Journal of the Statistical and Social Inquiry Society of Ireland
Vol. XLV

Barrington Lecture 2015/16

Progress and the Lack of Progress in Addressing Infant Health and Infant Health Inequalities in Ireland during the 20th Century†

Mark E. McGovern*

Queen's Management School, Queen's University Belfast
UKCRC Centre of Excellence for Public Health (Northern Ireland)

(Read before the Society, 3 March 2016)

Abstract There is a growing literature which documents the importance of early life environment for outcomes across the life cycle. Research, including studies based on Irish data, demonstrates that those who experience better childhood conditions go on to be wealthier and healthier adults. Therefore, inequalities at birth and in childhood shape inequality in wellbeing in later life, and the historical evolution of the mortality and morbidity of children born in Ireland is important for understanding the current status of the Irish population. In this paper, I describe these patterns by reviewing the existing literature on infant health in Ireland over the course of the 20th century. Up to the 1950s, infant mortality in Ireland (both North and South) was substantially higher than in other developed countries, with a large penalty for those born in urban areas. The subsequent reduction in this penalty, and the sustained decline in infant death rates, occurred later than would be expected from the experience in other contexts. Using records from the Rotunda Lying-in Hospital in Dublin, I discuss sources of disparities in stillbirth in the early 1900s. Despite impressive improvements in death rates since that time, a comparison with those born at the end of the century reveals that Irish children continue to be born unequal. Evidence from studies which track people across the life course, for example research on the returns to birthweight, suggests that the economic cost of this early life inequality is substantial.

Keywords: Infant Mortality, Early Life Conditions, Inequality
JEL Classification: I10, J10

1. INTRODUCTION

The lives of a country's children are a national asset (Millin, 1917). The welfare of young people is not only an indicator of a country's achievements, but also a marker for the future. A measure such as infant mortality is an important policy outcome because minimising the amount of lives lost is not only a goal in its own right, but also a reflection of other characteristics of a successful state, such as economic development, nutritional intake, access to education and healthcare, and the status of women. However, infant mortality is also an input because it reflects the underlying conditions that each cohort is exposed to as they grow up. Surviving children who are allowed to reach their full potential are best placed to make the most contribution to society in the future (Heckman and Masterov, 2007). Exposure to adverse conditions in early life, particularly excess mortality, reflects poorly on the organisation and management of a country, but can also harm future progress by impacting on both human and physical capital accumulation. Macro-level economic and social development depends on the productivity and labour force participation of future cohorts. Therefore, knowledge of the historical evolution of the mortality and morbidity of children can inform our understanding of past successes and failures, but also provide an insight into the current distribution of wellbeing in a population. The environment experienced at birth among those who grew up in the first half of the last century in Ireland likely has a continuing influence on those individuals and the country as a whole.

† I am grateful to David Bloom, David Canning, Liam Delaney, Alan Fernihough, Slawa Rokicki, and James P. Smith for informing my thinking on the topics discussed in this paper, and to seminar participants at the Statistical and Social Inquiry Society of Ireland and the Northern Ireland Statistics and Research Agency for comments and suggestions.
*Email: m.mcgovern@qub.ac.uk.

Motivated by these observations, the goal of this paper is to provide a survey of the health of children and infants born in Ireland during the 20th century. This country is a particularly interesting case study because of the historical patterns it experienced in early life conditions. I focus mainly on measures of mortality because they are the most readily available health statistics in historical data, and have been widely used as a more general proxy for the environment faced in early life, facilitating comparisons with other countries. These comparisons allow us to benchmark Irish performance, and in fact Ireland preformed favourably during the latter part of the 19th and early 20th centuries, with a lower rate of infant deaths than many of our neighbours, including England. However, there followed a period when there was a lack of progress in tackling high mortality, and during the 1930s and 1940s in particular excess mortality in the urban areas persisted longer than observed in the US or any of the parts of the United Kingdom, including Northern Ireland. Following World War 2, there was a rapid and sustained decline in infant mortality which continued for the remaining decades of the century and into the next. This relatively sustained urban penalty coupled with the subsequent rapid transition makes Ireland interesting from a policy perspective. In addition to allowing us to investigate the welfare of Irish children, a better understanding of the underlying sources of this decline would help other countries currently experiencing high rates of infant mortality in low and middle income settings.

As well as their aggregate impact on society, patterns in early life conditions are also important from an individual perspective. There is now a substantial body of literature, encompassing multiple disciplines, such as economics, public health, epidemiology, and psychology that attempts to address the question of whether initial conditions have a causal impact on later life outcomes. In general the correlation is clear, those who experience worse health or other types of adversity in early life have a greater risk of experiencing disadvantage in later life. Theories in economics, sociology, and epidemiology, amongst other disciplines, provide strong priors for expecting such relationships to be present in the data. Examples of hypothesised mechanisms include the technology of skill formation (Cunha et al., 2010), cumulative disadvantage (Angela, 1996), and structural development of biological systems (Barker, 1990).

Even in the presence of a strong association between initial conditions and later outcomes, care is needed in interpreting studies which do not account for unmeasured factors which are potential common causes of both initial health and outcomes in later life. However, there is growing evidence that some characteristics that might previously have been considered as innate are in fact an outcome of in utero environment. The implication is that children who are socio-economically disadvantaged go on to experience worse outcomes as they age at least in part because they experience less healthy conditions in utero (Currie, 2011, 2009). Reviews of the evidence from quasi-experimental studies linking early life human capital and health to outcomes across the life cycle support the existence of causal effects of initial conditions (Almond and Currie, 2011a, 2011b). This conclusion is supported by recent long-run follow-up studies of intervention cohorts who received nutritional supplements and cognitive stimulation as children (Gertler et al., 2014; Maluccio et al., 2009). These findings have a number of consequences for how we view historical trends in infant and child health. First, linking individuals in adulthood to their early life environment may provide some insight into contemporaneous disparities in wellbeing. Second, minimising inequality at birth is necessary to ensure that all children face an equal chance of success in life regardless of the characteristics of their parents. Third, historical adversity lives on and will result in long-term consequences because it continues to impact on those who experienced disadvantage as children.

There are a number of papers that address the lasting impact of early life conditions using Irish data. Motivated by biological theories about foetal programming (Barker, 1990; Forsdahl, 1978), (Pringle, 1998) examines whether counties in Ireland which experienced higher rates of infant mortality in the early part of the 20th century went on to experience higher death rates from ischaemic heart disease in the later part. There is no clear evidence that this is the case. However, it is difficult to account for migration when examining aggregate outcomes at the county level and thus assign the right exposure, especially given migration rates in Ireland. Instead, Delaney et al. (2011) tie individuals in the 2002 and 2006 censuses to their county of birth, and find that those who were born into places and times of higher infant mortality are more likely to experience disability in later life. The rapid changes in early life conditions during the middle of the last century in Ireland strengthen the argument that these results are causal and not due to omitted confounders. More recently, the Irish Longitudinal Study of Ageing (TILDA) (Kearney et al., 2011) has provided the opportunity to examine further whether the initial conditions experienced by Irish adults have contributed to their current welfare. McCrory et al. (2015) find that childhood adversity (measured by whether the respondent reported experiencing socioeconomic disadvantage or abuse before the age of 18) is positively associated with chronic conditions at ages 50 and older. Henretta and McCrory (2016) demonstrate that early life conditions (as measured by paternal education, rural residence, and self-rated health in childhood) predict functional mobility among the TILDA sample aged 50-59 who completed a medical assessment. Similar relationships for mental health and loneliness have been documented (Kamiya et al., 2014, 2013). Two studies which specifically examine childhood sexual abuse (which 7% of respondents in TILDA report experience of) find that those affected in childhood go on to experience poorer physical and mental health,

increased rates of hospital and doctor visits, and among males, lower rates of labour force participation, living alone, and income (Barrett et al., 2014; Kamiya et al., 2016). While the question of causality is, as always, difficult to address definitively, it seems clear from the available Irish data that the same associations we observe in other countries are equally likely to apply. As the predictive power of initial environment for later outcomes appears to be similar for the Irish population, this strengthens the motivation for describing the early life conditions experienced over the course of the 20th century in Ireland.

The rest of this paper is structured as follows. In **Section 2** I outline the trends in infant mortality in Ireland and Northern Ireland and compare them to those observed in other countries. In **Section 3**, I focus on the early part of the century and provide some evidence on infant health inequalities using birth records from the Rotunda hospital. **Section 4** presents information on one of the major events in the history of Irish public health in more detail, the dramatic decline in infant mortality and closing of the urban-rural gap which occurred after World War 2. In **Section 5**, I assess whether progress has been made in addressing historical inequalities in infant and child health. Finally, **Section 6** concludes.

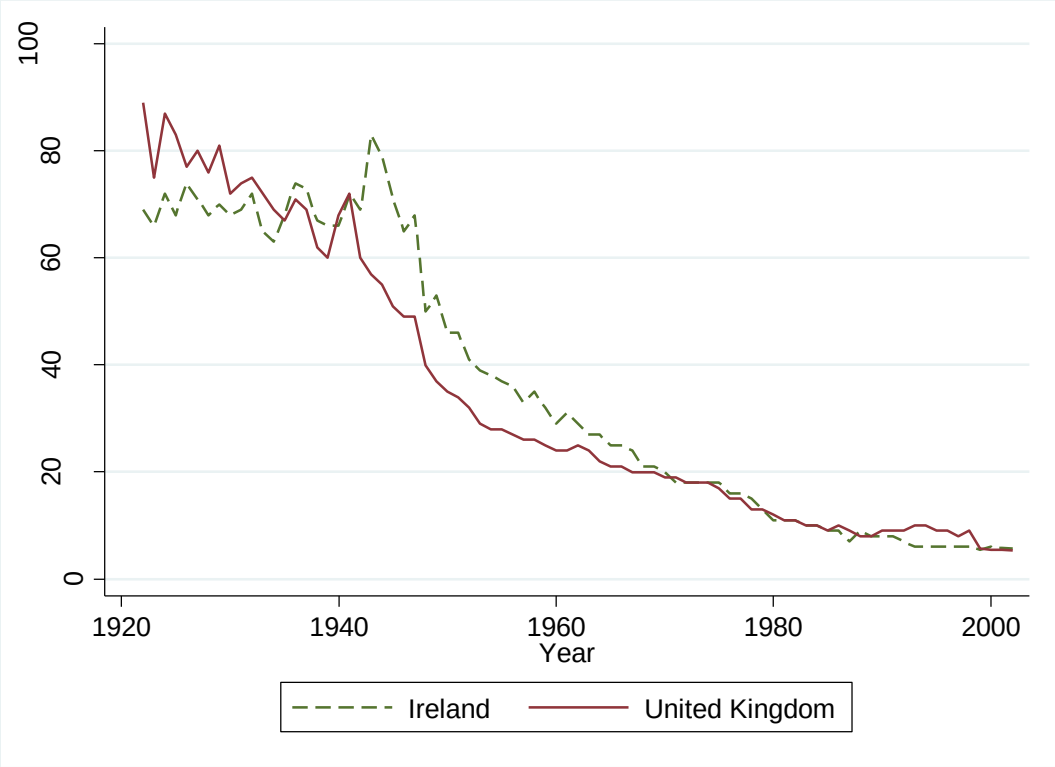
2. OVERALL TRENDS IN IRISH INFANT MORTALITY

It is clear from examining contemporaneous sources that infant mortality (deaths occurring in the first year of life) and the associated loss of life and human potential weighed heavily on policy makers, the medical profession, and society in general during the late 19th and early 20th century in Ireland. This concern is evident in, for example, Dáil parliamentary debates, the Journal of the Statistical and Social Inquiry Society and the Irish medical journals, and the memoirs of the key players in government and the civil service at the time (Breathnach and Moynihan, 2004; Browne, 1986; Deeny, 1989; Elwood, 1973; Grimshaw, 1889; Knaggs, 1958; Lyon, 1948, 1943; Millin, 1917). It is apparent from the data that there were a number of different phases in Irish infant mortality. In the late 19th century, infant mortality in Ireland compared favourably with the other parts of the United Kingdom, with lower death rates continuing through the first decades of the 20th. The rate in Ireland was relatively stable at between 9% and 10% (90-100 infant deaths per 1,000 live births). These data are presented in **Figure 1**. All regions experienced a downwards trend beginning around 1900, although in Ireland the pace of the mortality decline was not as impressive.

