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RETHINKING THE GEOGRAPHY OF DISTRESS IN NINETEENTH-CENTURY IRELAND: EXCESS MORTALITY AND THE LAND WAR

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Keywords: Land War, Excess Mortality, Ireland

JEL: N13, N33, I18

Rethinking the Geography of Distress in Nineteenth-Century Ireland: Excess Mortality and the Land War[1]

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Analysis of excess mortality holds the potential to revise understandings of key moments in modern Irish history. Yet aside from studies of the Great Famine, it has been neglected by historians of Ireland. Examining rates of excess mortality across post-Famine Ireland reveals that the Land War crisis of 1877-1882, a transformational period, was one of the worst public health crises of modern Irish history. In fact, during the years 1878-1880 excess mortality levels were much higher than during any other period from when registration records began in 1864 up to the present day. Western regions, particularly Co. Mayo, have long been considered the worst affected by this crisis, but from the perspective of excess mortality, we establish that this was an island-wide crisis and one that was more severe that previously understood. The study of excess mortality in Irish history has been neglected partly because of some concerns expressed by scholars about the reliability of the source material in the annual statistical reports of the Registrar General. Yet, we document the reliability of the registers by cross-referencing with census returns, demonstrating their accuracy in the 1870s and 1880s, and their importance as sources to provide vital insights and context in modern Irish history.

JEL Codes: N13; N33; I18
Keywords: Land War, Excess Mortality, Ireland.

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1 Introduction

Analysis of excess mortality holds the potential to revise understandings of key moments in modern Irish history. Yet aside from studies of the Great Famine, it has been largely neglected by historians of Ireland. Examining rates of excess mortality across post-Famine Ireland reveals that the Land War crisis of 1877-1882, a period of sweeping social and political change, saw the worst public health crisis in Ireland since vital registration began in 1864 to the present day. The years 1878, 1879 and 1880 represent the three worst years for annual deaths in Ireland in the period from 1864 to today. The year 1879 was the *annus horribilis*, with annual excess mortality rates notably higher than the recent Covid-19 pandemic and the infamous 1918 pandemic.[2] While later periods are associated with known epidemics and pandemics, the late-1870s are less associated with an epidemic but rather near-famine conditions and a highly politicised conflict between landlords and tenants. Western regions, particularly Co. Mayo, have long been considered to have been the worst affected by this crisis, but from the perspective of excess mortality we establish that this was an island-wide crisis and one that was more severe that previously understood. One reason for the neglect of excess mortality has been the concerns expressed by some scholars about the 'incompleteness and inaccuracy' of the source material in the annual statistical reports of the Registrar General.[3] A key aim of this study is to revise existing understandings of this unreliability, by demonstrating their accuracy and their importance as sources that can provide vital insights and context in modern Irish history.

The Land War crisis of 1877-1882 has long been recognized as a transformational period in Irish history. In the late-1870s Ireland experienced an economic downturn when European agricultural prices dropped due to increasing imports from North and South America. This coincided with climatic volatility associated with the 1877-1878 El Niño-Southern Oscillation which caused extreme weather and resulted in famine events across the world.[4] The years 1877-79 saw unusually cold and wet weather in Ireland,[5] with resulting poor harvests. This led to a food security crisis, with contemporary observers describing a 'famine' in the west of Ireland. A campaign of mass resistance to evictions and high rents emerged, led by the nationalist Land League, which combined a broad array of interest groups and aimed to abolish 'landlordism' and win 'land for the people'. The government responded with coercive measures, but the campaign achieved moderate gains for tenant farmers in the 1881 Land Act, though labourers, the class worst

[2] Christopher L. Colvin and Eoin McLaughlin, "Death, Demography, and the Denominator'.
[3] Vaughan and Fitzpatrick (eds.), *Irish Historical Statistics*, p. xv.
[4] Huang et al. 'How Significant Was the 1877/78 El Niño?'; Singh et al. "Climate and the Global Famine of 1876–78'; Ó Gráda, *Famine*, pp. 16-17.
[5] See Figures A4 & A5

affected by the crisis, benefitted little.[6]

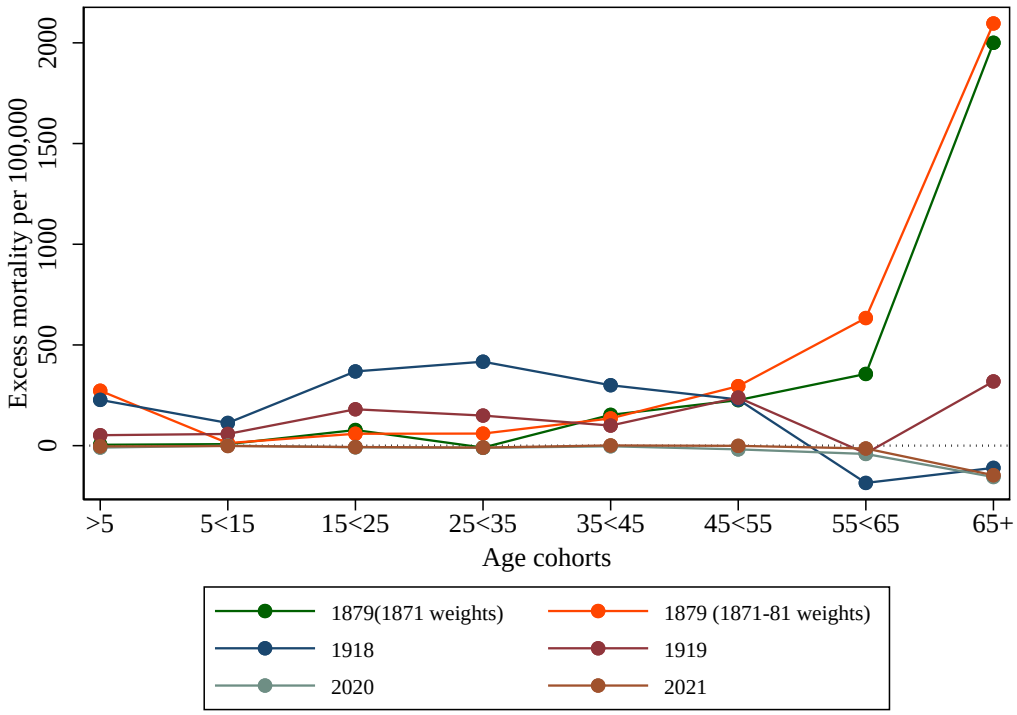
Scholarship on this period has primarily emphasized the importance of political and social change, though a number of studies, focusing on the west of Ireland, have examined the severity of distress in 1879 and the 'forgotten famine' of that year.[7] The crisis has been typically measured by rates of relief provision, food prices or the drop in potato tonnage, with excess mortality overlooked and even downplayed. Summarising the period, Ó Gráda noted that 'there was no excess mortality on a significant scale' during the Land War.[8] In contrast, we argue that analyzing excess mortality is vital to understanding the Land War crisis, and that it provides an important context for the social and political changes that occurred. Certainly, excess mortality in these years was not on the scale of the Great Famine, but in the context of post-Famine Ireland the rates were strikingly high in the three years of 1878, 1879 and 1880. These spikes are not seen in Britain and appear to be idiosyncratically Irish (see Figure 9 and Table A3). With excess deaths of 30,000 over the years 1878-1880, this bears greater similarity to other food crises in Ireland's past, such as 1799-1801, where excess mortality was estimated to have been between 24,000 to 30,000.[9] These figures are treble the excess mortality recorded during the 1918-19 influenza pandemic.[10] Not only was excess mortality higher, but when expressed as rates the 1878-80 excess deaths were the highest since the advent of registration of deaths (see figure 1 for comparison with recent public health crises).

We employ data from the A*nnual Reports of the Registrar General of Marriages, Births, and Deaths in Ireland* to explore excess mortality trends before and during the Land War crisis. Using this source we collect data deaths (and births) by registration district, of which there were 163 in total, from 1870-1880. To estimate excess mortality, we compare deaths in the Land War years with pre-land war averages by registration district. To construct age standardized estimates, we collect data on registration of deaths by age and corresponding ages from the 1871 and 1881 censuses. Thus, we compare both crude excess mortality and age standardized excess mortality estimates at the registration district level. In doing so we demonstrate the accuracy of the registers in these years and challenges ideas of the 'statistical weakness of Irish registration statistics' emphasised by Vaughan and Fitzpatrick's influential work, amongst others.[11] The annual registrar reports tended

[6] Whelehan, *Changing Land*, pp. 17, 26-7. The literature on the Land War is too lengthy to list, but includes Donnelly, *Land and the People*; Moody, *Davitt*; Solow, *Land Question*; Clark, *Social Origins*.
[7] Geary, *The Land War in Ireland*; Kinealy, King, and Moran (eds.), *The History of the Irish Famine.* ; Moran, "'Near Famine'"; O'Neill, 'Minor Famines in Galway 1815-1925'; Crawford, 'Indian Meal and Pellagra in Nineteenth-Century Ireland', pp. 118, 127-31.
[8] Cormac Ó Gráda, *Ireland*, 252.
[9] Liam Kennedy and Peter Solar, 'The Famine that wasn't?. The population in 1800 is estimated to have been similar as in 1878-80 giving these episodes a similar mortality rate.
[10]. Colvin and McLaughlin, 'Death, Demography, and the Denominator',
[11] Vaughan and Fitzpatrick (eds.), *Irish Historical Statistics*, p. xv.

to come with the caveat that under-reporting of births and deaths was likely more common in the west of Ireland compared to other regions (a perception which continued into the twentieth century), however this is difficult to support given the available evidence and it seems unlikely that such under/over reporting was purely a western phenomenon.[12] Contemporary enumerators sought to test the reliability of the new registers by triangulation of source material between the census and registers in 1871. This enables us to assess the scale of under/over reporting at registration district level (Poor Law Unions) and to make informed adjustments to these where necessary. However, bar a few outlier registration districts,[13] on the whole the measures are close approximations of each other. While we are conscious there was a likelihood of under-reporting of deaths, it was not significant enough to change the picture that emerges here based on the data from the annual registers.

