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"From Angela's Ashes to the Celtic Tiger:
Early Life Conditions and Adult Health in Ireland"

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From Angela's Ashes to the Celtic Tiger:

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Abstract

We use data from the Irish census and exploit regional and temporal variation in infant mortality rates over the 20th century to examine effects of early life conditions on later life health. Our main identification is public health interventions which eliminated the Irish urban infant mortality penalty. Estimates suggest that a unit decrease in mortality rates at time of birth reduces the probability of being disabled as an adult by between .03 and .05 percentage points. We find that individuals from lower socio economic groups had marginal effects of reduced infant mortality twice as large as those at the top.

JEL Classification: I19, N34

There has been remarkable growth in life expectancy across the developed world in the past century. Advances in longevity in the twentieth century were of the order of three years per decade, with little sign of this trend falling off. The west also experienced declining morbidity, particularly among the elderly, for whom rates of disability were reduced by 50% between 1984 and 2000 (Fogel, 2005). The onset of chronic disease is also occurring at later ages. Interest in the origins of these gains have led economists to focus on isolating causal mechanisms involved (Smith, 1999). This paper examines one possible contributory factor; the hypothesis that improving early life conditions equipped those who benefited with more robust health as adults, enabling part of this increased longevity. The key point is that the quality of the initial inputs into an individual's health production function may determine risk of disease in later life.

In Ireland, there were sharp declines in infant mortality rates beginning in the mid-1940s, with most of the gains occurring in urban areas over the next twenty years. This lead to a convergence of urban and rural infant mortality rates, essentially eliminating the urban mortality penalty. We argue that the reasons for the sharp fall in infant mortality during this period were due largely to legislative changes that improved sanitation and water, including food safety, and rubbish disposal.[1] With appropriate time lags, these changes improved the contemporaneous health of infants, and lead to a significant improvement in the health of affected cohorts at older ages.

Our analysis uses Irish micro-census data on the current health of affected cohorts. These data are linked to a unique data base characterizing Irish mortality conditions by county across the 20th century, enabling us to control for county level fixed effects and time trends. Strong links are found between these early life declines in infant mortality and latter life health outcomes. We also find evidence that those who benefited the most from the

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[1] Details are discussed in section 3.2.

public health investments in the 1940s were from the lower end of the socio economic distribution.

The rest of this paper is structured as follows. Section I provides background material on mortality trends in Ireland and reviews the relevant literature. Section II outlines regional variation in infant mortality rates in Ireland, and discusses the interventions, including the 1947 Health Act, which were successful in eliminating the urban infant mortality penalty. Section III describes the data, and section IV contains the results outlined above. Section V highlights our main conclusions.

I. Background

A. Trends in Mortality

Until relatively recently, Ireland lagged far behind the rest of Europe and the developed world in terms of reductions in mortality. Life expectancy at birth was 57.4 years in 1926, but rose to 79.9 by 2006 (table 1). On average, life spans for men have increased by a quarter of a year per annum since the start of the last decade, and .3 years per decade for women. It is projected that Irish children born today may live well into their 90s (Shane Whelan, 2008). Mortality rates dropped significantly between 1940 and 1960, with particularly dramatic improvements in infant mortality (fig. 1). The rate of progress in Irish life expectancy slowed from 1960-1980, and then picked up from the mid 1980s on. While declining child mortality drove life expectancy gains up to the 1980s, improvements at later ages have driven recent improvements.[2]

This is the same pattern observed in other countries. According to Cutler and Meara (2001), over half of gains in life expectancy in the first half of 20th century in the US were

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[2] Life expectancy at age 65 stagnated until the mid 1980s; there followed an increase from 16 to over 19 by 2006.

concentrated before age 14. In the second half, two thirds of gains were felt by over 45s, mainly due to reduced deaths from heart conditions. This pattern is being repeated in developing countries, but half a century later. Fogel (2005) and Cutler and Miller (2005) argued that there are clear stages in the battle against mortality. The first era in the 18th century involved Fogel's famous escape from hunger, the second in the 19th and early 20th century was mainly waged against infectious disease, and the final modern period is characterized by falling morbidity rates and mortality rates among the elderly, with the main enemy being chronic conditions such as heart disease.

The cohorts in the west living longer today enjoyed improvements in early life conditions in the first part of the last century. This, and the fact that reductions in deaths from cardiovascular illness for 70% of declines in mortality since 1960 is leading economists to focus on the importance of initial health endowments.[3] Similarly, Ireland's poor performance in life expectancy (compared to other developed nations) over the recent past mirrors its lag in mortality rates at the beginning of the 20th century. The urban-rural mortality penalty is an important facet of this. What sets Ireland apart is the delay in entering the final phase; the urban penalty was not eliminated until the 1960s. In this paper we exploit this delayed transition to identify the effect of early life conditions on adult health.

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[3] For example, Black et al. (2007) show that low birth weight has an independent negative effect on various outcomes in later life. Meanwhile, the medical literature has outlined a potential causal pathway for linking early life conditions to cardiovascular illness in later life via the Foetal Origins Hypothesis. Section 2.2 discusses previous studies in more depth.