Figure 1 Infant Mortality in Ireland and the United Kingdom at the End of the 19th Century

Source: (Woods et al., 1988), Registrar General Reports

Figure 2 Infant Mortality in Ireland and the United Kingdom since Independence



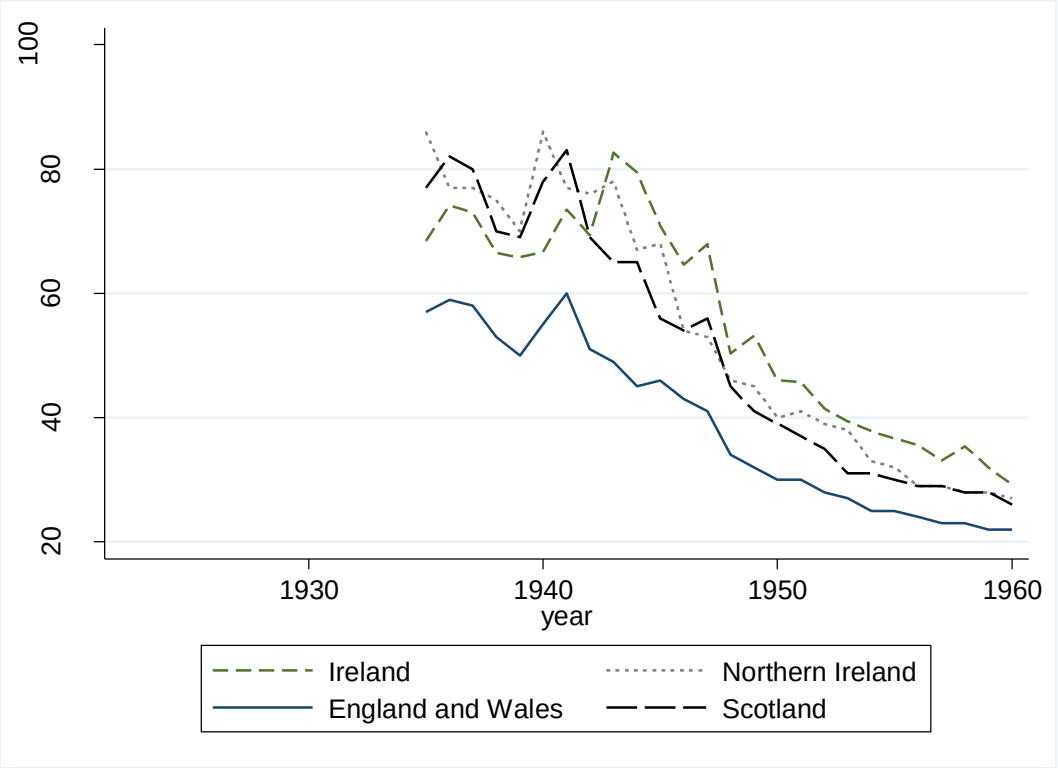
Source: Registrar General Reports

Moreover, by the 1940s infant mortality in Ireland was higher than in that in the United Kingdom as a whole, as demonstrated in **Figure 2**. After independence in 1922, when southern Ireland became what was then Saorstát Éireann and northern Ireland remained part of the United Kingdom, the South continued to experience lower infant mortality, however there was no decline in death rates. In contrast, a sustained decline saw the United Kingdom catch up rapidly prior to World War 2. By the late 1930s, and during the 1940s and 1950s in particular, there was higher infant mortality in Ireland. The 1970s saw rates in the two countries converge, and since then infant mortality in Ireland has often been lower, most notably in the 1990s. A similar pattern is apparent from **Figure 3**. Ireland did best from a relative perspective in the 1930s, with lower rates than either Scotland or Northern Ireland. However, from the 1940s to the 1960s, Ireland was the worst performing member of this group.

Because of the close geographic proximity and close cultural and economic links between the countries, this comparison with Ireland's nearest neighbours seems the most appropriate. However, it is also possible to compare the Irish performance with other countries. **Figure 4** gives the infant mortality rate over the period 1950-1955 among the 20 countries with the lowest infant mortality rates at the time. Ireland ranked towards the bottom of this group at 15th, with a mortality rate of 41.5 deaths per 1,000 live births (4.15%), compared to 46.3 in what is now the Czech Republic, and 19.7 in Sweden. Irish infant death rates at this time were therefore more than twice those in the best performing country.

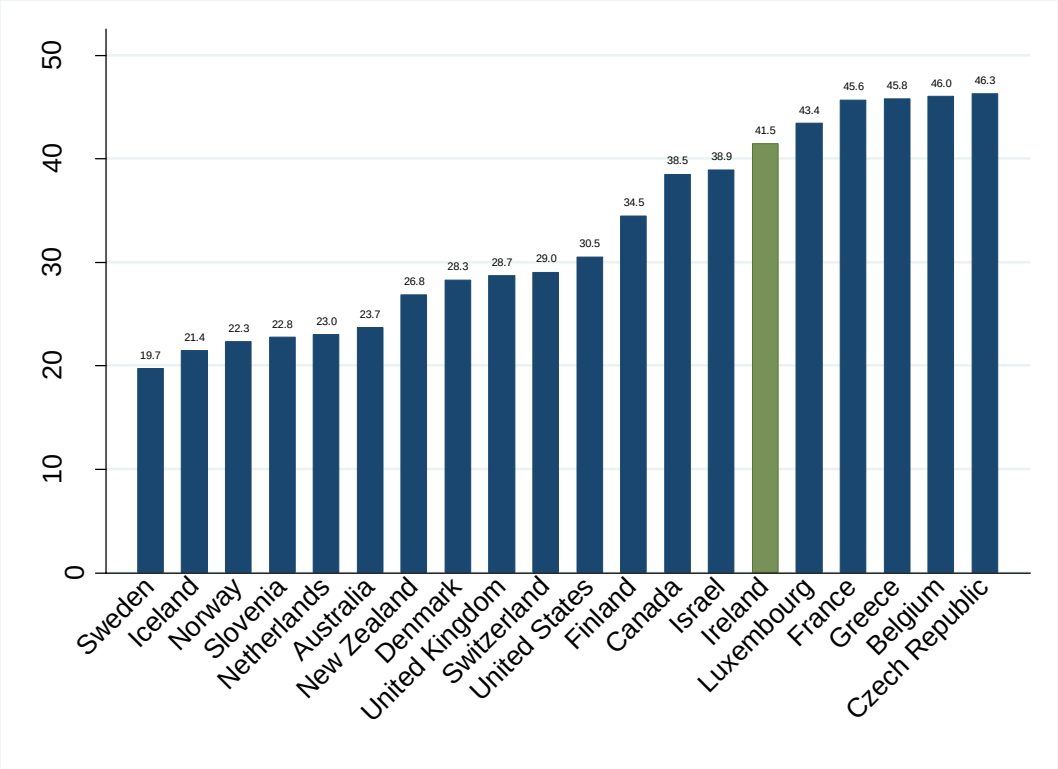
There is some literature on under and over registration of births and deaths in Ireland (Coward, 1982; Dean and McLoughlin, 1980; Dean and Mulvihill, 1972), however given the magnitudes involved it seems unlikely that these factors would qualitatively affect our understanding of the trends in infant mortality over time.

Figure 3 Infant Mortality in Ireland, England/Wales, Northern Ireland and Scotland



Source: Registrar General Reports

Figure 4 Infant Mortality 1950-1955 for the 20 Best Performing Countries



Source: United Nations World Population Prospects (2015)

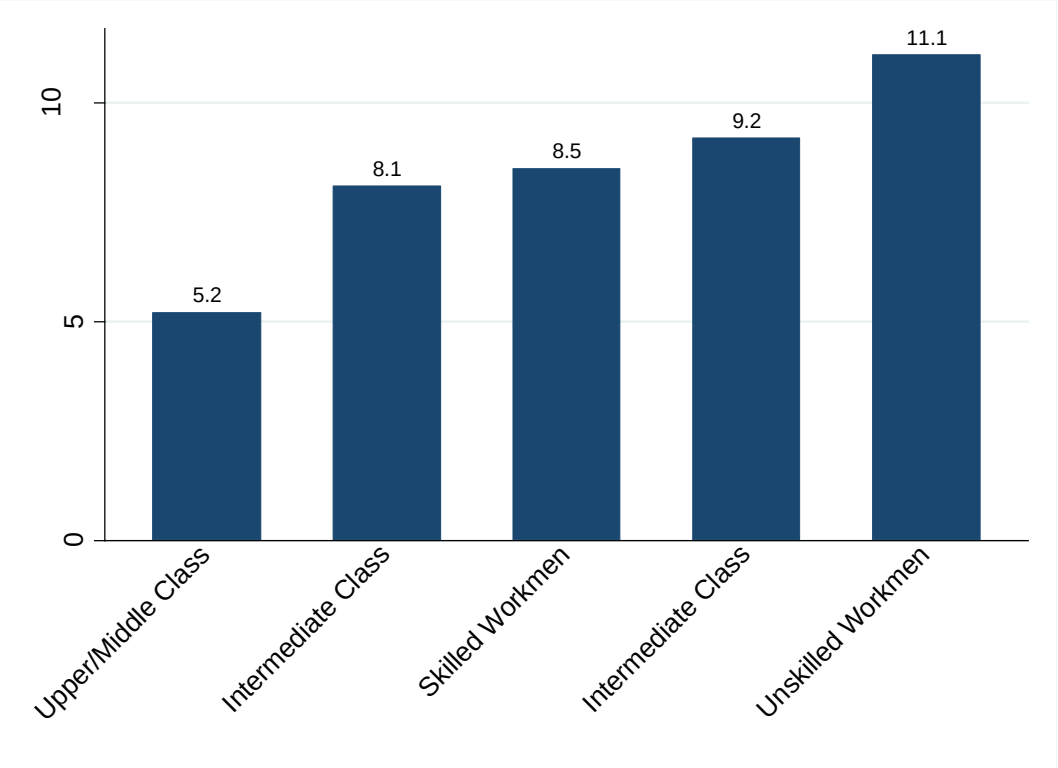
3. EARLY 20TH CENTURY: INSIGHTS FROM THE ROTUNDA HOSPITAL BIRTH RECORDS

One feature apparent in historical studies of infant death rates is that there was substantial variation within countries. This is partly due to geographic differences, particularly urban-rural disparities, as will be discussed in the next section. However, this variation was also partly driven by inequalities in mortality by socioeconomic status or social class. Children born to parents of higher occupational status were much less likely to die prematurely (Haines, 1995, 1985; Pamuk, 1988). For example, **Figure 5** demonstrates that the infant mortality rate in England and Wales was almost 6 percentage points higher in the lowest parental occupational class (unskilled workmen) compared to the highest (upper or middle class). These disparities are also apparent in previous studies of Irish data. In an analysis of Irish census data from the postal district of Pembroke (now Dublin 4), Ó Gráda (2004) estimates child (under five) mortality by paternal occupational class. Here the difference between lowest and highest occupational classes is more than 10 percentage points (**Figure 6**), however the outcome is child mortality which we expect to be higher than mortality for infants. In addition, the occupational classes are not measured using the same categories, and therefore the scale is different. While the two figures are not directly comparable, it nevertheless seems that the same socioeconomic disparities observed in other countries were also present in Ireland, or in Dublin at least.

Here I explore the disparities in initial health during the early 20th century in Dublin further using information from the Rotunda Lying-In hospital (UBC Research Data Collection Dataverse - Abacus Dataverse Network, 2012). These data have been used to describe and compare historical patterns in birth weight and birth length across numerous cities in Europe and the US (Ward, 1993, 1988), and were compiled by sampling 200 records from the births in the Rotunda each year from 1870 to 1930 (with a further 100 taken from 1869). The Irish data additionally contain information on whether the child was stillborn, but unfortunately that is the only mortality data available. Also included are some socio-demographic characteristics of the mother and family (such as age of mother, parity, place of residence, marital status, husband's occupational status). These variables, summary statistics for which are shown in **Table 1**, provide us with an opportunity to examine socio-economic disparities in the outcome of interest. Mean birth weight in the sample is 3,243 grams, while the mean birth length is 49 centimeters. In total there are 12,000 birth records, however many of these are incomplete, and therefore excluded. The coverage of the length variable is particularly poor.

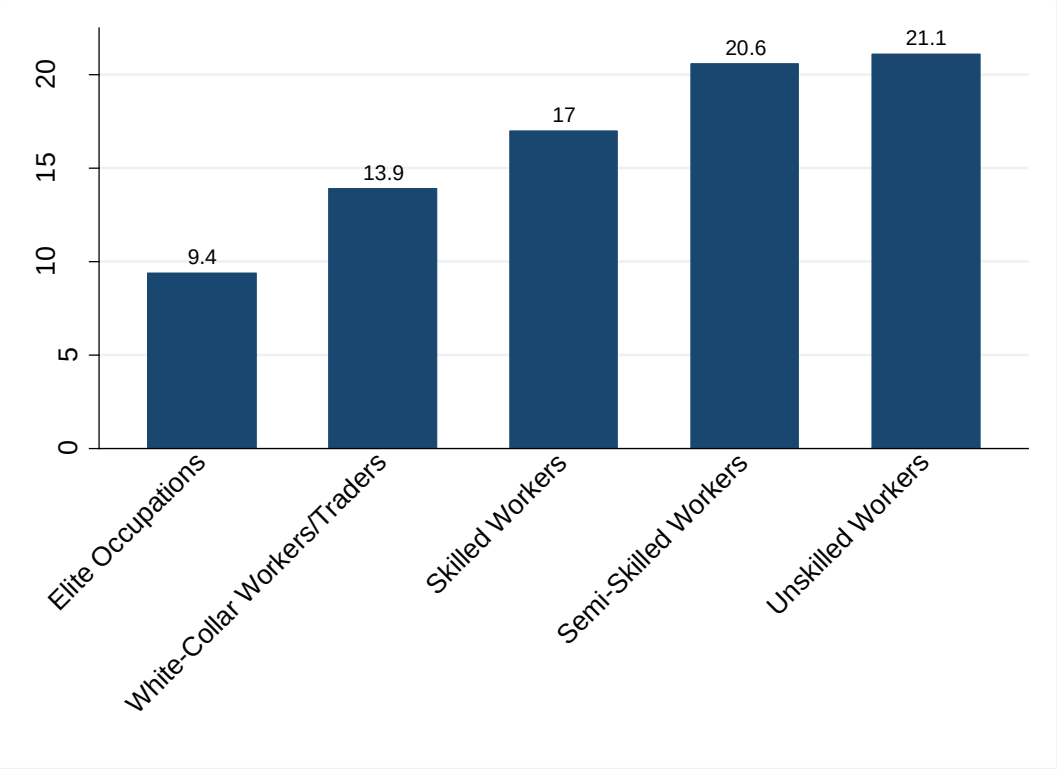
In order to determine sources of variation in infant health, I consider the predictors of stillbirth. **Table 2** presents a cross tabulation for this outcome with the socio-demographic covariates of interest. It is apparent from **Table 2** that outcomes are not uniform across groups. For example, males exhibit higher rates of stillbirths (4.3% versus 4.1%), while unmarried mothers have a stillbirth rate of 5.6% compared to 4.2% for married mothers. Place of residence is also a risk factor, those mothers living in the inner city (Dublin Core) have much higher rates of stillbirth. Mother's age group is positively associated with stillbirths, as is parity. Next I consider whether any of these differences remain after adjusting simultaneously for all risk factors. These results are shown in **Table 3**. For stillbirth as the outcome I present odds ratios from a logit model. The main conclusion from this analysis is that stillbirths are 74% higher in the disadvantaged city centre. The bivariate analysis indicates that unmarried mothers have higher rates of stillbirths, but this difference is not statistically significant in the regression model.