Figure 1: Comparison of excess mortality in the Land War, Spanish Flu and Covid-19



Sources: Authors calculations and Colvin & McLaughlin 'Death, Demography, and the Denominator'.

This article proceeds first by giving an overview of the registration process and critically evaluates the underlying data source, outline our methodology for calculating annual mortality,

[12] Breathnach and Gurrin, 'A Tale of Two Cities', p. 648, 656; Dean and Mulvihill, 'The registration of births and deaths in Ireland', pp 101–5; For a discussion of under-reporting of births see de Bromhead et al., '175 Years of Mismeasuring Ireland?', pp. 23-5.

[13] There are outliers in both directions which effectively cancel each other out in a national picture.

excess mortality, and age standardization procedures, at the poor law union level. We document regional patterns that go against traditional narratives. We then examine contemporary discussions of these patterns.

2 Annual Registration of Vital Statistics

The administration of registration of births, deaths, and marriages was superimposed on the existing poor law system and conducted within these administrative units (Figure 2) along with the new registrar offices. A central 'General Register Office' was formed in Dublin that was responsible for the collation of the various district registers. It was quite clear that registration was not conducted at national level nor at county level, but explicitly using the pre-existing local government apparatus. Many existing Irish mortality studies have focused on either national or county level pictures, but given the administrative structure of registration, we would argue that the Poor Law Union makes a more appropriate unit of analysis.

The annual registration reports provide a large repository of detailed demographic information for Irish society from 1864. Earlier generations of historians dismissed the reliability of registration figures to analyse mortality because they considered Ireland was 'merely less efficiently registered' than England and Wales in the initial period of registration.[14] In this view, subsequent improvements in registration then explained why there was only minor decline in mortality in Ireland compared to England, where mortality rates fell by 15 per cent between 1870 and 1900, while Irish mortality rates remained relatively constant.[15] One aspect of this was Ireland's 'premature aging',[16] which left Ireland with an unusually elderly population structure. However, to date there are no age standardized estimates of mortality across Ireland and Britain to assess whether this explains the discrepancy, which this article seeks to address in part. Although a complete age standardized mortality series is beyond the scope of this study.

2.1 Reliability of the vital registration[17]

The issue of under and over reporting has been a key concern for scholars regarding the reliability of the registration of deaths (and births). For example, in a 1957 UN report it was stated that:

[14] Kennedy and Clarkson, 'Irish Population History', p. 170.
[15] Kennedy and Clarkson, 'Irish Population History', p. 171. Kennedy and Clarkson, cite *the First and Second Reports from the Select Committee on Death Certification* (BPP 1893-94) as evidence of under registration. This source does not support the criticism of registration as certification of death (cause of death etc) was a distinct process from registering a death. The former is undoubtedly fraught with complications requiring coroner certificates, the latter is informing simple process of informing of a death.
[16] Gilleard, 'The other Victorians'.
[17] The reliability of birth registration has received greater attention. We discuss this in detail in Appendix 1.

> '[a] major factor producing unreliability in mortality statistics – both crude and specific – is, of course under-registration of deaths. Registration is a civil affair. It is a well-known fact that in countries where civil administration is not yet well developed, the requirements of death registration, although theoretically obligatory, are not well complied with.'[18]

In the 1950s, it was reported that only 30 percent of global deaths were reported, with registration as low as 7 per cent in some parts of East Asia compared with 100 percent in parts of the US and Europe.[19] In more recent times, there is still considerable variation in under registration of deaths globally,[20] with estimates of 36 per cent of deaths registered in 2000 and a slight increase to 38 percent in 2015.[21] A crude rule of thumb is that a system with registration over 60 percent is considered 'a useful source of information' as registration below 60 percent may be unrepresentative.[22] Our analysis of cross-tabulated results, shown below, is that registration in Ireland was close to 90 percent island wide, although with variation across registration districts discussed below.

A mid-twentieth century UN report stated that 'until quite recent times, governments paid little attention to the appraisal of the accuracy of the demographic statistics'.[23] While this statement may be true of many jurisdictions, the Irish administration in the 1860s and 1870s was in fact quite concerned with the accuracy of the newly introduced vital registration system. Compulsory registration for deaths was required within seven days of death. Notice of births was required within twenty one days and full information within three months.[24] Late registration of births was possible but expensive, the fee being two shillings and sixpence. Each union registrar was paid a rate of 'one shilling for every entry of birth or death included', and this came at the expense of ratepayers. There were penalties for failure to register births and deaths (between twenty to forty shillings) and for improper registration of births and deaths, or for losing or damaging registers (£10), which incentivised accuracy.

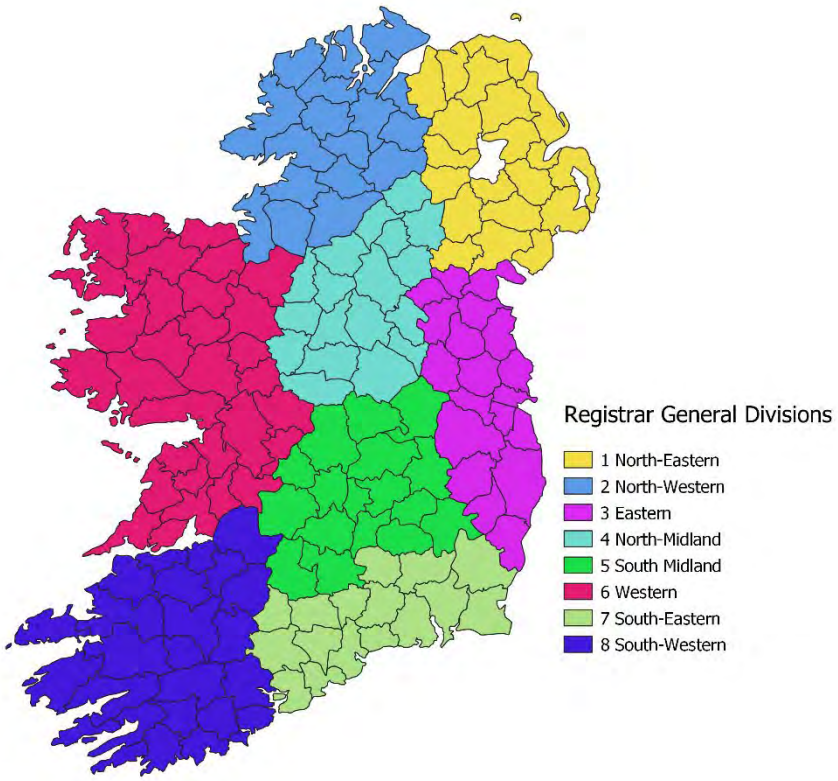
The 1871 census explicitly attempted 'to test the accuracy of the returns of death' by including a survey of deaths in the census enumeration forms and comparing this against the registration figures from when they began. The census commissioners concluded that 'comparison will be found to give very favourable results as to the accuracy of the Census returns always of course allowing a margin for such omissions as may be caused by emigration and the breaking up of

[18] UN Demographic Yearbook 1957, p. 2.
[19] Shryock et al., *The Methods and Materials of Demography,* p. 267.
[20] AbouyZahr et al., 'Civil registration and vital statistics'.
[21] AbouyZahr et al. 'Towards universal civil registration and vital statistics systems'.
[22] Siegel and Swanson. *The Methods and Materials of Demography*, p. 267.
[23] UN*, Manuals on methods of estimating population*
[24] 26 & 26 Vict. c. 11.

families, also the defects of memory on the part of those who made the returns and had no record to refer to'.[25] The census commissioners were thankful for the good fortune that the period of comparison was not an abnormal period of mortality and enjoyed the 'comparative freedom from epidemic disease', aside from a Cholera epidemic in Dublin in 1866-67.[26]

Figure 3 shows the distribution of the ratio of deaths in the census survey to registered deaths. The accuracy increases the closer the time periods match. In the worst cases outlying unions were approximately 30 percent out from census survey data, but as can be seen there were few such outliers and by 1870 there was considerable alignment between the census survey and death registration. This is clearly shown in Table 1, where 76 percent of Unions in 1870 had registrations within 10 percent of the census survey. The regional variation is illustrated in Figure 4 with no clear regional pattern evident.

Figure 2 Registrar General Divisions



[25] 1871 census
[26] 1871 census, p. cxvi.