Table 1 Irish Life Expectancy at Birth

Year	At Birth
1926	57.37
1936	58.2
1941	59.01
1946	60.47
1951	64.53
1961	68.13
1966	68.58
1971	68.77
1979	69.47
1981	70.14
1986	71.01
1991	72.3
1996	72.97
2002	75.07

Figure 1 Irish Infant Mortality 1925-1960
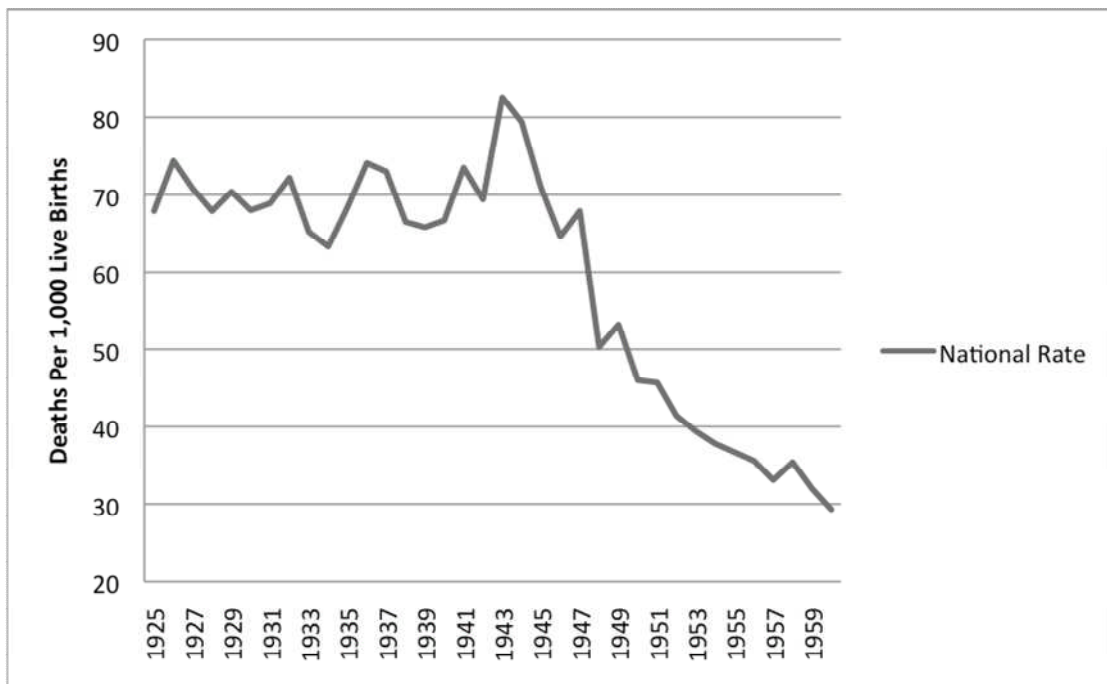
In Ireland, a series of interventions succeeded (albeit belatedly) in eliminating the urban mortality penalty following the 1947 Health Act. This is the variation in early life conditions we examine in this paper. We use current Irish census data to tie individuals back to the historical conditions into which they were born. This enables us to exploit both regional and temporal variation in these conditions, which we proxy with county level infant mortality data. The elimination of the urban mortality penalty provides the main source of identification when we include trends in the model. Our estimates suggest that a unit decrease in infant mortality rates reduces the probability of being disabled as an adult by between .03 and .05 percentage points.

As well as having the potential to explain changes in the current health distribution, early life conditions may also be important for explaining variation across social class. Although several studies have shown separately that Irish people from lower socio economic groups are more at risk of poor health as infants, and more likely to suffer from chronic conditions later in life, few papers have linked these two findings. In Ireland in 1999 the prenatal mortality rate was three times higher for children of unskilled manual workers than for those born in the higher professional category (Cullen, 2002). These disparities persisted despite sustained Irish economic growth, rising incomes and large investment in healthcare, and are not fully explained by access to insurance or health care. In this paper we find that individuals from lower SES groups are more at risk from poor early life conditions, with marginal effects twice as large for those at the bottom of the education distribution compared to the top.

B. Literature

This paper is part of an emerging literature which examines the role of early life conditions in determining adult outcomes. With stocks such as human capital and health,

there can be significant path dependence, and initial endowments and shocks in early periods can have significant long term consequences. Given that health is a function of past inputs, simply considering current behaviour and circumstance will not enable economists to accurately characterise distribution of health, nor be able to correctly identify the various causal factors for different health states.

The literature on the role of early life determinants of current health began with ecological studies which examined the correlation between infant mortality rates and subsequent death rates across regions. Two studies by Forsdahl (1977, 1978) showed correlations between infant mortality rates in Norwegian districts and subsequent arteriosclerotic heart disease. The cohorts which faced high infant death rates were also the cohorts which faced high rates of heart disease in later life. While Forsdahl focused on stress during early childhood and adolescence, Barker (1997, 2001) has argued that such chronic conditions have their origins even earlier in life.[4] [5]

A previous ecological study based on Irish data (Pringle, 1998), examined the correlation between infant mortality rates in Irish counties between 1916 and 1935, and deaths from heart disease between 1981 and 1990. Support for the early life conditions hypothesis was found to be ambiguous. Selective migration is a serious confounding factor here; according to the 2006 census around 65% of current residents were born in each county. Our data allow us to take account of this.

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[4] The Foetal Origins Hypothesis provides a pathway for linking early life conditions to adult outcomes. There are periods of sensitive development for both children and infants, and any interruption to adequate nutritional intake at these particular stages would result in long term damage to the system or organ concerned. This is principally due to the foetus diverting scarce resources to the brain. The main adaptive behaviours involved include the slowing of the rate of cell division, particularly in organs in critical stages of development, changes in the distribution of cell types, hormonal feedback, metabolic activity and organ structure (Barker, 1997).

[5] Barker (2001) discusses 80 published studies exhibiting a correlation between low birth weight and raised blood pressure as adults. A recent meta analysis of studies involving over 150,000 individuals found evidence of a significant correlation between low birth weight and future risk of diabetes (Peter Whincup, Samantha Kaye, Christopher Owen, Rachel Huxley et al., 2008).