Figure 5 Infant Mortality by Occupational Class in England and Wales 1895-7 to 1910



Source: (Woods et al., 1988)

Figure 6 Child Mortality by Occupational Class in Dublin 4, 1911



Source: (Ó Gráda, 2004)

Table 1 Summary Statistics for Rotunda Data

	Median	Mean	SD	N
Mother's Age	26	27	6	10,099
Parity	2	3	3	10,073
Infant Length (in centimetres)	50	49	3	5,017
Infant Weight (in grams)	3289	3243	618	10,037

Husband's Occupation			**Infant Sex**		
Un/Semi Skilled Labour	4,845	51	Male	5,156	51
Skilled Labour	2,430	26	Female	4,944	49
Domestic Service	379	4	Total	10,100	100
Commerce, Clerical, Government	1,329	14			
Professional, Managerial	150	2	**Live or Stillborn**		
Miscellaneous	373	4	Live	9,629	96
Total	9,506	100	Dead	445	4
			Total	10,074	100
Mother's Religion					
Catholic	9,031	90	**Marital Status**		
Jewish	7	0	Single	496	5
Protestant	1,040	10	Married	9,604	95
Total	10,078	100	Total	10,100	100
Month of Birth			**Mother's Address**		
Jan	754	8	North Dublin	5,099	51
Feb	791	8	South Dublin	1,881	19
Mar	918	9	North Suburbs	483	5
Apr	942	9	South Suburbs	536	5
May	922	9	Dublin Core	532	5
Jun	837	8	Dublin & Suburb	77	1
Jul	862	9	Other Ireland	177	2
Aug	846	8	Missing	1,315	13
Sept	902	9	Total	10,100	100
Oct	727	7			
Nov	711	7			
Dec	888	9			
Total	10,100	100			

Table 2 Cross Tabulation for Stillbirth

Stillbirth

Variable	Mean (%)	Variable	Mean (%)
Average	4.2%	**Time Period of Birth**	
		1900-1931	4.2%
Sex of Child		1869-1899	4.3%
Male	4.3%		
Female	4.1%	**Husband's Occupation**	
		Un/Semi Skilled Labour	4.2%
Marital status		Skilled Labour	4.3%
Single	5.6%	Domestic Service	4.2%
Married	4.2%	Commerce, Clerical, Government	4.5%
		Professional, Managerial	4.7%
		Miscellaneous	6.7%
Mother's Age Group			
<20	4.9%	**Mother's Address**	
20-29	3.8%	North Dublin	4.1%
30-39	4.8%	South Dublin	3.3%
40+	5.7%	North Suburbs	5.6%
		South Suburbs	4.3%
Parity		Dublin Core	6.8%
1	4.1%	Dublin & Suburb	5.2%
2	3.1%		
3	3.9%		
4+	5.1%		

It is important to note the limitations of these data. First, the Rotunda's population was not representative of Dublin as a whole, as the catchment area was mainly the north inner city. Details of the characteristics of the hospital population have been described elsewhere (Ó Gráda, 1995, 1991; Ward, 1993). Second, given that there may be other factors associated with parental characteristics and the risk of stillbirth, these results should not be taken as representing causal estimates, but rather associations only. Finally, compared to infant or child mortality, stillbirths are expected to be relatively rare. In addition, stillbirths may have a different a different aetiology. However, stillbirth is the only available mortality outcome in these data, and it seems reasonable to assume that the inequality apparent in this outcome would also be present, albeit to a greater extent, in the infant death rate. Therefore, bearing these caveats in mind, having established some of the likely socioeconomic patterns in early life health in early 20th century Dublin, I now turn to the mid-20th century and the urban penalty.

Table 3 Regression Results for Stillbirth

Variables	Logit (OR) Stillbirth	Logit (OR) Stillbirth
Year of Birth	1.00	1.00
	(0.00)	(0.00)
Infant Sex: Male	0.96	0.96
	(0.10)	(0.10)
Age Group (Omitted=<20)		
20-29	0.78	0.77
	(0.19)	(0.19)
30-39	0.92	0.90
	(0.26)	(0.25)
40+	1.05	0.99
	(0.40)	(0.38)
Mother's Religion (Omitted=Catholic)		
Jewish		
Protestant	0.85	0.86
	(0.17)	(0.17)
Private Patient	0.95	0.88
	(0.40)	(0.37)
Special Delivery Circumstances	3.04***	3.06***
	(1.07)	(1.08)
Parity (Omitted=1)		
2	0.79	0.80
	(0.14)	(0.14)
3	0.96	0.96
	(0.19)	(0.19)
4+	1.22	1.23
	(0.20)	(0.20)
Husband's Occupation (Omitted=Unskilled)		
Skilled Labour	1.03	1.04
	(0.14)	(0.14)
Domestic Service	0.98	0.89
	(0.30)	(0.27)
Commerce, Clerical, Government	1.11	1.07
	(0.19)	(0.18)
Professional, Managerial	1.34	1.25
	(0.57)	(0.54)
Miscellaneous	1.66*	1.59*
	(0.46)	(0.44)
Not Married	1.48	1.43
	(0.38)	(0.36)

(CONTINUED ON NEXT PAGE)

Mother's Address (Omitted=North Dublin)		
South Dublin		0.79
		(0.12)
North Suburbs		1.46*
		(0.32)
South Suburbs		1.11
		(0.25)
Dublin Core		1.74***
		(0.33)
Dublin & Suburbs		1.24
		(0.65)
Constant	0.12	15.02
	(0.77)	(100.60)
Observations	8,473	8,473

Robust standard errors in parentheses

*** p<0.01, ** p<0.05, * p<0.1

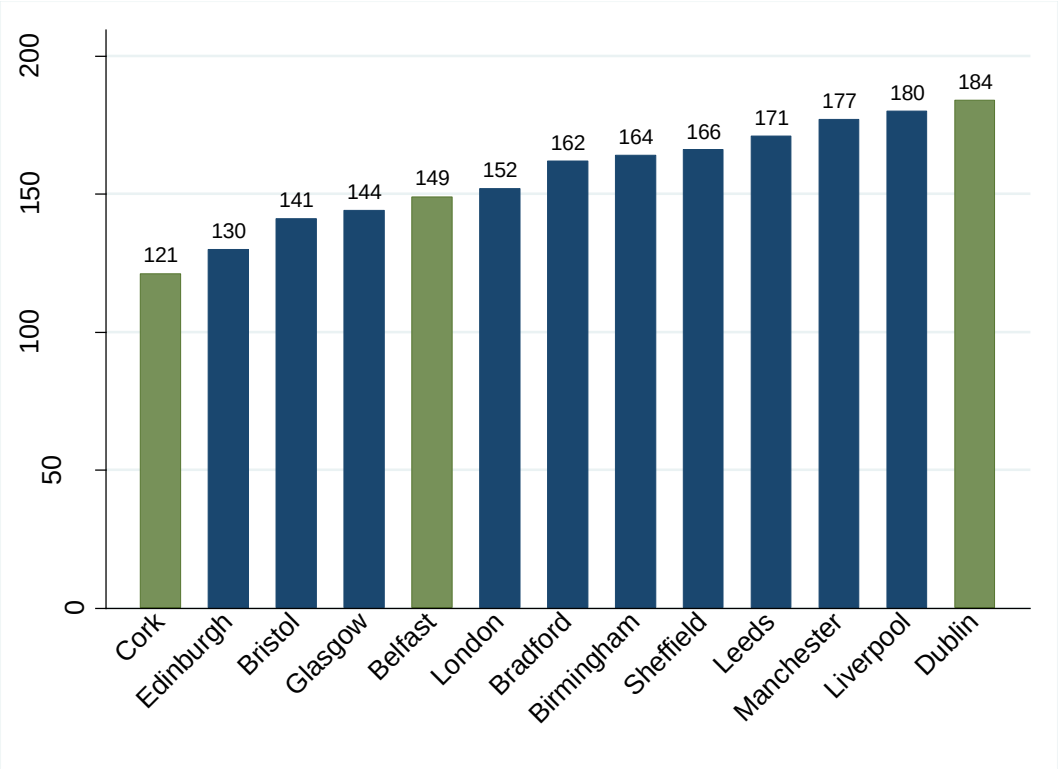
Odds ratios are shown.

4. MID-20TH CENTURY: THE URBAN INFANT MORTALITY PENALTY

A well-known historical phenomenon among infant and child death rates is the excess mortality associated with urban living. In most developed countries, infant mortality was much higher in cities than in rural areas at the turn of the century. This has been demonstrated for the UK (Woods, 2003), the US (Cain and Rotella, 2001), and was also true in Ireland. The reasons for this urban penalty are also generally understood to have been related to some of the features of cities at the time, including overcrowding, rapid spread of infectious disease, poor sanitation, nutrition and other factors such as clean water (Haines, 2001; Williams and Galley, 1995; Woods, 2003). For example, **Figure 7** shows infant mortality rates from different cities in the UK at the end of the 19th century. Even though the overall death rate was lower in Ireland than the UK (**Figure 1**), it is apparent that Dublin was at a significant disadvantage compared to the other cities, including Cork. The high rate of infant mortality in the cities in Ireland, especially Dublin, was the main driver of excess Irish mortality in the 1940s. By this time the US had already solved the problem of the urban mortality penalty (Haines, 2001). **Figure 8** compares infant mortality in Dublin and Belfast. Up until the 1930s, Dublin performed worse, rates were similar in the 1930s, 50s, and 60s, but again the excess mortality in Dublin is apparent after World War 2.

Similar to Garvin's question about the persistence of poverty of Ireland (Garvin, 2004; "Why was Ireland so poor for so long?"), a pertinent question is why the Irish excess urban mortality penalty persisted after it had been eliminated in the US (by the 1940s), rather than why it existed in the first instance. Many rural counties, such as Mayo and Westmeath, had relatively low rates throughout the period 1915-1962. Urban counties, particularly Dublin, but also to a lesser extent the other cities such as Cork, had much higher rates which were declining in the early years of the 20th century, but remained relatively stagnant from the mid-1920s until after World War 2. Within Dublin, mortality was substantially higher in the city than the rest of the county (CSO, 2016).

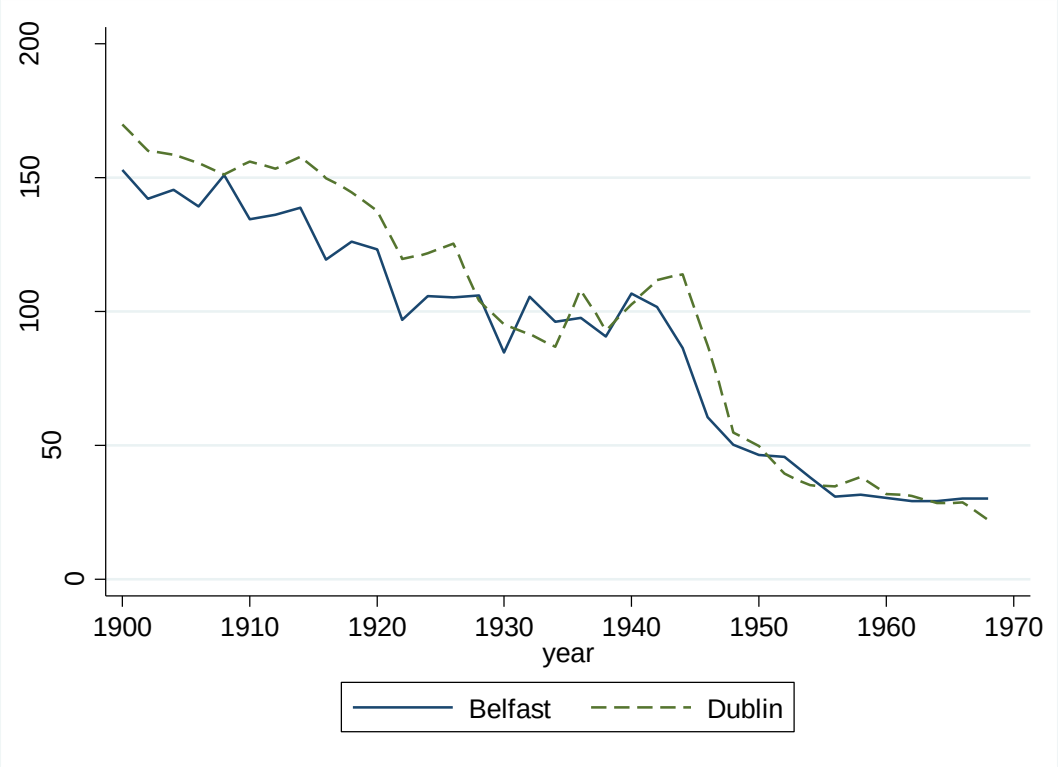
Figure 7 Mean Infant Mortality Rate in Selected Towns of the United Kingdom 1879-1888