Figure 3 Ratio of Registration of Deaths to Census death survey, 1864-1870

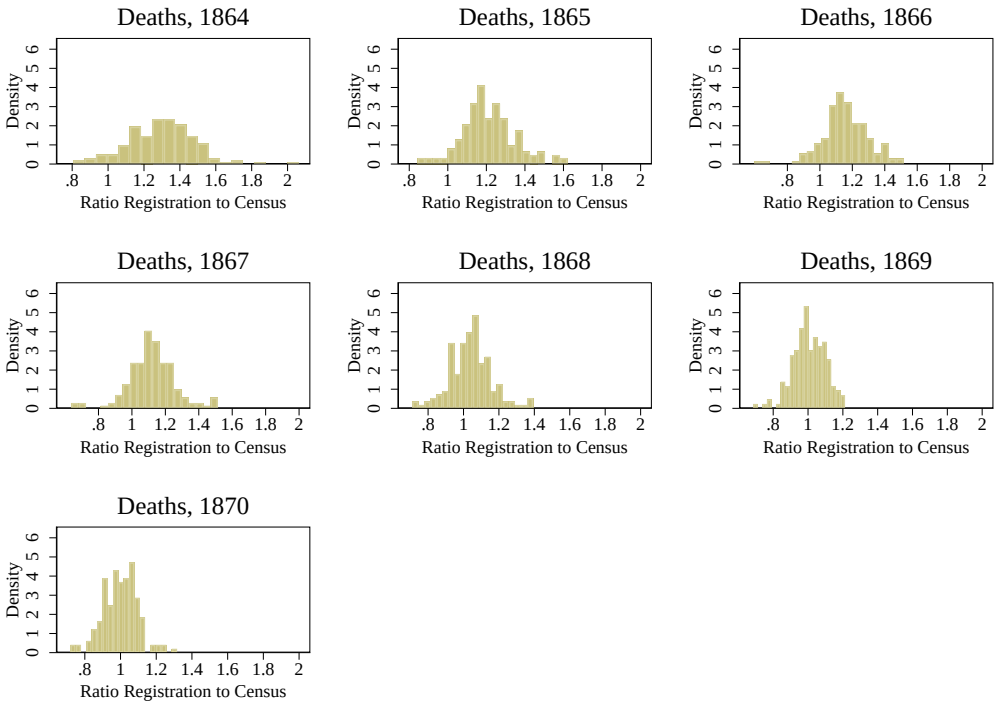


Table 1 Ratio of Registration of Deaths to Census survey 1864-1870

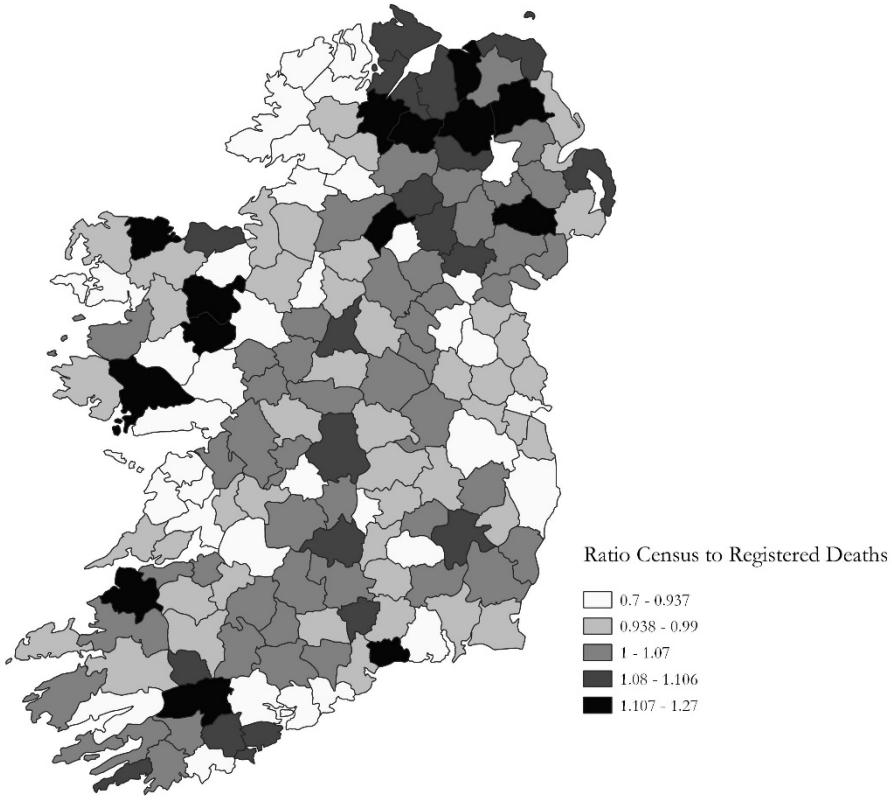
Year	Number of Unions	Mean	Std. Dev.	Min	Max
1864	163	1.294	0.190	0.806	2.064
1865	163	1.215	0.139	0.844	1.621
1866	163	1.157	0.140	0.597	1.517
1867	163	1.118	0.140	0.638	1.515
1868	163	1.042	0.118	0.711	1.393
1869	163	1.006	0.093	0.684	1.213
1870	163	0.999	0.097	0.719	1.317
Unions where ratio was between 10%					
1864	20	1.014	0.061	0.913	1.098
1865	21	1.027	0.048	0.915	1.085
1866	48	1.026	0.058	0.904	1.095
1867	65	1.031	0.050	0.912	1.099
1868	103	1.017	0.052	0.924	1.099
1869	117	0.998	0.054	0.900	1.097
1870	124	1.002	0.057	0.903	1.093

A similar exercise was not repeated in the 1881 Census, thus it is not possible to compare the statements about improving accuracy in registration. However, from this analysis the 1871 census survey data do show that reasonably accurate registration was in place. In fact, the census commissioners believed that with the existence of general registration of deaths meant that 'in future census compilations it will not be necessary to publish so many Tables of Deaths and to report thereon'.[27]

The major change to the system of registration came under the 1878 Public Health Act, which involved the incorporation of burial returns with death registration to adjust possible undercounting of deaths. The discrepancy between burial returns and registration was first highlighted and discussed in the 1871 census. Dublin was the primary region affected and there was roughly a 10 percent discrepancy between burials and registered deaths (see Figure A3). However, the general view that registration was accurate casts doubt on any assertions about improving registration under the 1878 Public Health Act, assertions that may have been made to distance the government from blame for rising mortality rates. Therefore, we believe that this aligns with Cousens conclusion that the 'discrepancy in [death] registration was not of great magnitude'.[28]

[27] Census of Ireland 1871: Part II. Vital Statistics, vol II, p. cxvi.
[28] Cousens, 'The Regional Variations in Population Changes in Ireland, 1861-1881' p. 305.

Figure 4 Ratio of Registration of Deaths to Census death survey



Given the discussion of registration, a pertinent question is whether the identified reporting issues are systematic across Poor Law Unions. Figure 5 examines this by comparing the ratio of death registration/census to birth registration/census,[29] this indicates some weak correlation between both. Table 2 explores this more systematically by regressing these ratios on each other and including the registration district controls with controls for poor law area, population, and valuation controls, as well as controls for the outliers in death and birth registrations. We see that the biases in recording of births are correlated with the misreporting of deaths and vice versa. We also see some district over-reporting of deaths in the North-Eastern by 5% but there is no systematic misreporting across all districts. Controlling for outlying districts has no effect on the death registration/census ratio.

[29] See Appendix 1 for discussion of the reliability of birth registration. Appendix 1 contains similar analysis for birth registration.

Figure 5 Scatterplot of Ratio of registered deaths to census and registered births to census enumerated infants

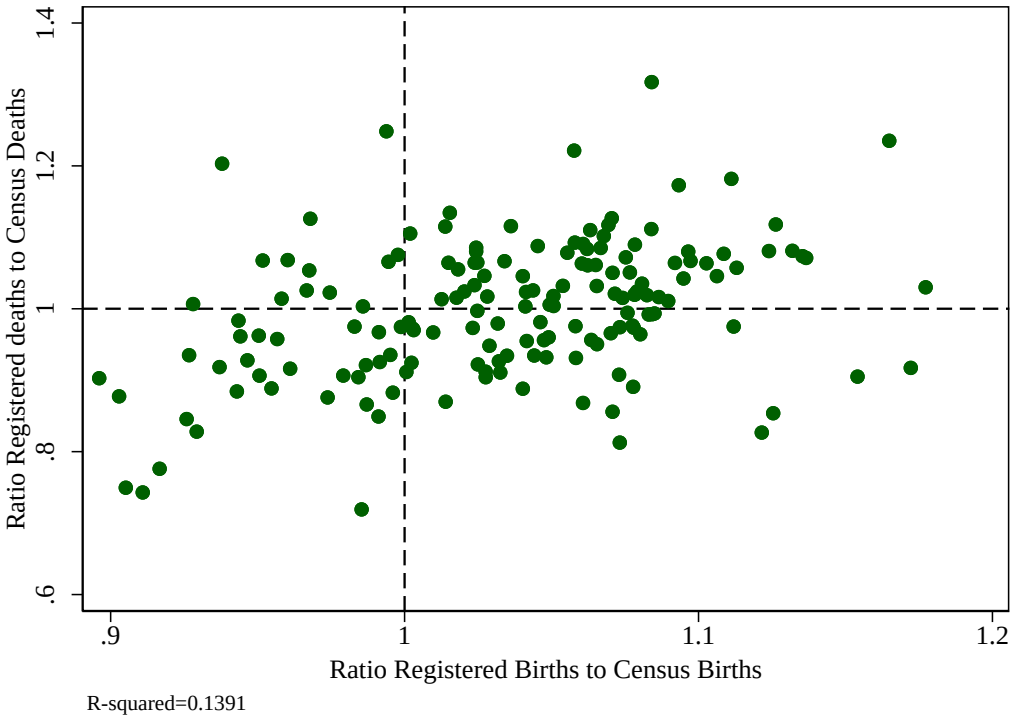


Table 2 Regression of Registered Deaths/Census and Registered Births/Census

	(1)	(2)
Population density	-0.02	-0.03
	(0.029)	(0.031)
Area	-0.00	-0.00
	(0.000)	(0.000)
Poor Law Valuation £	-0.0003	0.001
	(0.002)	(0.002)
Poor Law Valuation £ (10,000)	-0.02	-0.03
	(0.029)	(0.031)
Birth Registration/Census		0.01***
		(0.002)
	Registration districts	
Eastern	Reference	Reference
North-Eastern	0.09***	0.05**
	(0.020)	(0.023)
North Midland	0.04*	0.03
	(0.026)	(0.027)
North Western	-0.01	-0.01
	(0.035)	(0.033)
South Midland	0.02	0.01
	(0.028)	(0.024)
South-Eastern	0.02	-0.01
	(0.027)	(0.025)
South-Western	0.05**	0.02
	(0.024)	(0.023)
Western	0.01	0.01
	(0.031)	(0.030)
Death registration/census outliers	-0.01	0.00
	(0.026)	(0.026)
Birth registration/census outliers	0.00	-0.04
	(0.061)	(0.065)
Constant	0.99***	0.40**
	(0.026)	(0.189)
Observations	163	163
R-squared	0.11	0.19

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

3 Excess Mortality and Age Standardisation methodology

We focus our analysis on death rates and birth rates rather than on raw deaths and births. This is done to account for differences in the size of Poor Law Unions. However, calculating rates requires a denominator, for this period there are two census reference points, the 1871 and 1881 censuses. We make use of both census population counts, showing mortality using the 1871 population as a denominator and an estimated intercensal population using both the 1871 and 1881 censuses.[30] The choice of denominator is not a moot point. For example, when hosting a delegation from Dublin Corporation regarding infectious diseases, the Chief Secretary noted that the 'death rate is undoubtedly very high in Dublin'. Yet the rates were questioned by Dublin's chief

[30] From vital statistics we have two of the three components necessary to make intercensal population estimates, but it is almost impossible to accurately estimate annual migration between Unions. Although, from the two census points we are able to estimate annual emigration based on the cohort depletion approach, we cannot use the same method to estimate annual internal migration flows.

medical officer, Dr. Charles Cameron, on the grounds that comparisons were being made using an inappropriate denominator from the 1871 census given the noticeable population movements in the intervening years. He argued that if a more up-to-date denominator was used, then the increase would not be as apparent.[31] Yet, even taking this argument into consideration, the rates remained high as we demonstrate below.