In addition to the evidence on infant health, childhood health has also been shown to have important lasting consequences. Case, Lubotsky and Paxson (2002) demonstrate that poor health as a child is a significant predictor of ill health as an adult. Black, Devereux and Salvanes (2007) use a Norwegian administrative dataset on twins, which implicitly controls for genetic and socioeconomic endowments and eliminates the influence of length of gestation. The authors find that 10% increase in birth weight implies a .57 cm increase in height, a 1% increase in income and a 1% increase in the probability of high school completion. Another approach is to use data from natural experiments. In one such study, Almond (2006) uses the 1918 influenza outbreak in the U.S. to provide exogenous variation in early life conditions. Data from the US Census (1960, 1970, 1980), suggest that cohort in utero during the influenza pandemic received 1.5 less months of schooling, and were up to 5% less likely to graduate from high school than expected.

This paper contributes to the literature by examining the evidence for Ireland. The natural experiment in our case is the elimination of the urban mortality penalty. This study has a number of benefits relative to those mentioned above. Firstly, we proxy early life conditions directly with infant mortality rates, and have clear variation across regions, particularly for urban versus rural counties. Secondly, we are not reliant on extreme events such as famine, reducing the danger that results are reflecting a highly localized effect. The following section outlines regional variation in Irish infant health in more detail.

II. The Irish Urban Infant Mortality Penalty

Following Ireland's independence in 1922, the new government faced the difficult task of organizing and financing a new state. Quite apart from economic development, Ireland lagged behind in terms of other indicators, such as industrialisation and urbanisation. Ireland lingered in the second phase of Fogel and Omran's epidemiological transition, and

infectious disease and poor public health infrastructure remained to be tackled up to the 1940s. According to Garvin (2004), Irish towns had some of the worst slums in Europe at the time. The urban infant mortality penalty and its eventual elimination is one manifestation of this.

Substantial regional variation in mortality rates also existed prior to the 1940s. The urban penalty in Irish infant mortality rates remained high at around 50% throughout this period (fig. 2). It was not until the mid 1950s that this penalty was eliminated when urban and rural rates converged. Haines (2001) documents the experience in the US.[6] For states with reliable data, the penalty for infant mortality was also around 50%, but in 1900. By the 1930s full convergence had been achieved, and in fact the cities were marginally better for infants. The excess mortality of the cities was explained by greater density and crowding, leading to the more rapid spread of infection; lack of adequate clean fresh water and sewerage disposal, a consequently higher degree of contaminated water and food; and garbage and carrion in streets. (Haines, 2001). [7]

Another important factor in improving public health relates to the overcrowding that existed in Ireland's major cities. From the early 1930s, increased public awareness called for slum clearance, and between 1932 and 1939 there was great investment in housing by the government. A 1944 Report of the Dublin Housing Inquiry highlighted issues of persistent tenements in Dublin County Borough, and it became policy to give tax relief on developments which involved slum clearance. Finally, experimentation with privatization of

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[6] See, for example, Williams and Galley (1995) for a discussion of the experience in England.

[7] Costa and Kahn (2003) argue that state expenditures on public health lowered mortality rates from typhoid, dysentery, and diphtheria between 1910 and 1940 and that city public health expenditures circa 1910, particularly on sewage and water filtration, were effective in reducing childhood and infant mortality.

street cleaning system in Dublin and then Cork (1929) proved effective in reducing local refuse.

Figure 2 Urban and Rural Infant Mortality
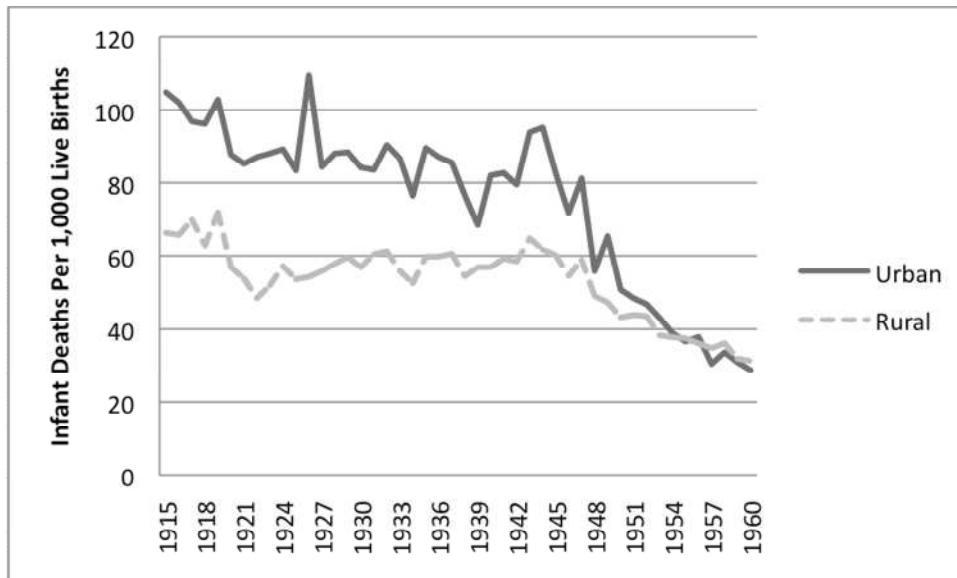
A. The 1947 Health Act

Following World War 2, there was renewed pressure on the Irish government to tackle the public health problems, which were particularly evident in urban areas. In fact there was not even a dedicated department of health until 1947. The 1947 Act signified a landmark in Irish policy representing a firm commitment to improve the health of the population. The act envisaged a substantial investment in public health infrastructure, estimated to cost up to £30 million over 10 years.[8] There was new legislation in a range of areas, from water supply to sewage disposal, devolution of power to local authorities, a focus on tackling infectious diseases, and a proposed provision of free medical care to mothers, children, and the poor (John H. Whyte, 1980).

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[8] The Irish Times, October 3rd 1947.