Source: (Grimshaw, 1889)

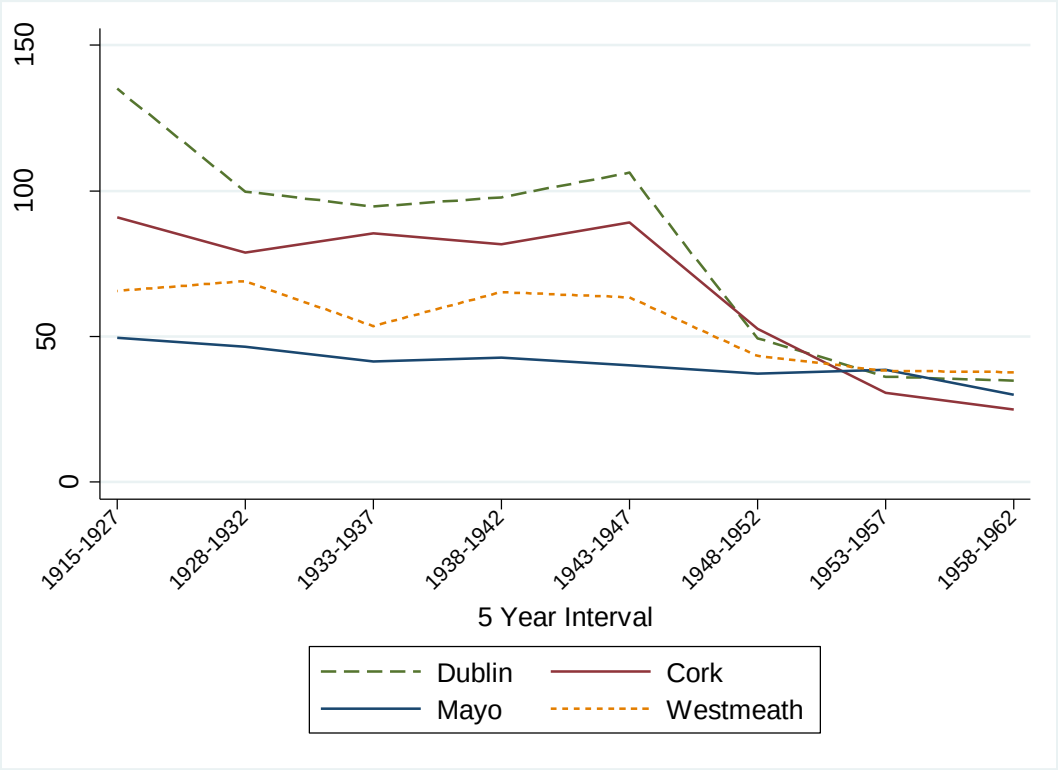
It was only after the war that the urban rates converged to the rural levels. Therefore, the key to understanding this period lies in understanding why cities such as Dublin performed so badly. The county-level data for Ireland are summarised in **Figure 9**. Specific factors contributing to the urban penalty highlighted in the Journal of the Statistical and Social Inquiry Society and other sources include slum clearance (Aalen, 1992; Canavan, 1938; Lawson, 1912), nutrition (Clancy Gore, 1944), poverty (Lyon, 1948, 1943), and sanitation (Malcolm, 1852; Mapother, 1864; O'Neill, 1906). The importance of breastfeeding in maintaining infant health, especially to guard against gastroenteritis, has also been widely emphasised (Daly, 2010; Deeny, 1995; Earner-Byrne, 2007), which is in line with the research on other countries (Millward and Bell, 2001; Woods et al., 1989). It is difficult, however, to definitively prove the contribution of each. There are only a limited number of papers which provide causal evidence on historical interventions targeted at improving infant and child health. One study on the historical urban penalty which does attempt to address the issue of causality is Cutler and Miller (2005). Based on the timing of clean water interventions rolled out across cities in the US, these authors attribute 50% of the decline in infant mortality rates to these programmes prior to 1940. Also in the US, the introduction of Sulfa drugs led to a substantial reduction in influenza and pneumonia-related death rates among children (Bhalotra and Venkataramani, 2015), however this was a relatively minor component of total infant deaths in most countries (including Ireland), and therefore played a relatively small part in the overall trends described in this section. Finally, a mother and child intervention programme in Sweden in the 1930s appears to have had a substantial impact on infant survival rates (Bhalotra et al., 2016).

Figure 8 Infant Mortality in Dublin and Belfast



Source: (Elwood, 1973)

Figure 9 Excess Urban Infant Mortality in Ireland (County-Level 5 Year Averages)



Source: Registrar General Reports

Some evidence on the Irish experience can be obtained by comparing infant mortality rates in locations where these risk factors vary, by comparing changes in the main causes of death, and by comparing relative declines in death rates at different ages. While the Registrar General reports contain the outcomes of interest, the main data source for other historical county-level characteristics which could be used as potential predictors of, for example, infant mortality, is the Irish census (the relevant years being those conducted in 1936, 1946, 1951, 1956, and 1961). Other sources with consistent data on local-level risk factor exposure (or public health expenditure and policy implementation) would be very valuable, especially if collected on a monthly or quarterly basis. However, to the best of my knowledge no such database is currently publicly available. This is an important direction for future research.

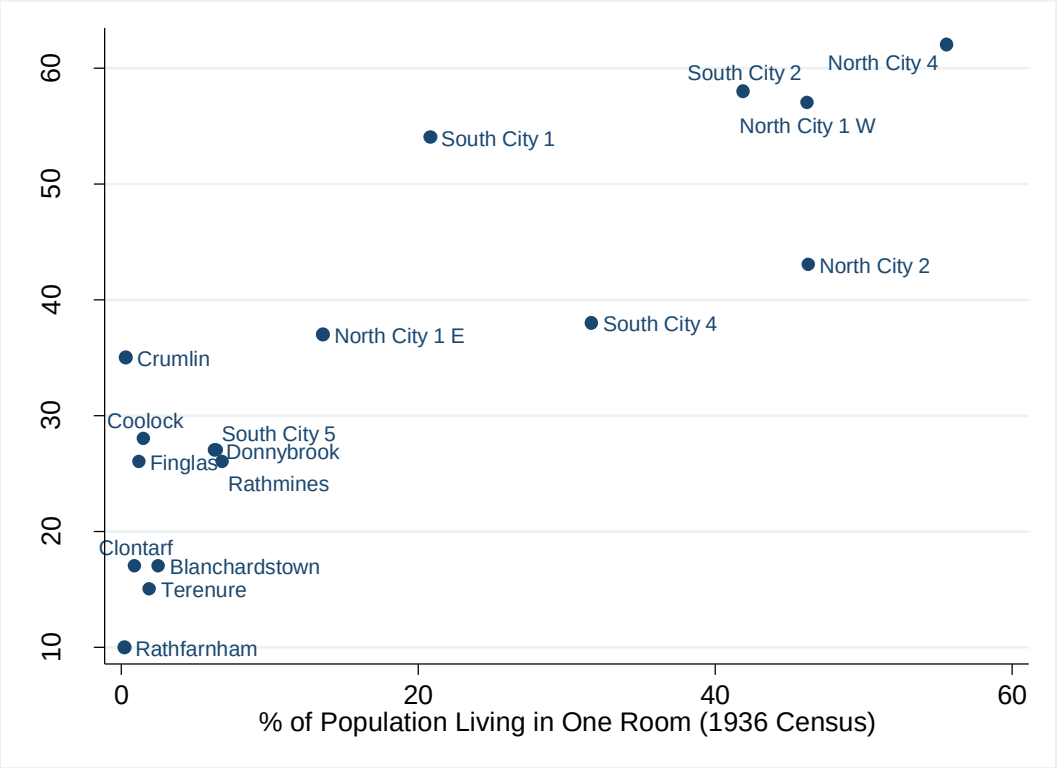
Delaney et al. (2011) show that the majority of improvements in mortality were concentrated specifically on infants (as opposed to children), and that the proportion of households living with shared sanitation facilities was positively associated with infant mortality at the county level. In Dublin, this applied to almost 40% of all families according to the 1946 census. The three major causes of death during this period were congenital debility, convulsions, and gastroenteritis. The latter was the main contributor to the overall rise in the death rate during period of World War 2, reaching epidemic proportions in the mid-1940s (Deeny, 1995). Some further data on the underlying causes of the excess mortality in Dublin can also be gleaned from the data on differences between locations within Dublin. The government's chief medical officer, James Deeny, conducted an analysis showing that overcrowding within Dublin districts was positively correlated with infant mortality (the results of which are summarised in **Figure 10**). One important contributor to the gastroenteritis outbreak was undoubtedly the reductions in nutritional intake and food quality associated with the war, and there may also have been corresponding reductions in rates of breastfeeding during this time. Data in support of the breastfeeding hypothesis from a survey of infant mortality in Belfast during the period 1941-1942 are provided by Deeny and Murdock (1944a, 1944b, 1943), and illustrated in **Table 4**. Even within strata (household income, residents per room, hygiene, and birth order), the proportion breastfed was higher among children who survived up to a month of age. Although not conclusive proof, this is clearly evidence in favour of the breastfeeding hypothesis.

Table 4 Breastfeeding and Infant Mortality (up to 1 Month) in Belfast 1941-1942

	Died	Lived		Died	Lived
	% Breastfed			% Breastfed	
Income per head per week			**Household Hygiene Classification**		
<10 shillings	51	77	A (very clean)	47	76
10-15 shillings	55	75	B (intermediate)	55	75
15+ shillings	48	75	C (not clean)	48	71
Persons Per Room			**Birth Order**		
<1	62	75	1	56	73
1-1.5	47	77	2	49	71
1.5-2	49	77	3	48	82
2+	53	68	4 or 5	46	82
			6+	54	75

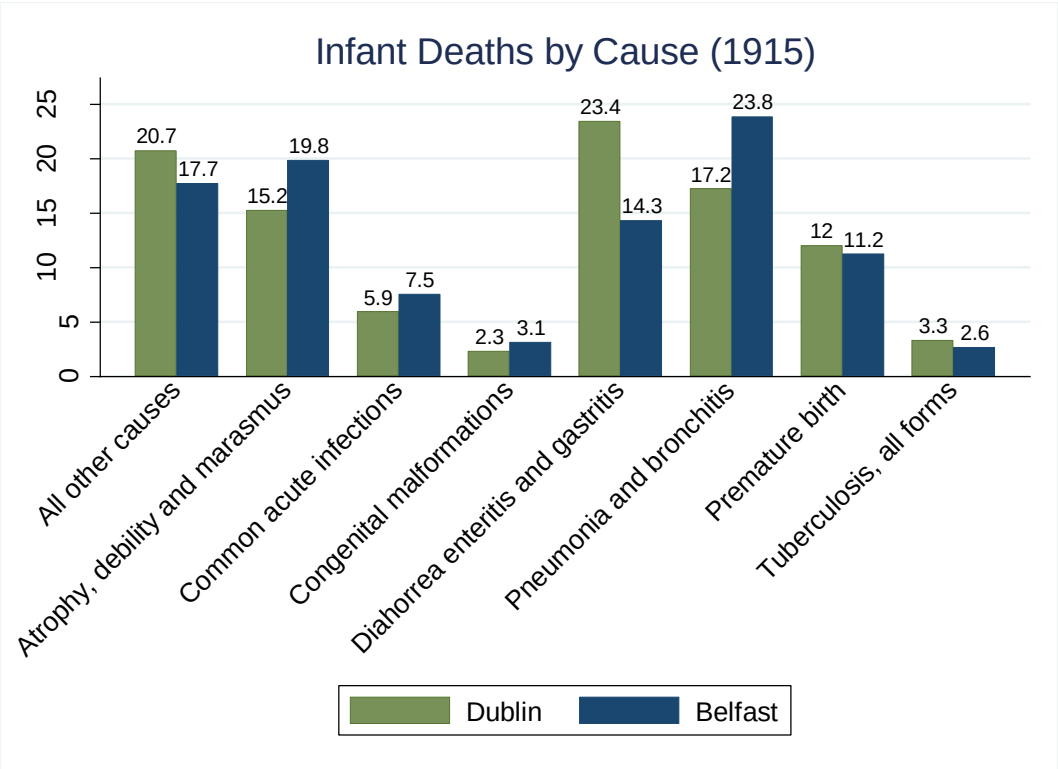
Source: (Deeny and Murdock, 1944b)

Figure 10 Infant Mortality and Overcrowding in Dublin Districts 1941-1944



Source: (Deeny, 1995)

Figure 11 Infant Deaths by Cause in Dublin and Belfast (1915)