The methodology for estimating crude and age standardised mortality rates adopted here is based on Colvin & McLaughlin's approach to the study of the 1918 "Spanish Flu" pandemic.[32] Following this , we calculate annual Crude Mortality Rates by Registration District (Poor Law Union):

$$M_{tu} = \frac{D_{tu}}{P_{tu}} \times 1{,}000 \quad (1)$$

Where $M_{tu}$is the mortality rate in time *t* by Union, D is deaths in time *t* by Union, and P is population in time *t* by Union. We then estimate excess crude mortality

$$EM_{tu} = M_{tu} - \overline{M}_u \quad (2)$$

where $\overline{M}_u$ is an average of mortality in the PLU in the 6 year period preceding the Land War (1871-1876),[33] we purposefully compare mortality in years 1877, 1878, and 1879 and 1880 with this baseline estimate of mortality as it is not affected by the Land War. In total, then we collect annual mortality data for 163 poor law unions over a 10 year period.

Age distributions from the 1871 and 1881 censuses are shown in Figure 6 which highlight the subtle differences in the composition of the population between the censuses.[34] Looking at the island as a whole there are some demographic changes evident between the census points, particularly the smaller share of the population under five and the rise of the over sixty five share. There were also some variations across the island too as indicated by the registration district areas. As it is widely known that the demographic composition of a population affects the crude mortality rate, for example aging populations are more likely to die and thus have higher mortality rates, therefore in order to draw meaningful comparisons across space we need to make adjustments for this. We calculate age-specific mortality:

$$M_{satu} = \frac{D_{satu}}{P_{satu}} \times 1{,}000 \quad (3)$$

[31] *Daily Express*, 9 December 1880.
[32] Colvin and McLaughlin, 'Death, Demography, and the Denominator' .
[33] 1871 is purposefully chosen as the starting point as it is a year after the aforementioned 1871 census survey of deaths to avoid undercounting deaths from the 1860s and thus overstating excess mortality in the late 1870s.
[34] Table A5 shows the age distributions of the population across the registration districts.

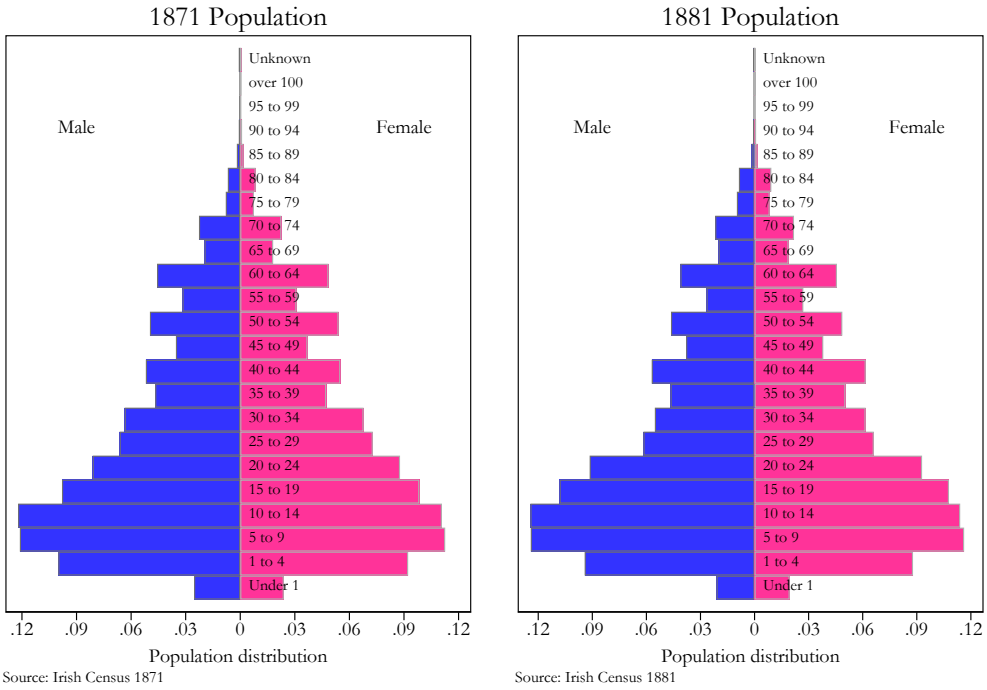
Where M_{satu} is the mortality rate by sex and age in year *t* in Union, deaths by sex and age in time *t* in each Union and Population by sex and age in year *t* in each Union. To make comparisons between regions of different age structures we calculate age standardised mortality:

$$m_{1st} = \frac{\sum m_{satu} P_a}{P} \times 1{,}000 \quad (4)$$

P_a is the standard population at each age, P is the total standard population. We adopt a direct standardisation using a "standard population" based on 1911 World populations from Colvin & McLaughlin (2021) – see Table A5.[35]

To summarise: we collect data on deaths across the ten age bands for all 163 unions over a ten year period, as well as data on ages by poor law union and births in poor law unions.

Figure 6 Distribution of population of Ireland, 1871 & 1881



[35] Colvin and McLaughlin, 'Death, Demography, and the Denominator'.

4 Mortality and Excess Mortality trends

In the late-1870s the reports of the Registrar General of Ireland clearly indicate a sharp upturn in the recorded deaths in Ireland. In 1877, 93,543 people died in Ireland, but this number rose significantly to 99,629 in 1878, and then to 105,089 in 1879, falling slightly to 102,906 in 1880. The annual rates of excess mortality nationally were, 1877: 48.1 per 100,000; 1878: 164.6; 1879: 274; and 1880: 256.2. The worst year was 1879, where deaths were 13.5 percent higher than the pre-Land War period. By comparison, in 1918, the year of the Spanish flu epidemic, 78,695 people died, and the excess morality rate was 139 per 100,000.[36] Looking at the quarterly mortality returns shows that while mortality during the influenza pandemics had acute quarters, the Land War period had back-to-back quarterly excess mortality leading to the pronounced increase in mortality.[37]

Figure 7 presents raw annual totals for births, deaths, and infant deaths from 1871-1882. A clear increase in the number of registered deaths is visible during the Land War period, starting in 1877, with a fall thereafter. Whereas for births there is a fall in birth registration, although infant deaths continue to rise which led to elevated infant mortality rates during 1879 and 1880.[38]

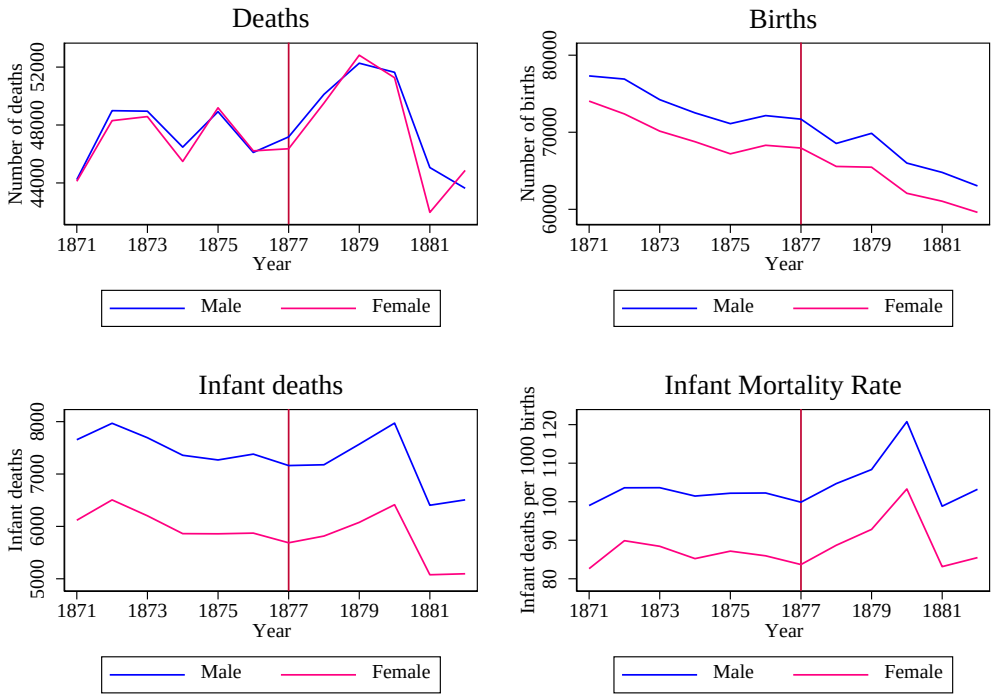
The crude mortality rates by province in the registrar's annual reports indicate that this crisis was far from being confined to the west. From 1877 to 1879 (see Table A4), the mortality rate in the western province of Connacht rose by 1.7 per 1000, in the northern province of Ulster by 1.9, in the south-western province of Munster by 2.2, and in the eastern province of Leinster by 2.4. In 1879 the crude death rate in Leinster was 22.9 per 1000 and 15.7 in Connacht. That year, the counties with the lowest registered deaths were Sligo, Mayo, Longford and Galway, while Dublin, Antrim, Westmeath and Limerick had the highest.[39] In 1880 the mortality rate in Connacht fell, but increased in Leinster, Munster, and significantly so in Ulster.[40] In 1881 distress eased, with the number of national annual deaths dropping significantly from 102,906 to 90,035. In the worst years of 1878-1880, deaths rates were highest outside of Connacht.