The transfer of responsibility for health to county councils involved substantial increases in funding from central government, and local authorities were given the power and obligation to monitor the well being of those in public institutions such as schools. Ministers were given sweeping powers to combat infectious disease, including the ability to impose compulsory detention for those afflicted.[9] The final set of measures related to what became known as the Mother and Child Scheme, a series of initiatives designed to provide free information, education and medical care to young mothers and babies. According to Garvin (2004), by the mid 1950s Ireland had one of the most modern health services in the world. What is clear is that a combination of these policies succeeded in eliminating the Irish urban infant mortality penalty by 1960.

From looking at the age-distribution of mortality declines in figure 3, it is clear that the main mortality improvement is focused on infants i.e. those who were less than one years of age. Although there were some improvements at ages 1 and 2, these were from a relatively low base compared to rates of over 8% for infant mortality. Mortality rates among the elderly were at best stable during this time.

Figure 4 displays the main declines in infant mortality by cause. In particular, the decline of both diarrhoea and deaths due to congenital abnormalities at birth are striking, and both are linked to sanitation and nutrition, and both decline very rapidly after 1947 having increased during the war. The available county level data also supports the hypothesis that sanitation and overcrowded living conditions were driving the urban mortality penalty. The censuses of 1946 and 1961 allow us to examine county level correlates of infant mortality,[10] and table 2 presents a regression analysis of these determinants. A higher proportion of families living with shared sanitation facilities, and a higher proportion of migrants living in

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[9] These measures were particularly aimed at combating problems associated with tuberculosis.
[10] Relevant county level data is only available for these two years.

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that county were both associated with higher levels of infant mortality.[11] Importantly, the fact that male unemployment has no independent effect confirms the hypothesis that differences in income were not driving the observed cross county differentials.

Figure 5 demonstrates the relationship between county level infant mortality in 1946 and the percent of families with shared sanitation facilities. This figure shows that the strongly positive shared sanitation – infant mortality relationship was mainly driven by the county boroughs (i.e. urban council areas), particularly Dublin city, where almost 40% of households were sharing sanitation facilities. By the 1961 census, a similarly estimated model indicates that this relationship had basically disappeared (fig. 6). The numbers living in these conditions had halved in Dublin by this time.

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[11] Other factors, in particular the proportion of families living in overcrowded accommodation, are also correlated with infant mortality, however these are collinear with other variables.

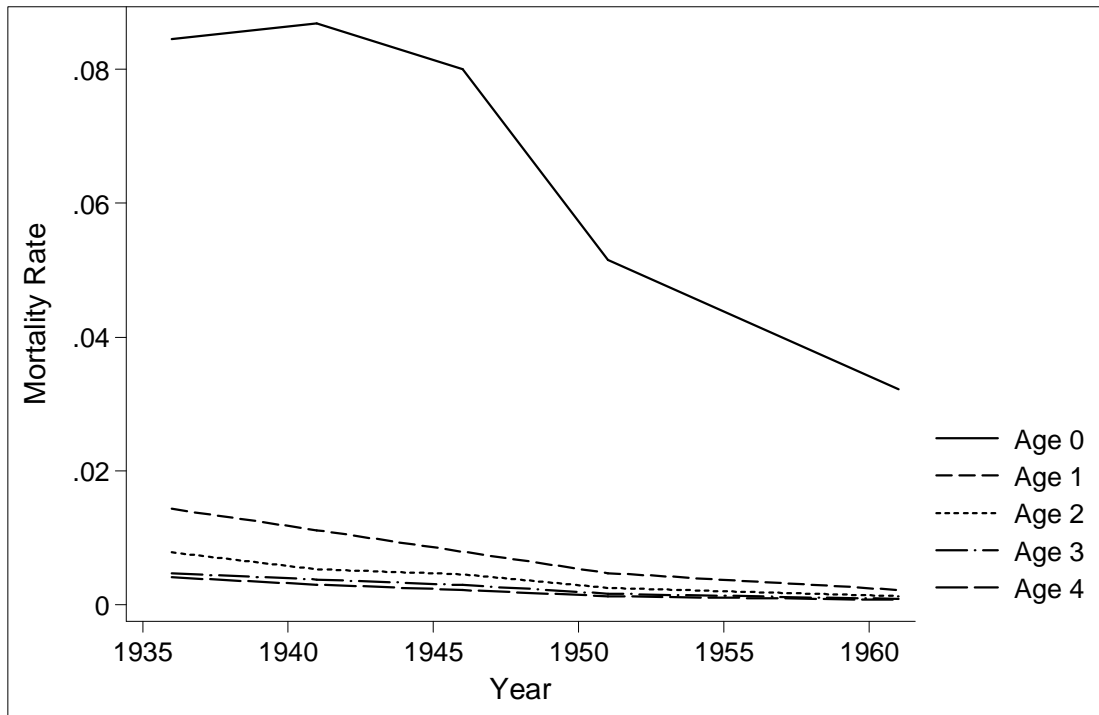**Figure 3. Early Age Mortality Rates (Source: Irish Life Tables)**
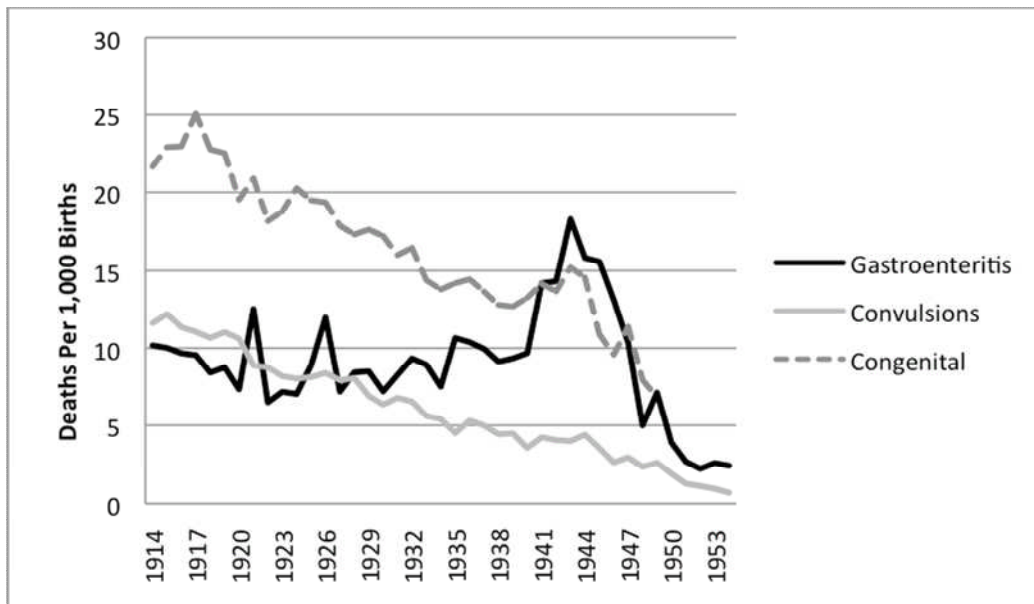