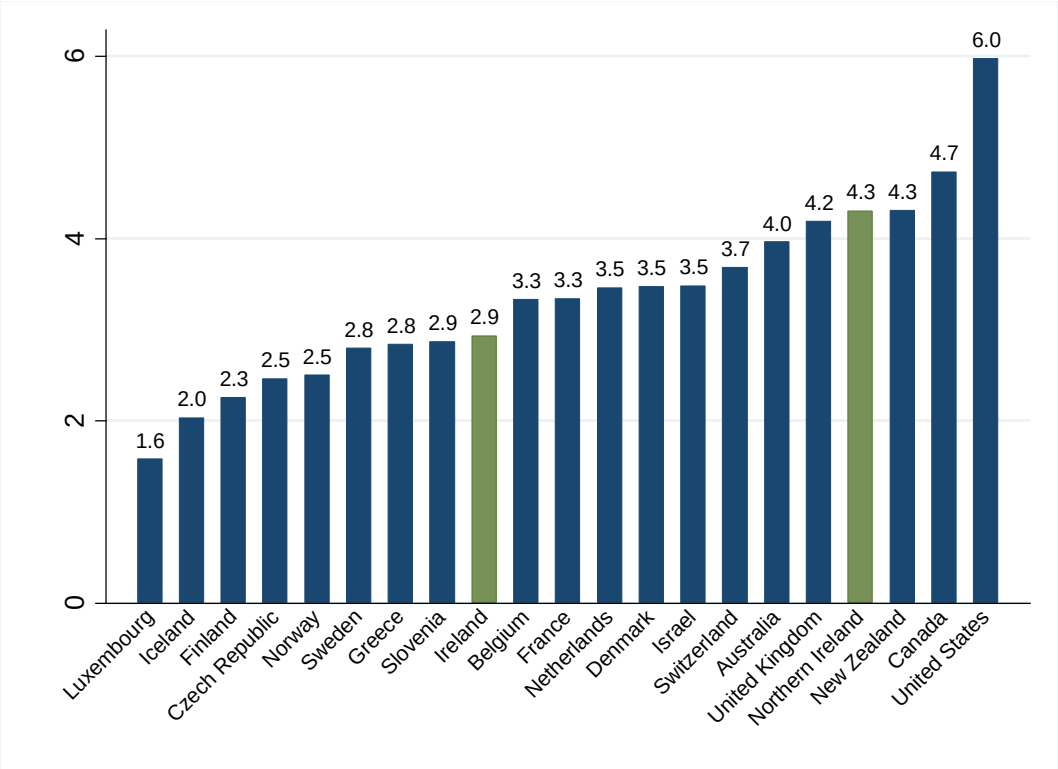
Source: (Elwood, 1973)

Figure 11 compares infant mortality by cause in Dublin and Belfast. Even as early as 1915, gastroenteritis made a larger contribution to death rates in Dublin (23.4% of total infant mortality) than Belfast (14.3%). However, pneumonia was a more important cause in Belfast (23.8%) than Dublin (17.2%). Atrophy, debility and marasmus were also higher in Belfast, while other causes were more important in Dublin (Elwood, 1973).

The fact that gastroenteritis was infectious exacerbated the problem, and created a major public health crisis during World War 2. However, despite reaching a peak after the war, within a couple of years the infant death rate would begin a rapid and sustained improvement. An important question is therefore what led to reductions in exposure to risk factors, and what drove the decline in infant mortality after 1947. The turning point in the Irish infant mortality series appears to be 1947, and this is confirmed by formal statistical tests for interruptions in the time series. However, it is difficult to be definitive because of external events. For example, in the absence of the war would gastroenteritis not have been so severe and would death rates have begun an earlier decline just as they had in England and Wales? Or was there a specific event or policy implemented in 1947 that precipitated a dramatic improvement?

The obvious explanation for the improvement in the mortality environment was the introduction of the 1947 Health Act, which had been proposed and developed over several years preceding its enactment, at least partly in recognition of the need to address the deteriorating state of public health. The extent of infant mortality, coupled with the lack of progress in combating infectious diseases, including tuberculosis and typhoid, was creating grave concern among politicians, clergy and the medical profession. In response to these concerns, the Health Act established, for the first time, a dedicated department of health, and gave it sweeping powers to deal with infectious disease, planned for a major increase in the health infrastructure budget, and finally, proposed a free programme of care specifically for mothers and children. The role of a number of dedicated individuals at the forefront of efforts to tackle the public health crisis is apparent. The most prominent of these included the chief civil servant in the newly established health department, Dr James Deeny, ministers of health Seán MacEntee (also for local government at the time), Dr James Ward, Dr James Ryan, and Dr Nöel Browne. Although the act passed, the mother and child scheme was not implemented immediately, and therefore seems unlikely to have played a role in at least the initial infant mortality decline after 1947. Subsequent attempts to roll-out the mother and child scheme as envisaged in the original act lead to the resignation of the then health minister, Dr Nöel Brown, and eventually to the fall of the government. When it was subsequently implemented by the de Valera administration in 1953, the result was a substantially diluted version of what had originally been planned. This experience may have had long run implications for the institutional provision of maternity services in Ireland (Kennedy, 2013). These events also demonstrated the tensions between the civil servants, who were planning for a more centralised system most likely motivated by the introduction of the National Health Service in Britain (Barrington, 1987), the medical profession who sought to ensure autonomy for their members, and the clergy who wanted to ensure that mothers and children had adequate choice of doctor. The events surrounding the scheme have been previously described from these different perspectives (Browne, 1986; Counihan, 2002; Earner-Byrne, 2007, 2006; McKee, 1986; Whyte, 1980). As already discussed, given that the scheme was not implemented it is difficult to attribute the post-1947 decline to the mother and child programme, although it is possible that it played a part in the improvements in infant mortality after 1953. Given the evidence from Sweden, it may have been beneficial to have implemented such a scheme earlier (Bhalotra et al., 2016). An alternative explanation for the fall in infant death rates after 1947 is economic growth and poverty reduction. However, this is also an unlikely cause given that Ireland's performance over the next few decades was poor (Garvin, 2004). The ratio of Irish to UK GDP was as low as 0.4 in 1943, but did not rise much above 50% during the 1950s (Ó Gráda, 2008). Another potential source of death rate declines was medical innovation, however this does not explain why Ireland performed worse than its neighbours despite presumably having access to the same technology, which would also have been available in, for example, Belfast. Another point to note is that the major causes of death, such as gastroenteritis, are more consistent with improvements in environmental factors such as sanitation and nutrition, and that in other countries declines in infectious disease were well underway before the introduction of relevant medical technologies (Cutler and Meara, 2003; McKeown et al., 1975). Perhaps the most simple explanation for the fall in infant mortality in Ireland during this period is the increase in the health budget, and the major hospital building project which occurred as a result of the 1947 Health Act (Barrington, 1987). Health expenditures were £617,905 in 1947, £2,347,485 in 1949 and £4,241,290 in 1951 (Breathnach and Moynihan, 2004). Garvin (2004) argues that the coming decades saw Ireland build a very modern health service. A final explanation is that the government, medical profession, and church succeeded in combining forces to target gastroenteritis in particular, and increase breastfeeding support practices. It is certainly true that deaths from gastroenteritis fell substantially during this period. Additional data would help distinguish between these factors, especially if local-level information on policy implementation and resources were available.

Figure 12 Infant Mortality 2010-2015 for the 20 Best Performing Countries and Northern Ireland



Source: United Nations World Population Prospects (2015), NISRA

5. COMPARISON WITH CURRENT DATA

Section 4 has discussed the fact that Ireland's infant mortality performance in the mid-20th century was not very impressive. In contrast, in 2015 Ireland was the 6th best performing country globally for infant deaths, with a mortality rate of .29% (2.9 infant deaths per 1,000 live births). These data are summarised in **Figure 12**. This is now considerably lower than the rate in the UK (.42%), and especially in the US (.60%) (Chen et al., 2016). Overall, the dramatic decline is apparent for all the countries in this group, with a mortality rate as low as .16% achieved in Iceland. This highlights the enormous progress made among developed countries during this time period. While infant mortality remains high in low and middle income countries, particularly in those experiencing war and famine, substantial gains have been achieved here too (Hill et al., 2012; Lozano et al., 2011; Rajaratnam et al., 2010).

There are important reasons to view these falls in infant mortality as a major success. From an epidemic affecting what must have been practically all families in Ireland in the first half of the century, particularly in the cities, infant deaths are thankfully now a rare event in this and most developed countries. In the current mortality environment it is difficult to imagine the extent of suffering which must have been caused by the amount of infant and child deaths in the early- to mid-1900s. The conclusions regarding absolute changes in mortality rates over time must therefore be considered as very positive; Ireland is now in one of the safest countries in the world to be born into. One caveat is that rates of caesarean section have been growing and are substantially above World Health Organization recommendations (Brick and Layte, 2011).

Despite overall reductions in mortality, there may still be important disparities within countries. Therefore, it is important to determine whether some of the historical differentials we observed in terms of the socioeconomic or demographic characteristics of children's parents have persisted even while the overall rates have improved substantially. Some evidence on inequality in infant health in Ireland and Northern Ireland is presented in **Table 5**. Here, I show absolute and relative differences in mortality, and in the final panel, birth weight. I consider gradients in parental occupational status, parental place of residence, and marital status. Socioeconomic differentials between highest and lowest groups are examined, and measured in terms of absolute (percentage points, $Outcome_{Highest} - Outcome_{Lowest}$) and relative (unadjusted relative risk ratios, $Outcome_{Highest} / Outcome_{Lowest}$) differences. The first three rows summarise historical data from the Rotunda

birth records, Ó Gráda (2004), and the Ulster Society of Economic Research (1937). The ratios for infant mortality, child mortality, and stillbirth are similar, indicating that those in the lowest occupational class or most disadvantaged place of residence were twice as likely to be stillborn, die in their first year, or die before the age of 5. The absolute differences are largest for child mortality (11.7 percentage points), not least because this outcome is much more common than the others. I compare this to inequality in perinatal mortality (deaths in the first week of life) at the end of the 20th century in Ireland (1984-1988 and 1999-2006) (Layte and Clyne, 2010), and Northern Ireland (NISRA vital statistics; Poverty Site, 2011). While the ratios remain similar, the absolute differences have declined substantially, as would be expected from the dramatic fall in the overall prevalence of perinatal and infant mortality.

Table 5 Comparisons of Inequality in Infant and Child Outcomes in Ireland and Northern Ireland During the 20th Century

Outcome	Place	Source	Parental Socio-Demographic Measure	Year	Highest - Lowest	Highest/Lowest
Outcome: Mortality						
Stillbirth	Dublin	Rotunda Birth Records	Place of Residence	1869-1930	6.8-3.3=**3.5**	**2.1**
Child Mortality	Dublin 4	(Ó Gráda, 2004)	Occupational Class	1911	21.1-9.4=**11.7**	**2.2**
Infant Mortality	Belfast	(Ulster Society of Economic Research, 1937)	Place of Residence	1932-1933	13-6.5 = **6.5**	**2.0**
Perinatal Mortality	Ireland	(Layte and Clyne, 2010)	Occupational Class	1984-1988	1.9-0.9=**1.0**	**2.1**
Perinatal Mortality	Ireland	(Layte and Clyne, 2010)	Occupational Class	1999-2006	1.4-0.6=**0.8**	**2.3**
Infant Mortality	Northern Ireland	Northern Ireland Statistics and Research Agency Vital Statistics	Place of Residence	1999-2011	0.7-0.35 = **0.35**	**2.0**

Outcome	Place	Source	Parental Socio-Demographic Measure	Year	Highest - Lowest	Highest/Lowest
Outcome: Mortality						
Stillbirth	Dublin	Rotunda Birth Records	Marital Status	1869-1930	5.6-4.2=**1.4**	**1.3**
Infant Mortality	Ireland	(Earner-Byrne, 2007)	Marital Status	1923-1950	24.6-6.2=**18.4**	**4.0**
Perinatal Mortality	Ireland	(Health Service Executive, 2014)	Marital Status	2013	0.7-0.6=**0.1**	**1.2**
Outcome: Birth Weight						
LBW	Ireland	(McAvoy et al., 2006)	Parent's Occupation	1999	6.1-2.9=**3.4**	**2.2**
LBW	Northern Ireland	(Pattenden et al., 2011)	Place of Residence	1992-2002		**2.0**
Birth Weight Mean	Ireland	(McGovern, 2013)	Household Income Quintile	2007	3551 - 3444 = **107**	**1.03**
Birth Weight Mean	Ireland	(McGovern, 2013)	Maternal Education	2007	3539 - 3399 = **140**	**1.04**

Note to Table 5: The final two rows give the average differences in birth weight between groups, other rows show differences in the prevalence of the outcome. Place of residence in Ulster Society of Economic Research (1937) is derived from Belfast districts. Place of residence in the Northern Ireland Statistics and Research Agency Vital Statistics data is local authority, and the associated relative and absolute differences are derived from graphs and therefore approximate. Place of residence in Pattenden et al. (2011) refers to ward, and the difference is taken at the 10^{th} and 90^{th} percentiles, adjusted for year. All other figures are the unadjusted differences between highest and lowest SES groups, or between married and unmarried (for marital status). LBW refers to low birth weight (<2,500g).

Next I turn to the disparity identified in the Rotunda birth records, marital status. For stillbirths, mothers who were not married were 1.3 times more likely to have a stillbirth compared to married mothers, with the absolute difference being 1.4 percentage points. Earner-Byrne (2007) presents data on differences in the overall infant mortality rate in Ireland between married and unmarried mothers (at the time termed "illegitimate"). Over the period 1923-1950, the infant mortality rate among this group was a staggering 25% on average, compared to 6% among married mothers, giving an absolute difference of 18.4 percentage points, with the implication that those born to unmarried mothers were 4 times more likely to die in infancy. From today's perspective, it is difficult to conceive how a difference of this magnitude in absolute terms could have arisen and persisted. It likely reflects some combination of poverty, nutrition, lack of access to medical care, environmental and behavioural risk factors, and discrimination. Some of these deaths may even been a form of infanticide, such were the social pressures applied to unmarried mothers-to-be (Earner-Bryne, 2013; Farrell, 2012; Rattigan, 2012). Further investigations identifying the underlying causes for this disparity would be very valuable.