Long run trends in excess mortality for Ireland from the commencement of registration in 1864 up to modern times are shown in Figure 8. This approach effectively creates a periodisation of Irish epidemiological history from one of frequent mortality spikes to one with much less frequent and lower spikes. The latter are indicative of the experiences of many countries in terms

[36] Figures taken from the annual reports of the Registrar General. Excess mortality is calculated by comparing mortality in the year with the average mortality in the preceding ten years prior to the Land War (1867 to 1876), 92,532 (17.22 per 1,000) and is based on the methodology employed in Colvin and McLaughlin, 'Death, Demography, and the Denominator'., Fig. 2, 4. Note that the mortality figures here for 1877-1880 do not employ age standardization.
[37] See Figure A4.
[38] On infant and maternal mortality in nineteenth-century Dublin see Breathnach and Gurrin, 'A Tale of Two Cities'; Breathnach and Gurrin, 'Maternal Mortality, Dublin, 1864–1902'.
[39] *Sixteenth Detailed Annual Report of the Registrar-General, 1879*, 15.
[40] Death rates given in *Fourteenth*, *Fifteenth* and *Sixteenth Annual Reports of the Registrar-General.*

of epidemiological transition,[41] highlighting a significant decline in mortality, particularly from the twentieth century onwards, much in line with recent work such as Delaney and Walsh.[42] The period before this contains regular spikes in excess mortality. In existing studies of mortality in Irish history, for example in Kennedy and Clarkson, there has been an inclination to primarily look at crude mortality rates to identify trends.[43]. However, examining excess mortality can show how mortality deviates from trend (or expected) values. Excess mortality has been used as an identifier of famine conditions,[44] most notably in Irish history in estimating the scale of the Great Famine, but also during famines in later nineteenth century in India.[45] Excess mortality can also help identify important epidemiological events; for example, Potter argues that spikes in excess mortality are indicative of influenza pandemics.[46]

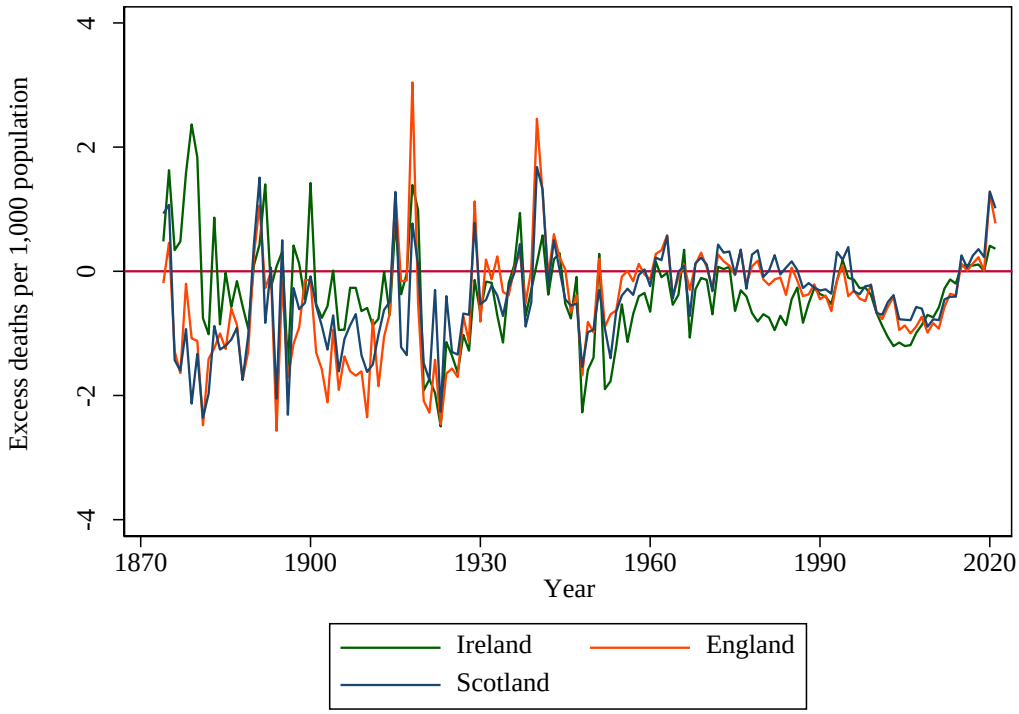
Figure 7 Annual Deaths, Births, Infant Deaths, and Infant Mortality rate, 1871-1882



Source: Annual Registrar General Returns of Births, Deaths, and Marriages, 1871-1882

[41] Mackenbach, 'The epidemiologic transition theory'..
[42] Liam Delaney et al.. 'From Angela's ashes to the Celtic tiger'; Walsh, 'Life expectancy in Ireland since the 1870s'; Eighan et al. 'The great convergence?'.
[43] Kennedy and Clarkson, 'Irish Population History',
[44] Ó Gráda, (2007). 'Making Famine History'
[45] Dyson, 'On the Demography of South Asian Famines: Part I'.
[46] Potter, 'A history of influenza'.

Figure 8: Excess mortality in Ireland, Scotland, and England, 1870-2021.



Note: Post-1922, Ireland contains both north & south. Excess mortality calculated as mortality in year t minus trend mortality. The figure uses a simple 5 year moving average for the under trend but other time series filters (e.g. Hodrick and Prescott filter, Kalman Filter, etc) provide similar results.

4.2 A spike in Excess Mortality

In 1879 the rise in mortality, particularly in Dublin, was partly explained by the Registrar by pointing to changes introduced to the system of registration by the 1878 Public Health Act, which involved the incorporation of burial returns to adjust possible undercounting of deaths. Yet, if the increase in deaths was solely due to an improvement in registration in 1878, then we would expect a one off increase and annual volatility in deaths would not be identifiable. However, Figure 9 clearly shows that there was volatility in mortality and that the increase in 1878 was not a one off. Moreover, if improvements in registration were a factor it was not a uniform improvement; by this we mean that deaths were not increased by the same factor for all age groups, as illustrated in Figure 9 through the inclusion of infant deaths. In 1878 an increase in the number of infant deaths similar to the total number of deaths was not evident, while there is similar change in 1879, total deaths and infant deaths had an inverse experience in 1880, while in 1881 deaths decreased across all categories. Clearly there is a deeper story than registration teething problems.

Figure 9: Annual growth of registered deaths and infant deaths

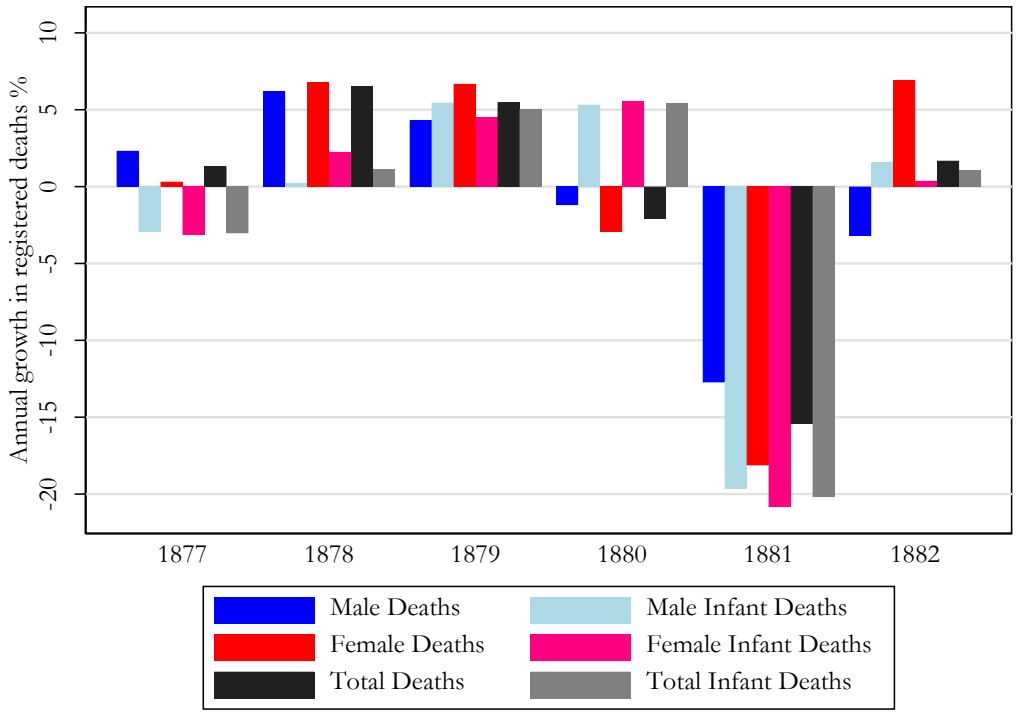


Figure 10 presents national excess mortality rates where rates are calculated as per equations 2 and 4 above for the land war years. Panel a presents crude mortality rates using the 1871 population weights and the estimated 1871-81 population weights. Clearly the 1871 weights somewhat overstate the extent of excess mortality but not by a large margin. This is explained by the fact that even though population fell between 1871 and 1881, the annual change was not as pronounced as the annual swings in mortality (see figure 9). However, when the changing demographic composition is accounted for, as in Panel b, the estimated excess mortality rates are higher for the estimated 1871-81 population; moreover, excess mortality rate estimates in Panel b are higher than those presented in Panel a and age standardised mortality in 1879 (2.5 per 1,000) was close to double that reported for the 1918 Spanish Flu pandemic (1.39 per 1,000).

