2014. Arguably the logic of decoupling will be so persuasive that the remaining support will be decoupled by the end of the implementation period for the Doha Round reductions even in the absence of any further WTO-driven discipline on direct payments.

A2.3.4 Enlargement of the European Union

In May 2004, ten central and eastern European countries (CEECs) acceded to the European Union.[117] Bulgaria and Romania are currently negotiating their entry to the EU and are expected to join in January 2007. Consequently, in the baseline the EU is assumed to be enlarged to a community of twenty-seven members by the end of 2014.

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[116] See http://europa.eu.int/comm/agriculture/capreform/index_en.htm

[117] Cyprus, Czech Republic, Estonia, Hungary, Latvia, Lithuania, Malta, Poland, Slovakia and Slovenia.

Accession to the EU implies the elimination of all remaining trade barriers between the new and old members. Import tariffs and export subsidies between the two regions, and between the CEECs themselves, are set to zero and the new members implement the EU's Common External Tariff towards third countries, including preferences for developing countries.

In addition, the CAP is extended to the CEECs upon entry. Price support measures have been transferred upon accession. However, to reduce the budgetary costs of enlargement, agreement was reached whereby new members would not become immediately entitled to the full level of direct payments existing in the EU15 countries.[118] Direct payments in the CEECs commence at 25 per cent of the level of the EU15, increasing to 100 per cent over a ten-year period with a facility for national governments in the new members to top-up these payments, up to a specified level. Thus, by the end of the baseline, the CEECs will be fully integrated into the CAP. All CAP direct payments are transferred at the full EU15 rate in the form of a land subsidy similar to decoupled payments.

An aspect of the EU enlargement not incorporated in this model is the use of Structural Funds. The accession countries are significantly below the average income levels in the EU15. Post-enlargement they will receive considerable inflows of structural funding to boost convergence between new and old members. However, due to the nature of structural funds, both their sourcing and disbursement, their representation in a model such as GTAP is not straightforward. Because structural funds are not targeted at specific commodities, this is incompatible with the structure of the model, see Frandsen

[118] Usually referred to as the Copenhagen Agreement, agreed by the European Council in Copenhagen in December, 2002.

and Staehr (2000) for a full discussion. However, the use of structural funds and cohesion funds is implicitly taken into account by assuming a relatively high level of GDP growth in the accession economies (see table A2.1), implying a degree of economic convergence over the baseline period.

A2.3.5 Everything But Arms Agreement

The Everything But Arms (EBA) Agreement covers trade between the EU and fifty of the world's least developed countries.[119] Simply put, the EU has agreed to the unilateral elimination of tariffs and quotas on imports from these countries, on all commodities except those related to the arms trade. Effective from 2001 for most products, the EBA agreement was fully phased in by beginning 2004.[120]

A2.3.6 Elimination of MFA Textile Quotas

The system of quotas on textile and clothing imports from some developing countries to industrialised countries, established by the Multi-Fibre Agreement (MFA), is eliminated as foreseen under the Agreement on Textiles and Clothing (ATC) from the end of 2004. These quotas, implemented in GTAP as export tax equivalents on the textiles and clothing sectors, are set to zero.

A2.4 Conclusion

This appendix describes the methodology used in the construction of the baseline model and database, projecting the world economy forward from 2001 to 2014. This baseline is

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[119] Due to the limited number of developing countries separately distinguished in the GTAP database it was not possible to include all 50 countries in the region named "EBA".

[120] Full market access will be delayed for some sensitive products: bananas (January 2006), sugar (July 2009) and rice (September 2009).

employed in chapters 3, 5 and 6 to improve the accuracy of the trade liberalisation simulations in those chapters. In particular, chapters 5 and 6 contain detailed descriptions of the changes to the Irish and developing country economies respectively over the period 2001 to 2014.

A2.5 Tables

Table A2.1: Macro-Projections used in the Baseline 2001-2014

Annual Growth Rates and Total Change over the Period 2001-2014 (both in %)

Region	GDP		Unskilled Labour		Skilled Labour		Population		Capital	
	Annual	Total	Annual	Total	Annual	Total	Annual	Total	Annual	Total
Ireland	4.61	80	0.77	11	0.51	7	0.77	10	6.86	137
United Kingdom	2.52	38	0.18	2	0.09	1	0.02	0	2.66	41
Germany	2.50	38	-0.33	-4	-0.59	-7	-0.29	-4	2.25	34
France	2.43	37	0.28	4	0.01	0	0.28	4	2.07	31
Rest of EU15	2.79	43	-0.19	-2	-0.55	-7	0.00	0	3.14	49
CEEC10	4.54	78	0.29	4	0.00	0	0.22	3	3.87	64
USA	2.66	41	0.54	7	0.56	7	0.81	11	3.13	49
Canada	2.68	41	0.75	10	0.45	6	0.80	11	3.66	60
China	7.46	155	0.92	13	3.98	66	0.73	10	8.97	205
India	4.84	85	1.75	25	4.83	85	1.50	21	5.36	97
EBA	4.33	73	2.94	46	3.50	56	2.60	40	3.74	61
Mercosur	3.78	62	3.79	62	3.72	61	1.22	17	3.79	62
Rest of ACP	3.58	58	2.05	30	3.65	59	1.87	27	3.13	49
Former Soviet Union	4.08	68	0.57	8	0.77	11	0.47	6	2.48	38
High-Income Asian	2.51	38	-0.24	-3	-0.13	-2	0.36	5	2.88	45
Rest of EFTA	2.15	32	0.24	3	-0.14	-2	0.17	2	2.58	39
Rest of Asia	4.74	83	2.19	32	4.46	76	1.83	27	4.86	85
Rest of Latin America	4.37	74	1.30	18	4.84	85	1.49	21	4.63	80
Mediterranean	3.68	60	2.56	39	4.73	82	2.39	36	2.48	38
Rest of World	3.97	66	1.91	28	2.74	42	1.41	20	3.61	58

Source: own calculations, Brockmeier *et al.* (2003), Jensen and Frandsen (2003) and ESRI (2003).

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