Lastly, the final four rows in **Table 5** consider inequalities in another indicator of infant health at birth, birth weight. Birth weight is considered a proxy for in utero environment (for a discussion see Almond et al., 2005). Birth weight has also been shown to be associated with later outcomes, and is a risk factor for medical complications, mortality, and poor outcomes later in childhood. According to a 2006 report on the prevalence of low birth weight (a weight of less than 2,500 grams) (McAvoy et al., 2006), the difference in the prevalence of low birth weight in Ireland between high and low parental occupational class (professional compared to unemployed) was 3.4 percentage points, with the result that babies born to parents in the lowest class were 2.2 times more likely to be born low birth weight. A similar figure was found for place of residence in Northern Ireland, based on ward data (Pattenden et al., 2011). In Ireland, mean birth weight is 107g and 140g less for babies born to mothers on the lowest household income quintile and educational group, respectively (McGovern, 2013).

As with **Table 3**, important caveats should apply to interpreting these data. First, the outcome measures are different and have different underlying prevalence rates, for example stillbirth is less prevalent than perinatal morality, which is in turn less prevalent than infant mortality and child mortality. In general, the extent of absolute differences will depend on underlying risk, so these figures are not directly comparable. Second, the measures of socioeconomic status also differ, and the categorisation of parental occupation and place of residence is not consistent across studies. Finally, the Rotunda records and the data presented in Ulster Society of Economic Research (1937) and Ó Gráda (2004) are not nationally representative, and therefore do not necessarily reflect the characteristics of Ireland or Northern Ireland. Another issue with this table is that these differentials are presented as the unadjusted figures, and are not intended to necessarily represent a causal relationship. There are other factors which could potentially be the underlying cause of both family background characteristics and the outcomes of interest. To the extent that we are interested in understanding and describing whether there are any differences by socio-demographic characteristics, this type of measurement approach will be useful. However, to understand which aspects of early life conditions are important from a policy perspective in the sense that these could potentially be altered in order to improve child and infant outcomes, further research is required. Properly addressing the issue of causality is important, but requires appropriate data and is beyond the scope of this analysis.

Therefore, this table is mainly intended to illustrate two broad features of infant health over time. First, there were substantial inequalities in infant health at the beginning of the 20th century, in terms of occupational class, place of residence, and marital status. Second, by the end of the century the absolute differences had declined substantially, however the relative risk remained similar for mortality, and although it had declined for marital status, was still present in 2013. Overall, the figures presented here for relative risk are towards the higher end of the estimates for inequality in early life health in the UK presented in the review by Weightman et al. (2012).

6. CONCLUSIONS

This paper has summarised trends in infant health and infant health inequality in Ireland over the course of the 20th century. At the end of the 19th century, infant mortality was high, at around 10% nationally, but compared favourably to the nearest neighbours in England/Wales and Scotland. Within Ireland, disparities in death rates were apparent by the socio-demographic backgrounds of parents, including occupational status, place of residence, and marital status. After independence, Ireland fell behind the UK and suffered a high urban penalty which persisted beyond that in other countries. The problems associated with urban living contributed to a gastroenteritis epidemic, which was particularly problematic in Dublin in the 1940s. At mid-century, Ireland was one of the worst performing developed countries. However, there followed a rapid, albeit belated, improvement in infant mortality, and by the 21st century Ireland now ranks among one of the safest countries to be born in, albeit with the caveat about the prevalence of caesarean section (Brick and Layte, 2011).

Throughout this paper I have mainly used data on stillbirths, infant mortality, and child mortality. Because the same outcomes were not available in every context examined, I assume that the basic trends and disparities of

interest can be summarised by examining any one of these measures. Ideally the same outcome would have been present in every dataset, however it seems reasonable that whatever patterns were present in stillbirths and infant mortality would also have been present in child mortality. Given the greater prevalence of child mortality, the loss of life apparent in the other two indicators will be an understatement. Another feature of this paper is that I have aimed to provide an overview of the main historical events relevant to early life mortality. Suggestions for further reading providing a more detailed background are provided in **Table 6** (Barrington, 1987; Browne, 1986; Deeny, 1995, 1989; Earner-Byrne, 2007; Hensey, 1988).

Table 6 Suggestions for Further Reading

Author	Year	Book Title
Lindsey Earner-Byrne	2007	*Mother and Child : Maternity and Child Welfare in Dublin, 1922-60*
James Deeny (Editor: Tony Farmer)	1995	*The End of an Epidemic : Essays in Irish Public Health 1935-65*
James Deeny	1989	*To Cure & to Care : Memoirs of a Chief Medical Officer*
Brendan Hensey	1988	*The Health Services in Ireland*
Ruth Barrington	1987	*Health, Medicine & Politics in Ireland, 1900-1970*
Nöel Browne	1986	*Against the Tide*

Assessing the impact of the improvements in early life conditions on the country as a whole is not straightforward. There are a number of different perspectives which ought to be taken into account when making an evaluation. First, sustained high infant death rates are clearly associated with an enormous loss of life, lost human potential, and the suffering exerted on parents and surviving family members (Moor and de Graaf, 2016; Rogers et al., 2008). An important question is how much of this suffering could reasonably have been avoided. Here I focus on the period when Ireland preformed most poorly, which was during the 1940s. During this decade, there were a total of 43,586 infants who died in Ireland. Therefore, as noted at the time, the loss of children during this decade alone corresponds to the destruction of a large Irish town (Deeny, 1995). When considering how much the infant death rate could have been lowered, it seems too high a standard to expect a reduction to modern rates of mortality. However, it does seem reasonable to ask how many lives would have been saved if the Irish rate had been the same as that in England and Wales during the period. On this basis, there were 13,948 excess deaths in Ireland during that single decade.

Second, the impact of historical improvements in health on economic performance have been noted, most especially by Fogel (2004, 1994). By improving early life conditions, there are a variety of channels through which we would expect those affected as children to become more productive members of society. These include the size of the labour market, greater work capacity and productivity because of better health, and greater cognitive ability. One way to assess whether the improvements in early life environment in Ireland during the 20th century were likely to have affected the performance of the economy is to examine the literature on a long-term marker of health, height. Height reflects the cumulative contribution of net nutrition and disease environment in childhood, especially up to age 2, and is related to aggregate measures of early life mortality, and post-neonatal mortality in particular (Bozzoli et al., 2009). **Figure 13** illustrates the improvements in the height of Irish males over the relevant birth cohorts. Mean height rose from 170cm in the early 1900s to almost 177cm in the 1980s. The macroeconomic literature on the effect of health on growth remains contentious (Weil, 2014), however to the extent that improvements in early life conditions reflect increases in human and physical capital accumulation, we would expect subsequent improvements in economic growth. For example, a recent paper suggests that every centimetre increase in mean height is predicted to raise income per capita by 6% (Akachi and Canning, 2015). Given the increase in Ireland during this period, this would imply that improvements in initial environment raised average incomes by around 42%. Other accounting- and macroeconomic modelling-based approaches find similarly large economic returns to health improvements (Becker et al., 2005; Bloom et al., 2014; Murphy and Topel, 2006).

At the individual-level, returns to investments in early life health are also likely to be substantial. Recent experimental evidence demonstrates that the wages of programme participants who received a nutritional and stimulation intervention increased by 25% in Jamaica and 46% (for men only) in Guatemala (Gertler et al., 2014; Hoddinott et al., 2008). In a review of the literature on the relationship between height and wages (McGovern et al., 2016), we find that, among quasi-experimental studies, each centimetre increase in stature is associated with a 4% increase for men and a 6% increase for women. In terms of birth weight, twin studies have found estimates of the effect of birth weight on earnings ranging from 1 percent for every 10 percent increase in birth weight

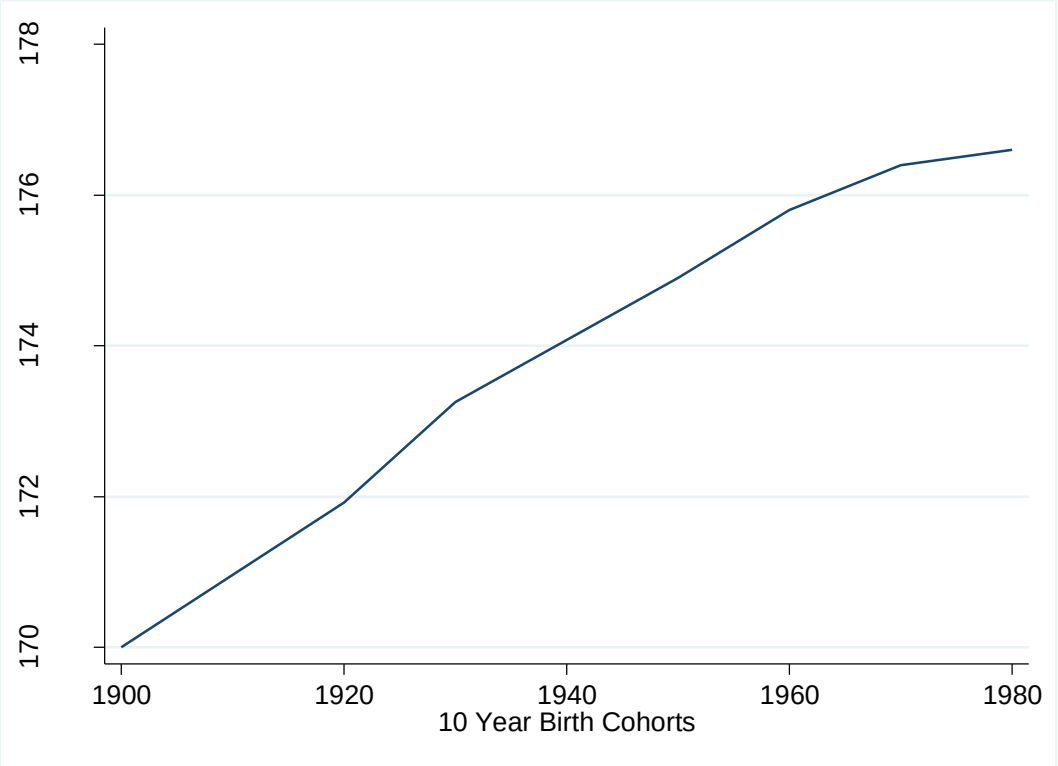
(Bharadwaj et al., 2015; Black et al., 2007) to a more substantial 7% per pound in the US (Behrman and Rosenzweig, 2004). Mean birth weight in the Rotunda sample was 3,215g, while mean birth weight in the Growing Up in Ireland Cohort Study (9 month cohort, interviewed in 2007-2008) was 3,513g. Therefore, these changes in birth weight over time (approximately a 10% increase) are less than those suggested by the height improvements, although this may reflect differences in biological process between the two outcomes. The increase in birth weight in Ireland appears to be greater than that observed in the US over a similar time frame; in the early 1900s birth weight in New York was substantially higher than in the Rotunda (Costa, 1998).

Moving from national averages to disparities between sub-groups, the conclusions regarding progress in addressing inequality over time depend on an assessment of the importance of relative compared to absolute disparities. In terms of absolute disparities, the mortality risk has clearly declined substantially and all groups in society now face a low risk of premature mortality. However, the relative differences remain. For example, those in the lowest socioeconomic groups in Ireland and Northern Ireland are approximately twice as likely to suffer a perinatal or infant death. The relative gap for marital status is currently lower than it was mid-century, but is still present with mortality risk 1.2 times higher for unmarried mothers. Also of note is the gradient in low birth weight (<2,500g), which has been noted by several authors (Madden, 2014; McAvoy et al., 2006; Nolan and Magee, 1994). There are a number of reasons why this gradient is a cause for concern. First, the absolute disparity is relatively large, at 3.4 percentage points (or a relative risk of 2.2). Second, the medical costs associated with low birth weight are substantial. Almond et al. (2005) find that, for the US, every gram increase in birth weight in the 2,000 – 2,500g range is associated with a reduction in hospital costs of $3, a reduction in $24 per gram in the 1,500-2,000g range, and even larger costs reductions for birth weight ranges below this. Twin studies have also demonstrated an association between birth weight and outcomes such as educational attainment, wages, and health. For example, McGovern (2013) demonstrates that birth weight is associated with school test scores, hospital visits, and health among children, but the Growing Up in Ireland data used do not currently go beyond childhood. Third, given that socioeconomic gradients widen throughout childhood (Case et al., 2002; Currie and Stabile, 2003), the initial relative differences may be of most interest to policy makers. Inequality in child health is also apparent in Ireland (Nolan and Layte, 2014). Moreover, intergenerational transmission of disadvantage through birth weight has been shown to occur. Mothers who were low birth weight themselves are more likely to have low birth weight children (Currie and Moretti, 2007). A final point to note is that of all the different types of inequality, inequality at birth may be not only among the most unjust, but economic returns to interventions in this area may be cost beneficial, making them worthy of consideration from a policy perspective (Deaton, 2013).