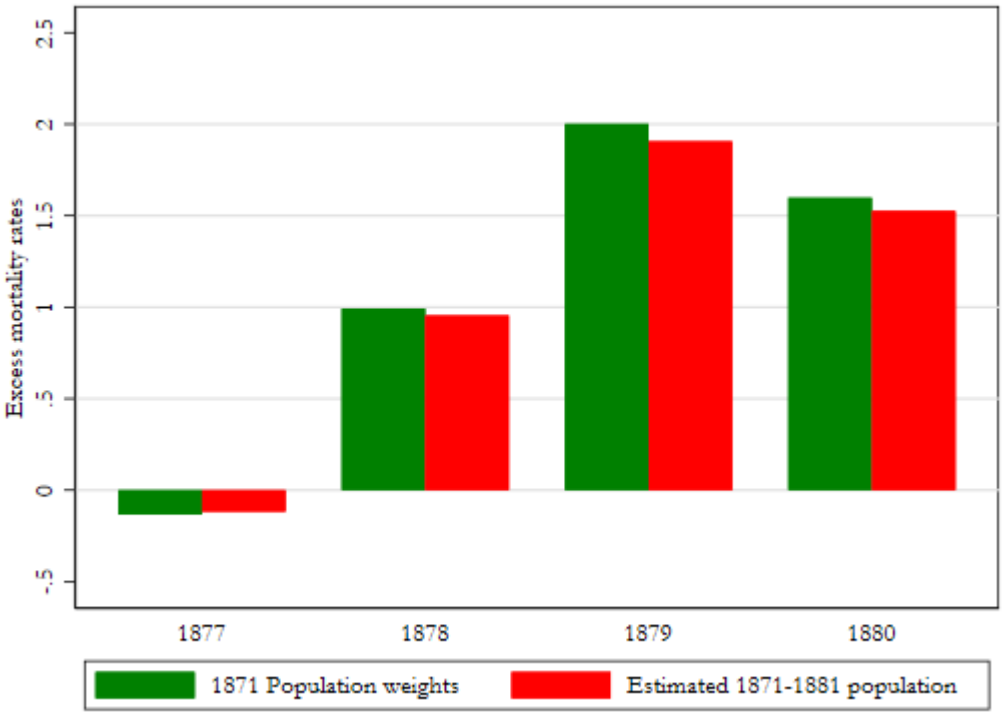
We explore the drivers of the excess mortality in 1879 and 1880 illustrated in Figure 10 by looking at age specific mortality (as per equation 3) in Figure 11.[47] We observe spikes in excess mortality for the young and the elderly. The biggest increases in excess mortality are in the over 65 cohort. Using 1871 census weights, the excess mortality rate for the over 65s is 21.45 per 1,000 for males in 1879, while a slightly lower excess rate is observed for females (18.61 per 1,000). Using 1871-81 population weights marginally increases the male rate (by 0.03 per 1,000) in 1879 but there is a more noticeable increase for females in the same year (1.80 per 1,000). Notable increases are

[47] A complete set of figures for 1877-1880 are shown in Figure A5 in the appendices.

found in the 55 to 64 cohorts, both male and female (3.10 per 1,000 for males; 2.46 per 1,000 for females).

Figure 10 Excess mortality using 1871 and 1871-1881 population weights

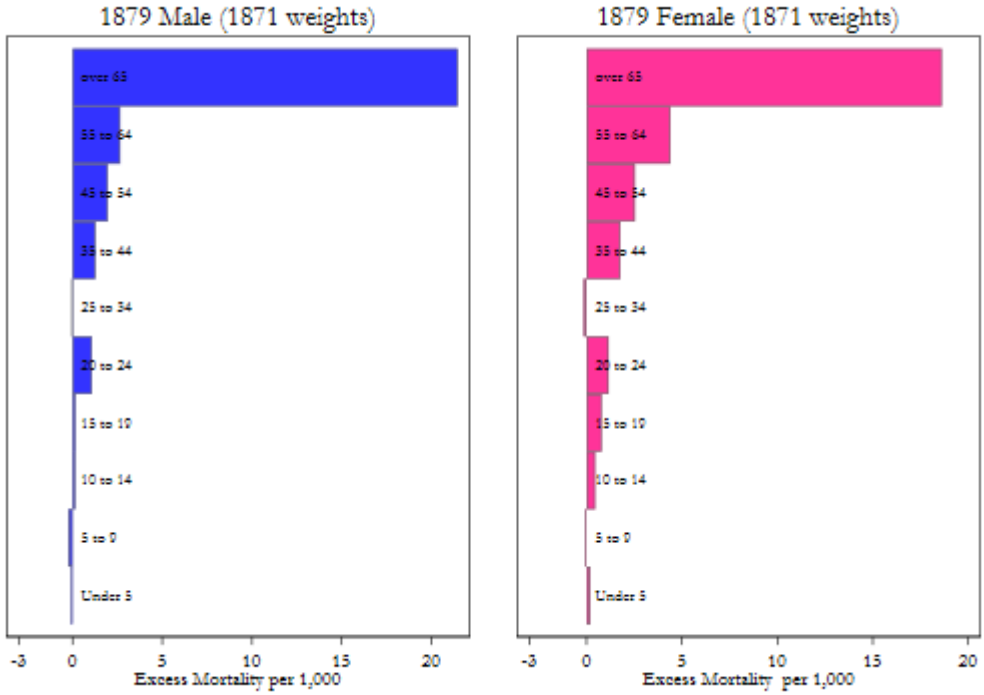
Panel a) Crude excess mortality



Panel b) Age adjusted excess mortality

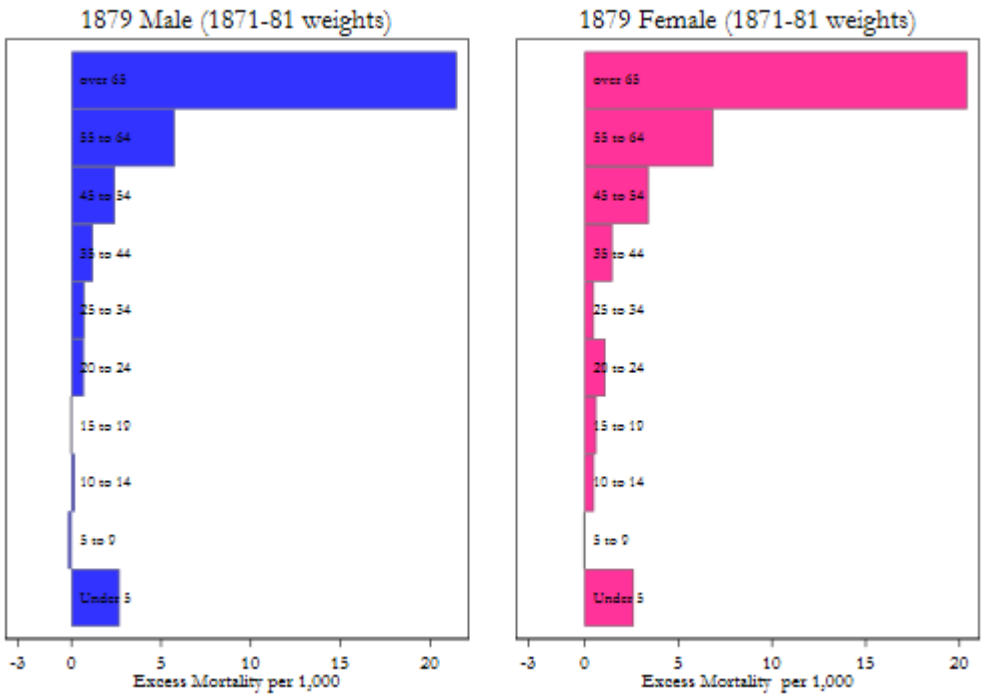
A major difference is the high excess mortality rate for the under 5s. Using the 1871 population weights, this hardly registers as the excess mortality for under 5s in 1879 was negative for males (-0.08 per 1,000) and slightly elevated for females (0.19 per 1,000). However, taking account of the falling birth rates and the lower share of under 5s in the 1881 census, we find excess mortality rates in 1879 at 2.68 and 2.25 per 1,000 for males and females respectively. Excess mortality for the under 5s further increased in 1880, evident with the 1871 census weights, but more pronounced in the 1871-81 weights. While these rates are clearly not at the level of the Great Famine, when Mokyr estimated average annual excess death rates of between 8.6 and 60.5 per 1,000,[48] they are noticeably higher than other epidemiological events in modern Irish history.

Figure 11 Excess mortality 1879
Panel a) 1871 census weights



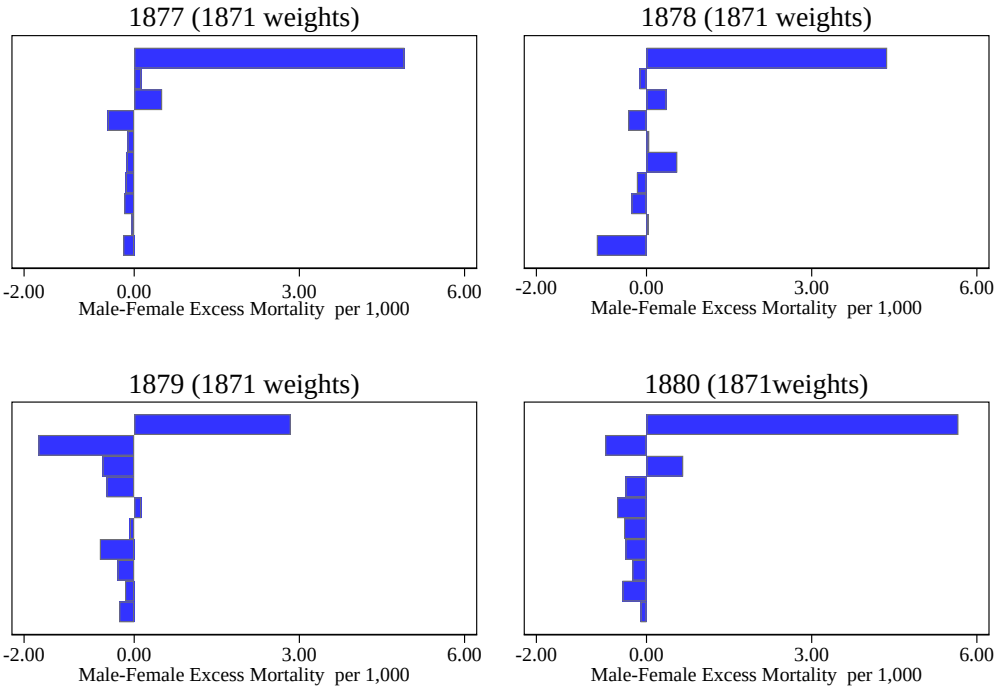
Panel b) 1871-81 census weights

[48] 8.6 per 1,000 lower bound for Leinster and 60.5 upper bound for Connacht. Figures for Ireland were 33 (upper bound) and 24.3 (lower bound): Joel Mokyr, *Why Ireland Starved*. Table 9.1.