Figure 4. Infant Mortality by Cause

Table 2 Model of County Level Infant Mortality in 1946

Variables	Infant Mortality
Proportion of Families with Shared Sanitation	1.004***
	(0.198)
Male Unemployment Rate	-0.939
	(0.571)
Proportion of Current Residents Born in County	-0.413***
	(0.133)
Wife's Age at Marriage	-0.0947
	(2.386)
Constant	95.00
	(64.78)
Observations	31
R-squared	0.678

Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Figure 5. Infant Mortality and Percentage of Families with Shared Sanitation Facilities
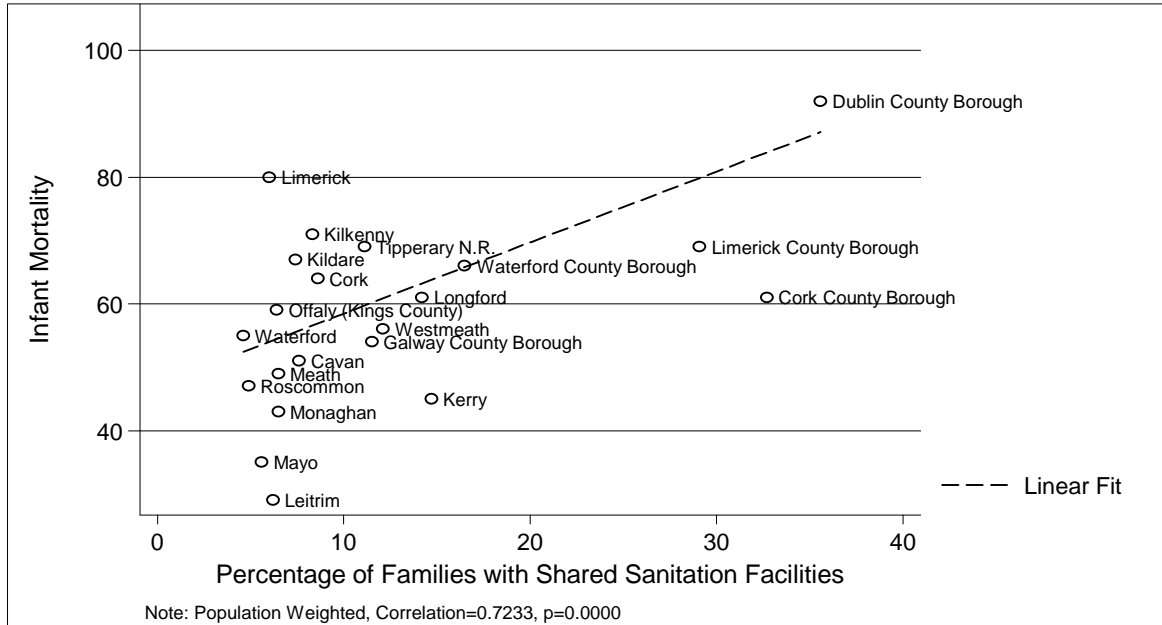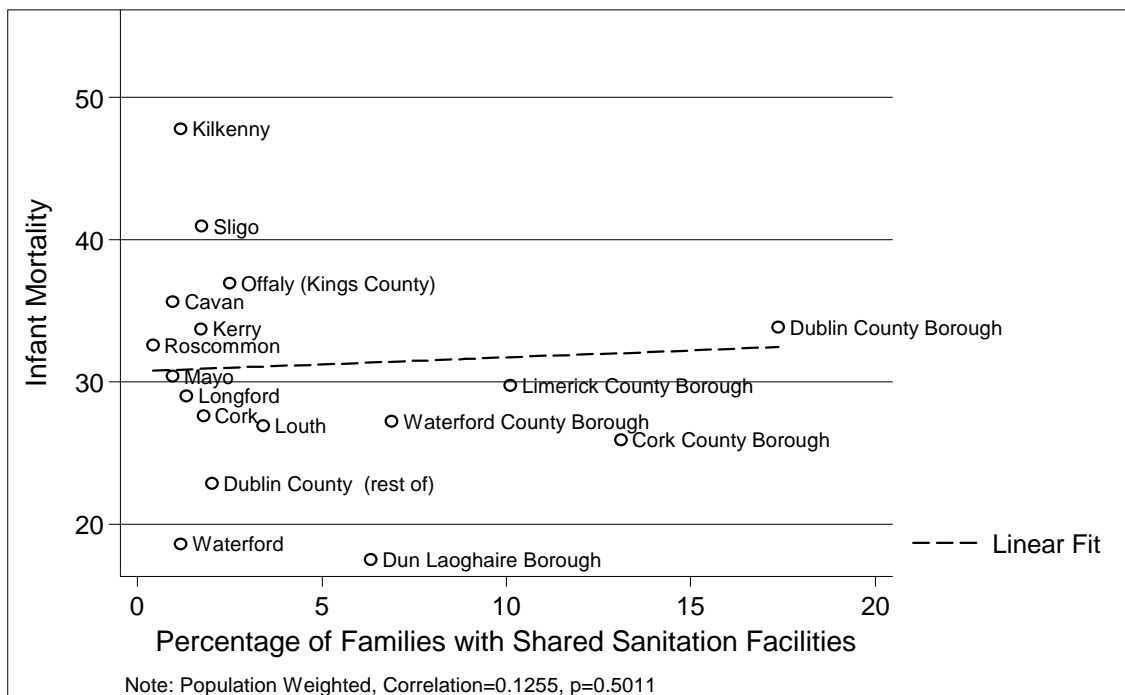
(Source: Census 1946)