In the Growing up In Ireland Survey, the mean birth weight difference between lowest and highest family income quintile is 107g. It is difficult to determine how important this is without having a causal estimate of the effect of birth weight on economic outcomes for Ireland. However, it is possible to make a rough assessment based on the magnitudes found in other countries. Taking the US estimate of 7% per pound (Behrman and Rosenzweig, 2004) implies that the initial birth weight disadvantage for a child born into the lowest family income quintile (107g) lowers their subsequent wages by around 1.6% compared to a child born into a family in the highest income quintile. Assuming a constant annual income roughly equal to the overall median of €32,000 in Ireland, this birth weight difference translates into roughly €512 less per annum, or approximately €23,000 lost over the course of a 45 year working life (undiscounted), which gives a net present value of around €15,000 (when discounted at 2%). The unadjusted education gap in birth weight between babies born to mothers with no education or a primary qualification and babies born to mothers with a postgraduate qualification is slightly larger, at 140g. This implies a difference in earnings of €704 per annum, approximately €32,000 (undiscounted) over the life course, and a net present value of around €20,000. According to the perinatal statistics report, there were 3,718 live births in Ireland in 2013 whose birth weight was below 2,500g (Health Service Executive, 2014). Ignoring mortality, direct health care costs, and potential spill-over effects, and taking the above figures as accurate, if even a third of these children could have their birth weight raised by 140g, we would expect an economic return of $1{,}329 * €20{,}000 = €24{,}780{,}000$. Clearly these estimates are based on simplified assumptions, not least regarding the causal impact of birth weight on future earnings and that interventions to increase birth weight would have the same impact as those suggested by empirical studies. Using the lower Scandinavian estimate of the return to birth weight would imply amounts roughly half these figures. At least to the extent that Ireland is more similar to the US than Sweden, the former may be more realistic. To the extent that age, experience, and tenure profiles are concave this may be an underestimate. Moreover, these figures refer to the pure birth weight effect, in reality disadvantage is likely to accumulate from a variety of different factors. Therefore, these estimates are mainly intended to illustrate the potential returns which might be realised from investing in initial health rather than pointing to a specific amount. More formal modelling of the economic benefits associated with early life interventions in Ireland would be a useful direction for future research. As far as I am aware there are no long-run follow ups of the impact of birth weight on later outcomes in Ireland, however, a recent evaluation of a randomised control trial of an early life intervention in Dublin has found substantial impacts on child outcomes at 48 months (Doyle, 2012; Preparing for Life, 2016).

Perhaps the most disturbing result apparent from the review of data on Irish mortality is the excess deaths associated with unmarried mothers in the middle of the 20th century. Among this group, one in every four babies, the vast majority of whom were based in institutions, died before the age of one. Even by the standards of the time, it is hard to view this as anything other than a terrible indictment of the treatment of a vulnerable and marginalised group in society. An overview of attitudes to gender and reproductive health is provided in Earner-Byrne (2008, 2006) and McKee (1986). While the extent of inequality according to the marital status of the mother is clear from the data, it would be useful to be able to point more confidently to the causal factors underlying these differences. A comparison with Northern Ireland may provide valuable evidence on this issue.

Figure 13 Male Height in Ireland during the 20th Century



Source: (Baten and Blum, 2012)

Another potential research agenda relates to the turning point in the Irish infant mortality series in the 1940s. While the sources of infant mortality declines across countries are known in a general sense (Woods et al., 1989), pointing to specific factors and quantifying their exact contribution is difficult. Especially in relation to Ireland, it would be interesting to test the hypothesis that the 1947 Health Act was the main factor responsible for the infant mortality decline after World War 2, or more specifically, which aspects of the Act were responsible, for example, whether the increase in spending was the key factor. Addressing the question from a causal perspective would require data on the roll-out of different policies across both time and geographic location. As well as being important for understanding historical patterns of mortality in Ireland, answering this question also has the potential to inform efforts to improve public health in low and middle income countries today.

In summary, great progress has been made in reducing the risk associated with being born. However, events at birth and prior to birth continue to maintain an influence over the lives of Irish children and adults. While absolute differentials between socio-demographic groups in infant health have narrowed, relative inequality remains. Evidence from research which attempts to address causality supports the hypothesis that there are important long run effects of early life conditions. Because infant health is both a measure of the success of a society and an input into future progress, a renewed focus on eliminating the remaining inequality at birth is a worthy policy goal, one which has potentially substantial economic returns.

References

Aalen, F., 1992. Health and housing in Dublin c. 1850-1921, in: Aalen, F., Whelan, K. (Eds.), *Dublin City and County: From Prehistory to Present*. Geography Publications, Dublin.

Akachi, Y., Canning, D., 2015. Inferring the economic standard of living and health from cohort height: Evidence from modern populations in developing countries. *Economics & Human Biology* 19, 114–128.

Almond, D., Chay, K.Y., Lee, D.S., 2005. The Costs of Low Birth Weight. *Quarterly Journal of Economics* 120, 1031–1083.

Almond, D., Currie, J., 2011a. Human Capital Development before Age Five, in: Card, D., Ashenfelter, O. (Eds.), *Handbook of Labor Economics* 4 (Part B). Elsevier, pp. 1315–1486.

Almond, D., Currie, J., 2011b. Killing Me Softly: The Fetal Origins Hypothesis. *Journal of Economic Perspectives* 25, 153–172.

Angela, M., 1996. The precious and the precocious: Understanding cumulative disadvantage and cumulative advantage over the life course. *The Gerontologist* 36, 230–238.

Barker, D.J., 1990. The fetal and infant origins of adult disease. *BMJ* 301, 1111.

Barrett, A., Kamiya, Y., O'Sullivan, V., 2014. Childhood sexual abuse and later-life economic consequences. *Journal of Behavioral and Experimental Economics* 53, 10–16.

Barrington, R., 1987. *Health, medicine and politics in Ireland 1900-1970*. Institute of Public Administration, Dublin.

Baten, J., Blum, M., 2012. Growing tall but unequal: new findings and new background evidence on anthropometric welfare in 156 countries, 1810–1989. *Economic History of Developing Regions* 27, S66–S85.

Becker, G.S., Philipson, T.J., Soares, R.R., 2005. The Quantity and Quality of Life and the Evolution of World Inequality. *American Economic Review* 95, 277–291.

Behrman, J.R., Rosenzweig, M.R., 2004. Returns to birthweight. *Review of Economics and Statistics* 86, 586–601.

Bhalotra, S.R., Karlsson, M., Nilsson, T., 2016. Infant health and longevity: evidence from a historical trial in Sweden. *Journal of the European Economic Association* Forthcoming.

Bhalotra, S.R., Venkataramani, A., 2015. Shadows of the captain of the men of death: Early life health interventions, human capital investments, and institutions. Working Paper.

Bharadwaj, P., Lundborg, P., Rooth, D.-O., 2015. Birth Weight in the Long Run. NBER Working Paper No. 21354.

Black, S.E., Devereux, P.J., Salvanes, K.G., 2007. From the Cradle to the Labor Market? The Effect of Birth Weight on Adult Outcomes. *Quarterly Journal of Economics* 122, 409–439.

Bloom, D., Cafiero-Fonseca, E.T., McGovern, M.E., Prettner, K., Stanciole, A., Weiss, J., Bakkila, S., Rosenberg, L., 2014. The Macroeconomic Impact of Non-Communicable Diseases in China and India: Estimates, Projections, and Comparisons. *Journal of the Economics of Ageing* 4, 100–111.

Bozzoli, C., Deaton, A., Quintana-Domeque, C., 2009. Adult height and childhood disease. *Demography* 46, 647–669.

Breathnach, C., Moynihan, J., 2004. Who killed Koch's bacillus? *Irish Journal of Medical Science* 173, 166–171.

Brick, A., Layte, R., 2011. Exploring Trends in the Rate of Caesarean Section in Ireland 1999-2007. *Economic and Social Review* 42, 383–406.

Browne, N.C., 1986. *Against the tide*. Gill and Macmillan, Dublin.

Cain, L., Rotella, E., 2001. Death and spending: urban mortality and municipal expenditure on sanitation. *Annales de Démographie Historique* 1, 139–154.

Canavan, J.E., 1938. Slum clearance in Dublin. *Journal of the Statistical and Social Inquiry Society of Ireland.*

Case, A., Lubotsky, D., Paxson, C., 2002. Economic Status and Health in Childhood: The Origins of the Gradient. *American Economic Review* 92, 1308–1334.

Chen, A., Oster, E., Williams, H., 2016. Why is infant mortality higher in the US than in Europe? American *Economic Journal: Economic Policy* 8, 89–124.

Clancy Gore, C., 1944. Nutritional standards of some working-class families in Dublin, 1943. *Journal of the Statistical and Social Inquiry Society of Ireland.*

Costa, D.L., 1998. Unequal at birth: A long-term comparison of income and birth weight. *Journal of Economic History* 58, 987–1009.

Counihan, H., 2002. The Medical Association and the Mother and Child Scheme. *Irish Journal of Medical Science* 171, 110–115.

Coward, J., 1982. Birth under-registration in the Republic-of-Ireland during the 20th-century. *Economic and Social Review* 14, 1–27.

CSO, 2016. *Life in 1916 Ireland: Stories from Statistics, Central Statistics Office* [WWW Document]. URL http://www.cso.ie/en/releasesandpublications/ep/p-1916/1916irl/bmd/births/#d.en.97677(accessed 4.25.16).

Cunha, F., Heckman, J.J., Schennach, S.M., 2010. Estimating the technology of cognitive and noncognitive skill formation. *Econometrica* 78, 883–931.
Currie, J., 2011. Inequality at Birth: Some Causes and Consequences. *American Economic Review* 101, 1–22.
Currie, J., 2009. Healthy, wealthy, and wise: socioeconomic status, poor health in childhood, and human capital development. *Journal of Economic Literature* 47, 87–117.
Currie, J., Moretti, E., 2007. Biology as Destiny? Short-and Long-Run Determinants of Intergenerational Transmission of Birth Weight. *Journal of Labor Economics* 25, 231–264.
Currie, J., Stabile, M., 2003. Socioeconomic Status and Child Health: Why Is the Relationship Stronger for Older Children? *American Economic Review* 93, 1813–1823.
Cutler, D., Meara, E., 2003. Changes in the Age Distribution of Mortality over the 20th Century, in: Wise, D. (Ed.), *Perspectives on the Economics of Aging.* University of Chicago Press, Chicago.
Cutler, D., Miller, G., 2005. The role of public health improvements in health advances: the twentieth-century United States. *Demography* 42, 1–22.
Daly, M.E., 2010. Death and Disease in Independent Ireland, c. 1920–1970: A Research Agenda, in: Catherine Cox, Maria Luddy (Eds.), *Cultures of Care in Irish Medical History, 1750–1970.* Springer, pp. 229–250.
Dean, G., McLoughlin, H., 1980. The registration and certification of deaths in the West of Ireland: a follow-up study. *Irish Medical Journal* 73, 269–270.
Dean, G., Mulvihill, C., 1972. The registration of births and deaths in Ireland. *Journal of the Irish Medical Association* 65, 101–105.
Deaton, A., 2013. What does the empirical evidence tell us about the injustice of health inequalities?, in: Nir, E., Hurst, S., Norheim, O., Wiclker, D. (Eds.), *Inequalities in Health: Concepts Measures, and Ethics.* Oxford University Press, Oxford, pp. 263–281.
Deeny, J., 1995. *The End of an Epidemic: Essays in Irish Public Health 1935–65*. A & A Farmar, Dublin.
Deeny, J., 1989. *To Cure & to Care: Memoirs of a Chief Medical Officer*. Glendale Press, Dun Laoghaire.
Deeny, J., Murdock, E.T., 1944a. Infant Feeding and Mortality in Belfast. *BMJ* 1, 146.
Deeny, J., Murdock, E.T., 1944b. Infant mortality in the city of Belfast. *Journal of the Statistical and Social Inquiry Society of Ireland.*
Deeny, J., Murdock, E.T., 1943. Some Aspects of the Infant Mortality Problem in Belfast. *Ulster Medical Journal* 12, 117.
Delaney, L., McGovern, M.E., Smith, J.P., 2011. From Angela's Ashes to the Celtic Tiger: Early Life Conditions and Adult Health in Ireland. *Journal of Health Economics* 30, 1–10.
Doyle, O., 2012. Breaking the cycle of deprivation: An experimental evaluation of an early childhood intervention. *Journal of the Statistical and Social Inquiry Society of Ireland.*
Earner-Bryne, L., 2013. "What else could I do?"Single mothers and infanticide, Ireland 1900–1950. *Irish Studies Review* 21, 233–236.
Earner-Byrne, L., 2008. Reinforcing the family: The role of gender, morality and sexuality in Irish welfare policy, 1922–1944. *History of the Family* 13, 360–369.
Earner-Byrne, L., 2007. *Mother and Child: Maternity and Child Welfare in Dublin, 1922-60.* Manchester University Press, Manchester.
Earner-Byrne, L., 2006. Managing motherhood: Negotiating a maternity service for Catholic mothers in Dublin, 1930–1954. *Social History of Medicine* 19, 261–277.
Elwood, J., 1973. Infant mortality in Belfast and Dublin—1900–1969. *Irish Journal of Medical Science* 142, 166–173.
Farrell, E., 2012. "Infanticide of the ordinary character": An overview of the crime in Ireland, 1850-1900. Irish *Economic and Social History* 39, 56–72.
Fogel, R., 2004. Health, Nutrition, and Economic Growth. *Economic Development and Cultural Change* 52, 643–658.
Fogel, R., 1994. Economic Growth, Population Theory, and Physiology: The Bearing of Long-Term Processes on the Making of Economic Policy. *American Economic Review* 84, 369–395.
Forsdahl, A., 1978. Living conditions in childhood and subsequent development of risk factors for arteriosclerotic heart disease. The cardiovascular survey in Finnmark 1974-75. *Journal of Epidemiology and Community Health* 32, 34–37.
Garvin, T., 2004. Preventing the Future: Why was Ireland so poor for so long? Gill & Macmillan, Dublin.
Gertler, P., Heckman, J., Pinto, R., Zanolini, A., Vermeersch, C., Walker, S., Chang, S.M., Grantham-McGregor, S., 2014. Labor market returns to an early childhood stimulation intervention in Jamaica. *Science* 344, 998–1001.
Grimshaw, T.W., 1889. Child mortality in Dublin. *Dublin Journal of Medical Science* 88, 1–19.
Haines, M.R., 2001. The urban mortality transition in the United States, 1800-1940*Annales de Démographie Historique* 1, 33–64.