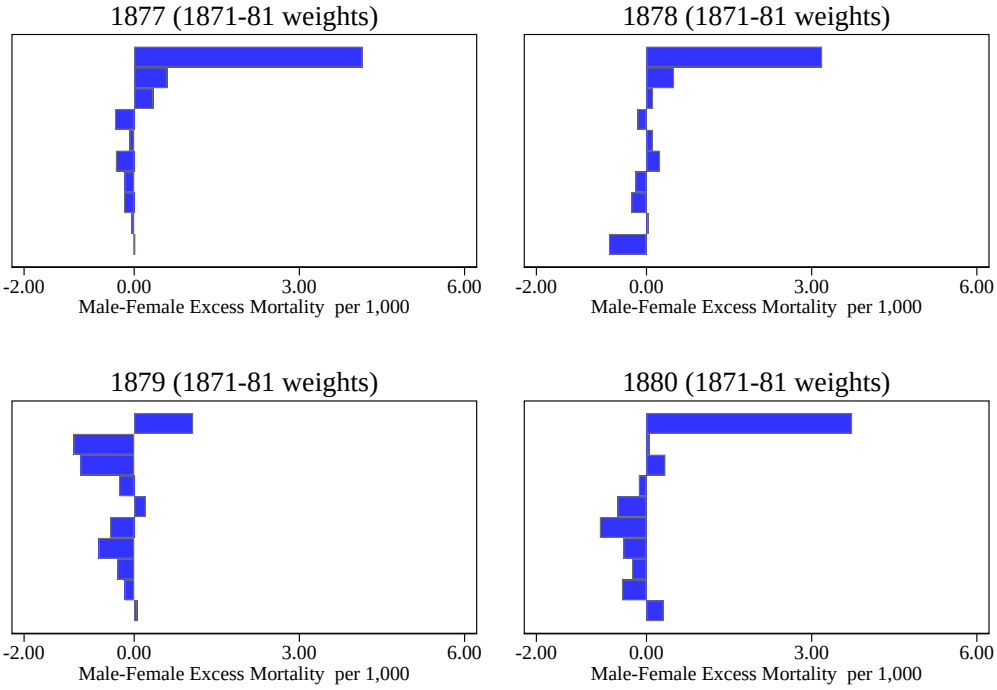


Finally, we compare male and female mortality in crisis years in Figure 12. A tell-tale sign of malnutrition is a disproportionate rise in male mortality. For the years 1877, 1878 and 1880 this appears to be the particularly acute for the over 65s. However, for 1879 excess mortality rates for males and females appear to be of a similar magnitude, with female rates slightly higher.

Figure 12 Differential between Male and Female Excess Mortality 1877-1880
Panel a) 1871 census weights



Panel b) 1871-81 census weights



5 Geography of Excess Mortality

Heretofore we have documented trends in excess mortality at a national level, but where were these excess deaths? Were deaths concentrated in the west as per the focus of contemporaries (see discussion below), or were other regional patterns evident?

Firstly, looking at descriptive statistics (see Table 3) we highlight how 1879 had the highest mean excess mortality although with considerable variation ranging from -2.76 to 7.99. Table 3 also highlights the best and worst performing unions by year. Crude excess mortality highlights the range of outcomes, Killala Union in Mayo had the lowest excess mortality rate (-2.76 per 1,000 – i.e. fewer than expected deaths) while Roscommon had the highest. However, adjusting for age we see a slightly narrow range (-10.48) and a different rank order, while Killala remains the best performing union and South Dublin is now the worst performing union.

Table 3 descriptive statistics of excess mortality, 1877-1880 (1871-81 denominator)

Year	*Mean*	*Std. Dev.*	Min	Max	Best Union	Worst Union
Crude Excess Mortality rates per 1,000						
1877	0.09	1.56	-5.32	3.91	Castletown	Urlingford
1878	1.34	2.00	-5.32	8.03	Killala	Lismore
1879	2.28	1.82	-2.76	7.99	Killala	Roscommon
1880	1.63	1.99	-3.09	8.86	Gort	North Dublin
Age adjusted excess mortality per 1,000						
1877	0.14	1.45	-4.97	4.02	Castletown	Urlingford
1878	1.33	1.87	-4.62	7.87	Killala	Lismore
1879	2.14	1.70	-1.98	8.28	Balrothery	South Dublin
1880	1.61	1.97	-3.03	9.58	Gort	North Dublin

Note: see Table A6 for descriptive statistics using 1871 as denominator

Zooming in on the 1879 figures, Table 4 displays descriptive statistics by registration district and here we see considerable variation. The two regions with the highest mean excess mortality rates were the North-Eastern and North-Western districts, where there were no unions experiencing negative excess mortality rates. Perhaps on the surface this is unsurprising given the industrial cluster in the North-Eastern district. That being said, one revealing aspect of this was how low the excess mortality rate was in Belfast (0.83 per 1,000), the second lowest in the district. Although the rate in Belfast was relatively higher when age adjusted (1.76 per 1,000), this still placed Belfast in the bottom quintile of the district. Yet Lurgan and Newry had the highest rates in the district, suggesting that urbanisation per se was not a driver of the excess mortality. In the North-Western district Derry had the lowest excess mortality (0.26 per 1,000) and second lowest

age-adjusted mortality (0.76 per 1,000). The highest rates were found in Donegal, Stranorlar and Letterkenny.

Table 4 Descriptive statistics by Registration district 1879

	Unions	Mean	Std. Dev.	Min	Max	Best Union	Worst Union
	Crude Excess Mortality rates per 1,000						
Eastern	19	2.51	2.40	-1.54	7.60	Balrothery	South Dublin
North-Eastern	20	2.89	1.21	0.75	4.74	Larne	Lurgan
South-Eastern	16	1.35	1.50	-0.68	3.70	Middleton	Mitchelstown
North-Midland	18	2.78	2.12	-0.77	7.99	Longford	Roscommon
South-Midland	17	2.81	1.24	0.76	5.97	Thurles	Roscrea
Western	31	1.67	2.02	-2.76	6.65	Killala	Corrofin
North-Western	17	2.71	1.47	0.26	4.97	Derry	Letterkenny
South-Western	25	1.93	1.59	-0.72	6.17	Bandon	Croom
		Age adjusted excess mortality					
Eastern	19	2.37	2.64	-1.98	8.28	Balrothery	South Dublin
North-Eastern	20	2.66	1.16	0.60	4.79	Larne	Newry
South-Eastern	16	1.13	1.44	-0.94	3.18	Kilmacthomas	Dungarvan
North-Midland	18	2.61	1.96	-0.68	7.35	Longford	Roscommon
South-Midland	17	2.42	1.03	0.54	4.89	Thurles	Roscrea
Western	31	1.60	1.70	-1.89	5.17	Killala	Swineford
North-Western	17	2.62	1.39	0.48	5.03	Ballyshannon	Letterkenny
South-Western	25	2.02	1.34	-0.39	4.90	Bandon	Kanturk

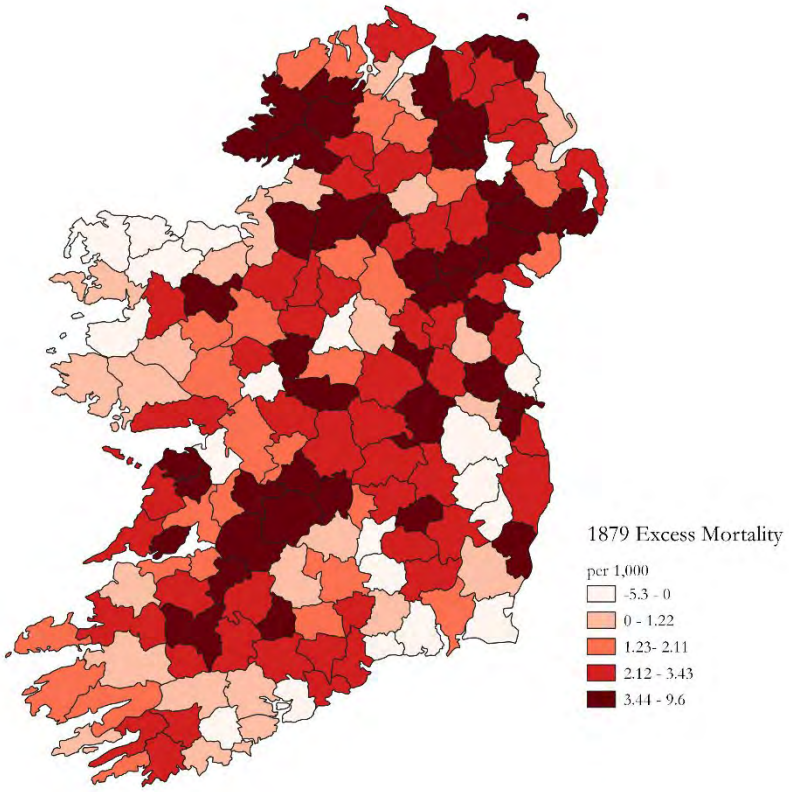
We further document regional patterns in 1879, the peak year of excess mortality, using both excess mortality and age standardised excess mortality. Figure 13 maps excess mortality in 1879; panel a presents crude excess mortality while panel b makes age adjustments.[49] The difference between the panels highlights the importance of age adjustment. Without adjustment there are 41 unions in the highest band with a mean excess mortality rate of 4.60 per 1,000, however after age adjustment there are only 27 unions in the high category with a mean of 4.77 per 1,000.