Figure 6. Infant Mortality and Percentage of Families with Shared Sanitation Facilities

(Source: Census 1961)

IV. Data

A. Census data on Disability and Health

This research relies on successive waves of the Irish census data in 2002 and 2006.[12] There are several advantages to this data. This is a representative micro sample of the entire Irish population, which allows us to examine individuals from all counties in the Republic of Ireland in all age groups. Data on education allow us to test the hypothesis that early life conditions differentially affected socio economic groups. The large sample size of about 200,000 in each Census is important given our reliance on the geographic distribution of the population. Finally, the census is almost unique among Irish surveys in that it asks respondents for their place of birth.

In this paper we examine the determinants of suffering from a disability as this is the only health related variable available in the census micro files. The question on employment status also identifies those who are out of work due to illness, but there are small numbers in this category. We combine these measures into a single disability variable.[13] Table 3, which shows the types of disability broken down by their causes, demonstrates that random events such as accidents are typically not major contributors to overall disability rates, accounting for only around 5% for most disabilities. Such random events would be difficult to trace to childhood illnesses. On the other hand, illness is the most important cause of disability for all types of disabilities.

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[12] Irish Census data is freely available from the Irish Social Science Data Archive (www.ucd.ie/issda).

[13] The disability variable is generated from a number of questions in the census, and includes almost all dimensions. A detailed breakdown is unavailable in the census micro file we use in this paper, only the aggregated disability variable. A concern is that disability caused by events such as accidents which are obviously unrelated to early life conditions are included. However, as long as these factors do not vary systematically with the other covariates in the analysis, this is measurement error and will bias downwards the estimates of the effect of infant mortality. This does not appear to be an issue, for example other data show that urban areas are not over-represented on disabilities such as accidents (National Disability Survey, 2008).

Table 3 Cause of Disability by Type (Source: National Disability Survey 2006)

					Type Of Disability				
Cause	Seeing	Hearing	Speech	Mobility	Remembering	Intellectual	Emotional	Pain	Breathing
Hereditary	17.6	15.3	19.5	10	11	24.7	10.4	8.5	13
Accident	6.2	4.8	4.2	16.1	5	3.4	6.6	18.3	1.7
Illness	38.7	18.7	35.6	45.5	32.7	33.1	39.6	48.9	59.1
Work	0.9	12.1	0.5	3.3	0.6	0	1.8	4.6	2.3
Stress	1.3	1.3	1.5	1.8	8.7	1.3	17.5	2.3	1.6
Other	15.1	21.7	18	13.4	18	11.9	12.5	9.2	10.4
No Specific Cause	9.8	12.3	8.2	4.6	10.1	8.7	4.5	3.4	3.3
Don't Know	10.7	14.1	12.8	5.9	14.4	17.5	8.3	5.5	6.4
Total	100	100	100	100	100	100	100	100	100

Given the pattern in infant mortality rates across counties, we make two predictions. An individual born in the 1930s or 1940s in an urban area should entail a higher risk of adult disability, as they faced a higher risk of being in poor health as infants. However, by the 1950s birth cohorts, there should be no difference between those born into urban or rural areas. Figure 7 plots disability rate for people born in both Dublin and rural areas for 5 year birth cohorts.[14] Current adult disability rates for those born in Dublin and rural areas follow the same pattern as infant mortality - high in Dublin followed by convergence in the 1950s. We investigate the importance of early life conditions by statistical analysis discussed in Section 5.

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[14] Due to the process of anonymisation employed by the Irish Central Statistics Office, we only know a person's 5 year age group, as opposed to their actual year of birth. Since we only know whether a person is over 75, the analysis is restricted to those under 75. We also limit the sample to those over 25 as many under this age are still in education.

Figure 7 Disability by Dublin and Rural Birth Cohorts (Source: Census)
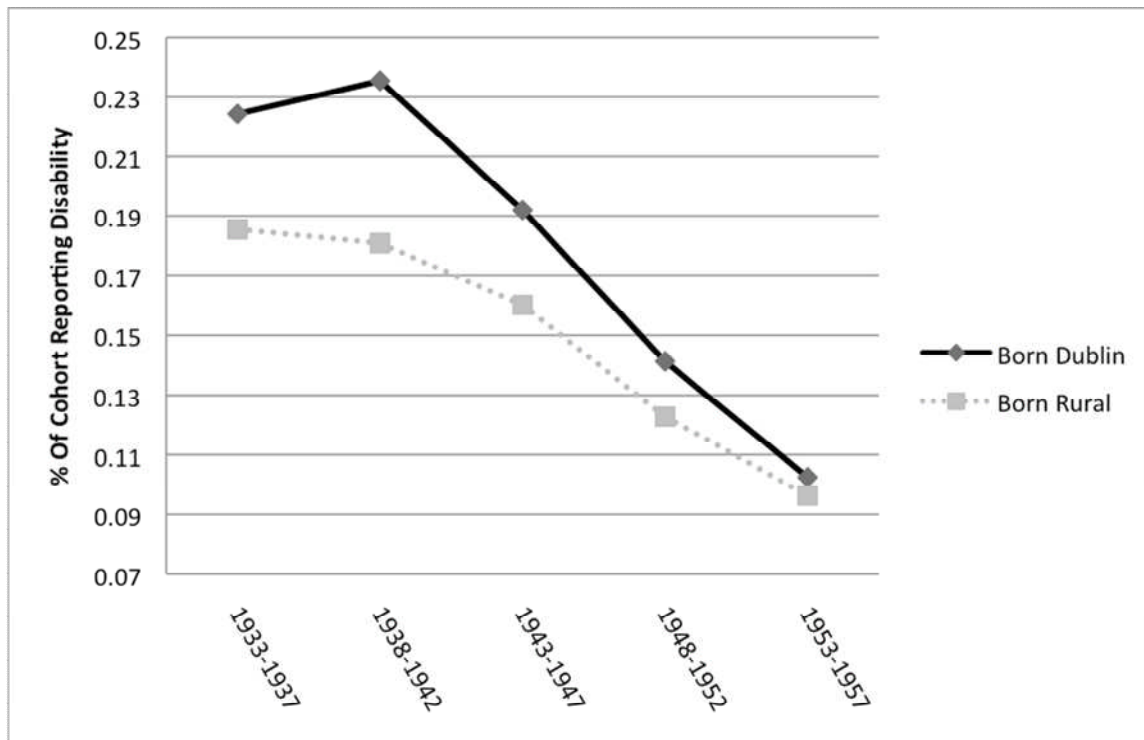
B. Infant Mortality Data