Haines, M.R., 1995. Socio-economic differentials in infant and child mortality during mortality decline: England and Wales, 1890–1911. *Population Studies* 49, 297–315.
Haines, M.R., 1985. Inequality and childhood mortality: A comparison of England and Wales, 1911, and the United States, 1900. *Journal of Economic History* 45, 885–912.
Health Service Executive, 2014. *Perinatal Statistics Report 2013*. Healthcare Pricing Office (HPO), Health Service Executive (HSE), Dublin.
Heckman, J.J., Masterov, D.V., 2007. The productivity argument for investing in young children. *Applied Economic Perspectives and Policy* 29, 446–493.
Henretta, J.C., McCrory, C., 2016. Childhood Circumstances and Mid-Life Functional Mobility. *Journal of Aging and Health* 28, 440–459.
Hensey, B., 1988. *The health services of Ireland*, 4th ed. Institute of Public Administration.
Hill, K., You, D., Inoue, M., Oestergaard, M.Z., 2012. Child mortality estimation: accelerated progress in reducing global child mortality, 1990–2010. *PLoS Medicine* 9, e1001303.
Hoddinott, J., Maluccio, J.A., Behrman, J.R., Flores, R., Martorell, R., 2008. Effect of a nutrition intervention during early childhood on economic productivity in Guatemalan adults. *The Lancet* 371, 411–416.
Kamiya, Y., Doyle, M., Henretta, J.C., Timonen, V., 2014. Early-Life Circumstances and Later-Life Loneliness in Ireland. *The Gerontologist* 54, 773–783.
Kamiya, Y., Doyle, M., Henretta, J.C., Timonen, V., 2013. Depressive symptoms among older adults: The impact of early and later life circumstances and marital status. *Aging & Mental Health* 17, 349–357.
Kamiya, Y., Timonen, V., Kenny, R.A., 2016. The impact of childhood sexual abuse on the mental and physical health, and healthcare utilization of older adults. *International Psychogeriatrics* 28, 415–422.
Kearney, P.M., Cronin, H., O'Regan, C., Kamiya, Y., Savva, G.M., Whelan, B., Kenny, R., 2011. Cohort profile: the Irish longitudinal study on ageing. *International Journal of Epidemiology* 40, 877–884.
Kennedy, P., 2013. Change in Maternity Provision in Ireland: "Elephants on the Move." *Economic and Social Review* 43, 377–395.
Knaggs, J.F., 1958. Natality in Dublin in the year 1955. *Journal of The Statistical and Social Inquiry Society of Ireland.*
Lawson, W., 1912. Remedies for overcrowding in the city of Dublin. *Journal of The Statistical and Social Inquiry Society of Ireland.*
Layte, R., Clyne, B., 2010. Did the Celtic Tiger decrease socio-economic differentials in perinatal mortality in Ireland*? Economic and Social Review* 41, 173–199.
Lozano, R., Wang, H., Foreman, K.J., Rajaratnam, J.K., Naghavi, M., Marcus, J.R., Dwyer-Lindgren, L., Lofgren, K.T., Phillips, D., Atkinson, C., 2011. Progress towards Millennium Development Goals 4 and 5 on maternal and child mortality: an updated systematic analysis. *The Lancet* 378, 1139–1165.
Lyon, S., 1948. Natality in Dublin in the years 1943, 1944 and 1945. *Journal of the Statistical and Social Inquiry Society of Ireland.*
Lyon, S., 1943. Some observations on births in Dublin in the years 1941 and 1942. *Journal of the Statistical and Social Inquiry Society of Ireland.*
Madden, D., 2014. The relationship between low birth weight and socioeconomic status in Ireland. *Journal of Biosocial Science* 46, 248–265.
Malcolm, A.G., 1852. The sanitary state of Belfast, with suggestions for its improvement. *Journal of the Statistical and Social Inquiry Society of Ireland.*
Maluccio, J.A., Hoddinott, J., Behrman, J.R., Martorell, R., Quisumbing, A.R., Stein, A.D., 2009. The Impact of Improving Nutrition during Early Childhood on Education among Guatemalan Adults. *Economic Journal* 119, 734–763.
Mapother, E., 1864. The sanitary state of Dublin. *Journal of the Statistical and Social Inquiry Society of Ireland*.
McAvoy, H., Sturley, J., Burke, S., Balanda, K., 2006. *Unequal at Birth: Inequalities in the occurrence of low birthweight babies in Ireland.* Institute for Public Health in Ireland, Dublin.
McCrory, C., Dooley, C., Layte, R., Kenny, R., 2015. The Lasting Legacy of Childhood Adversity for Disease Risk in Later Life. *Health Psychology* 34, 687–696.
McGovern, M.E., 2013. Still Unequal at Birth: Birth Weight, Socioeconomic Status and Outcomes at Age 9. *Economic and Social Review* 44, 53–84.
McGovern, M.E., Krishna, A., Aguayo, V.M., Subramanian, S.V., 2016. A Review of the Evidence Linking Child Stunting to Economic Outcomes. Working Paper.
McKee, E., 1986. Church-State Relations and the Development of Irish Health Policy: The Mother-and-Child Scheme, 1944-53. *Irish Historical Studies* 25, 159–194.
McKeown, T., Record, R., Turner, R., 1975. An interpretation of the decline of mortality in England and Wales during the twentieth century. *Population Studies* 29, 391–422.
Millin, S.S., 1917. Child life as a national asset. *Journal of the Statistical and Social Inquiry Society of Ireland*.

Millward, R., Bell, F., 2001. Infant mortality in Victorian Britain: the mother as medium. *Economic History Review* 54, 699–733.
Moor, N., de Graaf, P.M., 2016. Temporary and Long-Term Consequences of Bereavement on Happiness. *Journal of Happiness Studies* 17, 913–936.
Murphy, K.M., Topel, R.H., 2006. The Value of Health and Longevity. *Journal of Political Economy* 114, 871–904.
Nolan, A., Layte, R., 2014. Socio-economic Inequalities in Child Health in Ireland. *Economic and Social Review* 45, 25–64.
Nolan, B., Magee, H., 1994. Perinatal mortality and low birthweight by socio-economic background: evidence for Ireland. *Economic and Social Review* 25, 321.
Ó Gráda, C., 2008. The Irish Economy half a Century ago. Working Paper.
Ó Gráda, C., 2004. Infant and child mortality in south Dublin a century ago, in: Breschi, Marco, Pozzi, Lucia (Eds.), *The Determinants of Infant and Child Mortality in Past European Populations*. Forum, Udine.
Ó Gráda, C., 1995. The Rotunda and the people of Dublin: glimpses from the hospital's archives, in: Alan Browne (Ed.), *Masters, Midwives and Ladies-in-Waiting: The Rotunda Hospital 1745-1995*. A & A Farmar, Dublin.
Ó Gráda, C., 1991. Dublin's demography in the early Nineteenth century: evidence from the Rotunda. *Population Studies* 45, 43–54.
O'Neill, H., 1906. The progress of sanitary science in Belfast. *Journal of the Statistical and Social Inquiry Society of Ireland.*
Pamuk, E.R., 1988. Social-class inequality in infant mortality in England and Wales from 1921 to 1980. *European Journal of Population/Revue Européenne de Démographie* 4, 1–21.
Pattenden, S., Casson, K., Cook, S., Dolk, H., 2011. Geographical variation in infant mortality, stillbirth and low birth weight in Northern Ireland, 1992–2002. *Journal of Epidemiology and Community Health* 65, 1159–1165.
Poverty Site, 2011. Northern Ireland: Infant Deaths [WWW Document]. URL http://www.poverty.org.uk/i21/index.shtml#ext (accessed 4.20.16).
Preparing for Life, 2016. Promoting Child Development by Supporting Parents: Learning from the Evaluation of the Preparing for Life Home Visiting Programme [WWW Document]. URL http://preparingforlife.ie/article/download-our-48-month-results-briefing-document-here (accessed 5.20.16).
Pringle, D., 1998. Hypothesized foetal and early life influences on adult heart disease mortality: an ecological analysis of data for the Republic of Ireland. *Social Science & Medicine* 46, 683–693.
Rajaratnam, J.K., Marcus, J.R., Flaxman, A.D., Wang, H., Levin-Rector, A., Dwyer, L., Costa, M., Lopez, A.D., Murray, C.J., 2010. Neonatal, postneonatal, childhood, and under-5 mortality for 187 countries, 1970-2010: a systematic analysis of progress towards Millennium Development Goal 4. *The Lancet* 375, 1988–2008.
Rattigan, C., 2012. *"What Else Could I Do?": Single Mothers and Infanticide, Ireland 1900-1950*. Irish Academic Press, Dublin.
Rogers, C.H., Floyd, F.J., Seltzer, M.M., Greenberg, J., Hong, J., 2008. Long-term effects of the death of a child on parents' adjustment in midlife. *Journal of Family Psychology* 22, 203.
UBC Research Data Collection Dataverse - Abacus Dataverse Network, 2012. Birth weight and economic growth data sets, The Rotunda (lying-in hospital), Dublin, 1869-1930.
Ulster Society of Economic Research, 1937. Health and Poverty in Belfast. *Ulster Medical Journal* 6, 125–130.
Ward, W.P., 1993. *Birth weight and economic growth*. University of Chicago Press, Chicago.
Ward, W.P., 1988. Birth weight and standards of living in Vienna, 1865-1930. *Journal of Interdisciplinary History* 19, 203–229.
Weightman, A.L., Morgan, H.E., Shepherd, M.A., Kitcher, H., Roberts, C., Dunstan, F.D., 2012. Social inequality and infant health in the UK: systematic review and meta-analyses. *BMJ Open 2*, e000964.
Weil, D.N., 2014. Health and economic growth, in: Philippe Aghion, Steven N. Durlauf (Eds.), *Handbook of Economic Growth* (2 A). Elsevier.
Whyte, J.H., 1980. *Church and state in modern Ireland: 1923-1979.* Gill and Macmillan, Dublin.
Williams, N., Galley, C., 1995. Urban-rural differentials in infant mortality in Victorian England. *Population Studies* 49, 401–420.
Woods, R., 2003. Urban-rural mortality differentials: An unresolved debate. *Population and Development Review* 29, 29–46.
Woods, R.I., Watterson, P.A., Woodward, J.H., 1989. The causes of rapid infant mortality decline in England and Wales, 1861–1921. Part II. *Population Studies* 43, 113–132.
Woods, R.I., Watterson, P.A., Woodward, J.H., 1988. The causes of rapid infant mortality decline in England and Wales, 1861–1921 Part I. *Population Studies* 42, 343–366.

DISCUSSION

Seán Lyons: Thank you for the extremely interesting paper. I would like to echo John's comment that this work very much reflects the best tradition of SSISI. Given that gastroenteritis was historically one of the significant contributing factors behind infant mortality, it might be worth checking for data on the timing and geographical coverage of the public works schemes in water and sewerage schemes in the 19th and early 20th centuries. There should be detailed records on these, and these data could help you control for this confounding factor when you are looking at the effects of other policies.

The broader policy implications of this work might be even more relevant to developing countries where infant mortality is still high. But have the causes of infant mortality and perinatal problems changed a lot over time? In particular, it seems like the main causal factors have got harder for policymakers to address; whereas at one time public investments in water, sewerage and housing infrastructure could have made a big difference, now the remaining problems seem to be more to do with risky behaviours such as smoking during pregnancy.

Christopher Sibley: "Yesterday the Central Statistics Office produced its publication on the 1916 rising (http://www.cso.ie/en/statistics/lifein1916irelandstoriesfromstatistics/), one of the highlights between 1916 and today was the vast improvement in infant mortality. The author might find the CSO publication interesting, particularly since both draw on the Census records of the time. One note of caution to place on the interpretation of the current infant mortality figures for Ireland in comparison to other countries, is that along with the very low rate of infant mortality we also have a very high rate of caesarian section relative to other developed countries.

Finally in terms of the author's curiosity around the name of the Lying-In hospital, this relates to the lack of maternity services up to 1745, where home birth in very poor conditions was the norm. When Bartholomew Mosse founded the first lying in hospital in a house on Georges Lane off South Great Georges Street opposite Fade Street this was the first time that the poor women of Dublin were provide food shelter, warmth and somewhere to remain for the birth of their child. This first lying in Hospital opened its doors on Friday 15 March 1745 with its first patient delivering a boy on 20 March 1745, the Rotunda Hospital as we know it now was acquired by Mosse in 1748.

Stephen Weir: Regarding the reasons for the rapid fall in infant mortality in the late 1940s, one possible reason, in addition to the increase in funding, was that the issue of infant mortality had obviously attracted attention in society to such an extent that the Mother and Child scheme was proposed. Its unpalatable features to the medical profession ensured that the scheme was not adopted. However, in order to ensure that the issue did not arise again, the medical profession and others may have concentrated efforts and resources into tackling the issue in a different, less contentious manner.

John FitzGerald: In 1923 in the second issue under the Irish Free State of what later became *Vital Statistics*, the Registrar General, Thompson, drew attention to the exceptionally high death rate among babies of lone parents. The rat was running at about a third in the first year of life. The Report also showed that most of the deaths occurred in an institutional environment. BcGovernA better understanding of the role of gastroenteritis and breast feeding might be obtained by looking at deaths of infants aged under 1 month, under 3, under 6 and under a year.