For our analysis, we use information gathered on annual infant mortality by county of birth.[15] Due to restrictions on knowing a person's exact age mentioned above, we average infant mortality in a county by 5 year age bands recorded in the census and then merge this information with the census files, allowing us to proxy for early life conditions and initial health endowments. While the census only contains county level information, the infant mortality database contains separate information on urban areas. Therefore, where the census lists a birth county dominated by an urban area (e.g., Dublin or Cork), the urban rate was used. Since county of birth is only listed for those born in the Republic of Ireland, we restrict our sample to those born in those 26 counties. These restrictions leave us with a final sample size of around 200,000 individuals.

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[15] There were numerous sources for this data, including the Central Statistics Office, Registrar General Reports, and the Department of Health. For a significant proportion of the information, building up this database involved obtaining the data in hard copy and inputting it into electronic format.

IV. Results

A. Model Specification

We examine the effect of early life conditions on adult health by regressing whether a person reported a disability on age, age squared, infant mortality in that person's age group in their county of birth, and education level. These models also control for county of birth fixed effects, county of current residence fixed effects, county specific trends, and survey year. To check robustness of results, we also extend the model to include lags and leads of infant mortality. As the outcome variable is binary, we estimate this model using a probit. Two issues relating to standard errors arise - serial correlation and heteroskedasticity. In our case, we expect observations to be correlated within counties and age groups, as individuals were most likely exposed to similar environmental factors. We therefore cluster standard errors by county of birth X age group. To deal with the second issue, a model is estimated allowing the variance to depend on age (heteroskedastic probit). In each case, we fail to reject the null hypothesis (that variance depends on age), and conclude that this specification is correct. We present results from a combined dataset of the 2002 and 2006 census, although the analysis of the individual census separately reach similar conclusions. The following equation summarizes the model. γ is the vector of control variables outlined above.

$$Disability_i = \alpha + \beta_1 Age_i + \beta_2 AgeSquared_i + \beta_3 Sex_i + \beta_4 Education_i$$
$$+ \beta_5 InfantMortality_{yob}$$
$$+ \gamma_i$$

We first present marginal effects at the mean of the independent variables. However, to examine whether early life conditions have the same effect across socio economic groups marginal effects are also evaluated at different levels of education.

A legitimate concern is that infant mortality is correlated with some other unobserved variable. County level fixed effects would capture any confounding influence which does not change over time. Also, including county specific time trends has important consequences for the analysis as identification of the effect of infant mortality is reduced to using sharp non-linear breaks such as the dramatic declines in the urban areas in the 1940s.[16] However, this specification has the benefit of reducing the scope for some omitted variable to bias the results. In order for some omitted factor to be driving these results, it would have to vary in exactly the same non-linear pattern as county infant mortality, i.e. differentially affect those born in urban areas up to the 1950s, and not thereafter. In order to further address this issue we include lags and leads of infant mortality. This is an additional way of addressing concerns that infant mortality may be correlated with some other unobserved variable that affected cohorts at a later stage.

B. Regression Analysis

Table 4 presents marginal effects from the heteroskedastic probit regression outlined above. The control variables mentioned above are omitted, and all coefficients are multiplied by 1000 to aid ease of interpretation. The first column refers to the model outlined above. Several variables in this model are statistically significant. Not surprisingly, age is associated with an increased risk at an increasing rate of disability, as is being female. More education

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[16] In fact omitting county trends has little effect on either the magnitude or significance of these results.

strongly reduces the risk of disability, while county infant mortality is significant at the 5% level with a coefficient of 0.0347. More central to our hypothesis, a unit decrease in the infant mortality rate (deaths per 1,000 live births) is associated with a .035 percentage point decrease in the probability of currently suffering from a disability. This result is strongly statistically significant.

The second column restricts the sample to those over 40, the central focus of our hypothesis. Now infant mortality in the year and county of birth is significant at the 1% level, with a somewhat larger coefficient. The final regression in the third column includes lags and leads (infant mortality 5 and 10 years before and after birth). Infant mortality at the time of birth is still significant (at the 5% level), again with a similarly sized coefficient. The leads and lags of infant mortality in county of birth are not jointly statistically significant indicating that it is what happens around the time of birth that matters for latter life disability.

Results in all specifications suggest that a decline in the infant mortality rate at birth reduces the probability of being disabled. These conclusions are robust to using standard probit, logit and linear probability model approaches, with estimated coefficients ranging from .03 to .04 percentage points. A natural question is whether results of this magnitude are economically significant. Given that the average disability rate in Ireland according to the 2006 census is around 10%, these are large effects. Using the estimate from this analysis, the improvement in national early life conditions in the 1940s (proxied by the infant mortality rate), a fall of around 35 points, was associated with approximately a ten percent decrease in the probability of disability for those cohorts who benefited. Improvements over this period were even more dramatic in some counties, particularly the urban areas. For example, in Dublin the infant mortality rate fell from an average of 103 in the period 1938-1942 to an average of 43 in the period 1948-1952.

Table 5 presents the marginal effects from our main specification evaluated at different levels of education, again scaled by 1000. Taking schooling as a proxy, there is a clear indication that those from lower socio economic groups are more vulnerable to the adverse effects of poor early life conditions. The marginal effect of infant mortality on the probability of disability is twice as large for those with primary education compared to those with a postgraduate qualification.

Table 4 Marginal Effects for Disability

Variables	Disability	Disability(>40)	Disability (Lags and Leads)
Age	0.8231*	0.6742	0.9354
	(0.6362)	(1.6815)	(0.6651)
Age Squared	0.0106	0.00705	0.016**
	(0.00542)	(0.0134)	(0.00703)
County Infant Mortality (5 Year Average)	0.347**	0.4084***	0.315**
	(0.1365)	(0.1351)	(0.1258)
Female	5.5383***	0.00511	5.5278***
	(1.7696)	(2.4438)	(1.769)
Primary	141.5422***	125.1728***	141.7184***
	(3.3583)	(3.5478)	(3.2909)
Lower Secondary	35.1131***	36.1505***	35.0428***
	(2.0647)	(3.2339)	(2.0761)
Tertiary	-6.97***	-4.7618	-7.0128***
	(2.0009)	(3.7619)	(2.0008)
Postgraduate	-30.0087***	-31.1007***	-29.9821***
	(2.0844)	(3.3748)	(2.0627)
County Infant Mortality +5 Years			0.0602
			(0.171)
County Infant Mortality +10 Years			-0.2851
			(0.2078)
County Infant Mortality -5 Years			0.0583
			(0.1468)
County Infant Mortality -10 Years			-0.151**
			(0.0707)
Wald Heteroskedasticity Test	396.63***	217.12***	403.32***
Observations	193888	120245	193888

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

Clustered standard errors in parentheses

All coefficients scaled by 1,000

Table 5 Marginal Effects for Infant Mortality Evaluated by Education Group

Education Level	Marginal Effect	Standard Error
Primary	0.595	0.23
Lower Secondary	0.4163	0.16
Tertiary	0.3304	0.13
Postgraduate	0.2788	0.11

All coefficients scaled by 1,000

V. Conclusions

This paper has outlined an analysis of the effect of early life conditions on later outcomes in Ireland, using a dramatic shift that occurred in initial health endowments around the middle of the 20th century. A database on county infant mortality was combined with census files, and the determinants of disability were analysed with particular focus on the role of infant health in a person's county of birth, at their time of birth. County infant mortality is significant in all specifications, with a remarkably robust coefficient, even when county trends and lags and leads were included in the model. Results suggest that the fall in infant mortality in the 1940s reduced the risk of suffering from a disability by around ten percent. There is also evidence that individuals from lower socio economic groups are more at risk from poor early life conditions, with marginal effects twice as large for those at the bottom of the education distribution compared to the top.

There is strong evidence that the main mechanism for Ireland was the 1947 Health Act, which introduced a raft of reforms aimed at dramatically improving sanitation conditions, particularly in urban areas. The act included provision for improving food safety,

refuse collection, infection control and other features of sanitation. These policies focused explicitly on urban areas, including hiring specific officers to enforce these policies and they are also more likely to have affected city areas as the more crowded urban conditions would make poorer families more vulnerable to collective sanitation hazards. We have shown that these policies were successful in eliminating the relationship between sanitation facilities and infant mortality by the 1960s. Indeed the bulk of the improvement in the infant mortality rate was generated in urban areas with the initially wide disparity between urban and rural rates disappearing by the mid 1950s. Dublin, Cork and Limerick (the main cities in Ireland) saw particularly dramatic declines.

The argument that these improvements were driven by the 1947 Health Act is given further credence by looking at the causes of death that generated the decline. In section 3 we showed that deaths from gastroenteritis and congenital deformity experienced the steepest declines. Both of these causes of death are particularly linked to poor sanitation conditions. It is difficult to separate between the different facets of sanitation that may have been responsible with the existing data. The fact that major urban clear-outs were underway from the early 1930s without impacting on infant mortality suggests that crowding itself may have been less of a problem than actual treatment of water and rubbish. The fact that marginal effects of early life conditions on disability are so much higher for people with lower education is consistent with the sanitation theory in the sense that poorer households would have been more exposed to these effects.

Other competing explanations are unlikely to be the real mechanism behind the improvements in Irish infant health in the 1940s. A time series analysis suggests that there is no evidence of a relationship between either national GDP per capita or real wages and infant mortality. At a regional level, table 2 demonstrates there was no relationship between county unemployment rates and infant mortality in 1946. Factors such as the differential introduction

of drugs are highly unlikely to have generated the non-linear changes in infant mortality rates seen in the data. Instead, the specific improvement in early age mortality, and the county level, are much more supportive of the hypothesis that changes in sanitation and hygiene were the most important factors. Furthermore, environmental factors such as rainfall did not exhibit any permanent change and do not match well the regional-temporal features of the mortality reductions. Birth rates did increase slightly during the war, in part due to changes in registration legislation, however this occurred too early to explain the fall in infant mortality after 1947.

Overall, the evidence presented in this paper suggests that the changes in health policy in the 1940's in Ireland both improved the contemporaneous health of infants, and equipped the cohorts who benefited with more robust health as adults.

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