Given the narrative around the west during the Land War period it is surprising to see how the Western registration district has one of the lowest rates of excess mortality. The Western

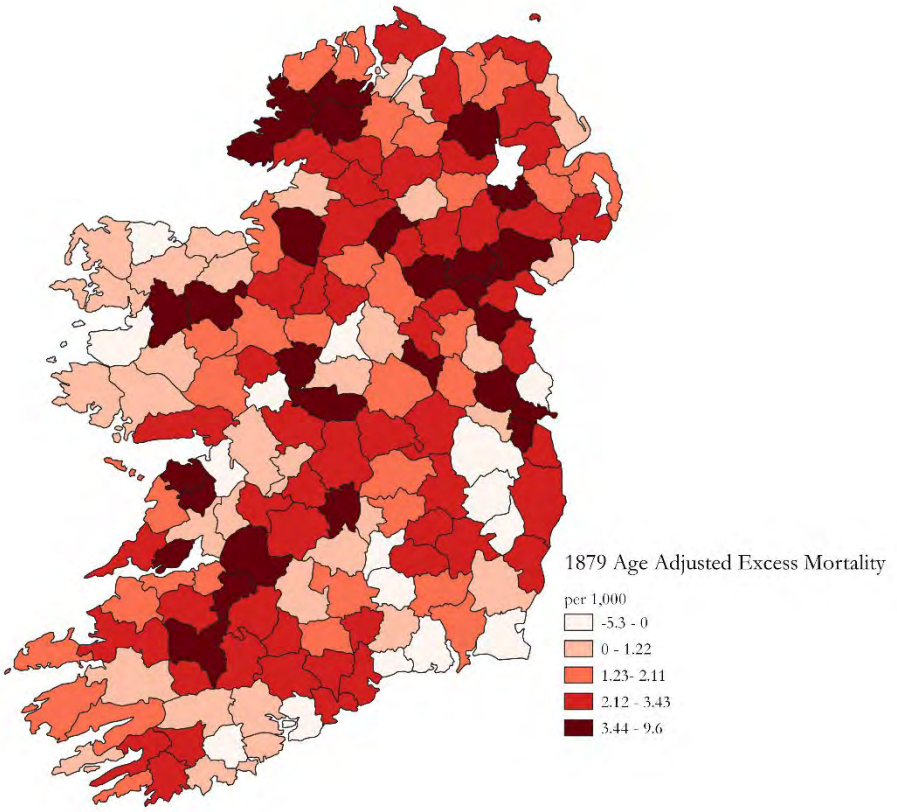
[49] Excess mortality rates for the years 1877 through 1880 are found in Figure A6.

district is also one of the largest districts so perhaps this explains the low rates. Looking within the district we see that 5 unions have excess rates greater than 3.41 (Killadysert, Scarriff, Swineford, Ballyvaughan, and Corrofin); age adjustment sees Castlebar replace Scarriff in this list. Excluding these unions, the mean rate of excess mortality in the Western district would be 1.02 per 1,000 (age adjusted it is 1.10 per 1,000). The contrast is most striking when considering the geographic variation during the Great Famine when excess mortality in the western district was closer to 60 per 1,000.

Figure 13 Excess Mortality 1879
a) Excess mortality



b) Age adjusted excess mortality



Note: Both panels use bands selected to highlight the distribution of excess deaths from 1877 to 1880. The lowest band have either negative excess mortality or no excess mortality. The remaining bands reflect four levels of severity, ranging from low to acute excess mortality.
Source: Author calculations. Shapefile from Gregory & Ell (2004).

The unions which had persistently high rates were found in the capital. When age adjusted, the South Dublin Union had the highest rate in 1879, this was a steady increase from 0.81 per 1,000 in 1877, to 3.12 per 1,000 in 1878, 8.28 per 1,000 in 1879, and 8.18 per 1,000 in 1880. The North Dublin Union saw a much more rapid increase in excess mortality from 1.72 per 1,000 in 1877, to 1.65 per 1,000 to 7.18 per 1,000 in 1879 and 9.58 per 1,000 in 1880. For comparison, during the Great Famine excess mortality was estimated at 0.7 per 1,000 in Dublin, so clearly something was happening in the city driving this excess mortality during the Land War.

To explore this further, we run regressions of excess mortality and the control variables outlined in Table 2 above (see Table A9 for summary statistics). The primary motivation for this regression is to see if our results are being driven by our underlying methodology, i.e. do places which had high pre-crisis mortality see lower excess mortality later. Results are presented in Table 5, we first see if the excess mortality is driven by our estimate of pre-crisis mortality ($\bar{M}_u$) as well as the ratio of census deaths to registration as a corrective for mismeasurement (column 1), we then then add basic poor law controls (column 20, then in column 3 we add registration dummies. Here, North-Eastern is used as a reference given the low excess mortality rate. In the first instance,

the pre-crisis average mortality rate is only marginally significant in model 2 and halved in size when district dummies are included. Population density is the most striking feature of these correlations, with higher population density a key driver of excess mortality. Notably district controls are negative, particularly Western and South-Eastern have large negative coefficients.

Table 5 Regressions of age standardisation in 1879

	(1)	(2)	(3)
$\bar{M}_u$	0.04	-0.13*	-0.07
	(0.078)	(0.076)	(0.100)
Census death: Registration	-1.54	-0.75	-1.70
	(1.724)	(1.625)	(1.713)
Population density		1.26	1.63**
		(0.782)	(0.755)
Valuation (£10,000)		0.01	-0.04
		(0.045)	(0.049)
Area (10000)		-0.01	0.01
		(0.031)	(0.032)
Eastern			-0.36
			(0.605)
North-Eastern		Reference	
North-Midland			0.05
			(0.576)
North-Western			-0.08
			(0.490)
South-Eastern			-1.16*
			(0.588)
South-Midland			0.03
			(0.444)
South-Western			-0.43
			(0.462)
Western			-1.13**
			(0.488)
Constant	3.13*	4.54**	5.14**
	(1.692)	(1.892)	(2.282)
Observations	163	163	163
R-squared	0.01	0.11	0.18

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

We further explore excess mortality by examining the geographical features of the crisis . In spatial data, as we presented above, explanatory variables may be geographically clustered. Therefore, a concern is that excess mortality may have been affected by general conditions in neighbouring Poor Law Unions (i.e. spillovers). Tests reveal some evidence of weak unconditional spatial autocorrelation (see Table A7 and Figure A10), this is explored further in Table 6.[50] Again, we look at age standardised excess mortality in 1879 and regress this on pre-crisis levels of mortality, spatial lags (trends in neighbouring Unions in 1879), temporal lags (excess mortality in the previous year), as well as a temporal spatial lag (trends in neighbouring unions in previous

[50] See Table A10 for analysis of the years 1878 and 1880.

years). We incorporate temporal lags here to assess whether the previous years experience of crisis persisted into the following year. Column 1 presents a simple spatial lag model and a lag of excess mortality in 1878. While the spatial lag term is not statistically significant, there is a persistent temporal lag. This implies that trends from the previous years influenced the current mortality trends, but again this effect is modest. Given the existence of a temporal lag, the regressions also include temporal lags of the spatial lags to assess whether crisis in the previous years are spilling over into the current years. Again, these are not statistically significant. What does, however, appear to be an important consideration is population density (column 2). Including district level controls (column 3) does not change this story and population density is an important variable and key to understanding the nature of the crisis which appears to have been most acute in towns and cities.[51]

Table 6 Temporal and Spatial regressions of 1879 age standardised excess mortality

	(1)	(2)	(3)
$\bar{M}_u$	0.01	-0.16**	0.01
	(0.045)	(0.068)	(0.079)
Spatial lag Age standardised excess	0.36	0.23	0.23
	(0.236)	(0.200)	(0.167)
Age standardised excess mortality (t-1)	0.26***	0.29***	0.42***
	(0.070)	(0.065)	(0.071)
Spatial lag Age standardised excess (t-1)	-0.27	-0.17	-0.06
	(0.246)	(0.220)	(0.196)
Population density		1.29**	1.34**
		(0.539)	(0.536)
Valuation (£10,000s)		0.01	-0.05
		(0.043)	(0.045)
Area (10,000 acres)		-0.02	-0.02
		(0.032)	(0.032)
Under reporting from 1871 census	-0.81	-0.05	-1.57
	(1.534)	(1.445)	(1.437)
Constant	2.06	3.79**	3.82**
	(1.684)	(1.759)	(1.806)
Observations	163	163	163
Wald chi2	18.14	43.55	79.23
Psuedo R2	0.0909	0.2089	0.316
Wald test of spatial terms	2.36	1.27	1.88
District Controls	N	N	Y

Standard errors in parentheses, *** p<0.01, ** p<0.05, * p<0.1

[51] Similar results are found when repeating the analysis using arbitrary clustering along the lines of Colella et al. (2019). 'Inference with arbitrary clustering' (see Table A8).

6 Public health crisis or statistical mirage?

Given the supposed uncertainty surrounding the reliability of vital registration in this period, how likely is it that these estimates of excess mortality are real or are they statistical artefacts? Using the ratio of the registered deaths and the census deaths (see figure 4) we adjust all reported deaths in each year. This ratio is only for total deaths, but we assume the mismeasurement is consistent across age bands. For Dublin, the main concern was under reporting. This was estimated to be around ten per cent for both unions but the under registration, relative to the census survey of deaths, was more of an issue for the North Dublin Union than the South Dublin Union. However, it is believed that by 1879 there is a more complete registration of deaths in Dublin, therefore we do not adjust the 1879 and 1880 figures but do adjust all figures in the years preceding to increase the reported deaths; that is we assume there are more deaths than were recorded in Dublin in the years 1871 to 1878, but that the registration of deaths in 1879 and 1880 is complete.

The result of this adjustment exercise is presented in Table 7. This table is best read in comparison to Table 3 as both tables have the same denominator (the estimated population from 1871-81). While the mean and standard deviations reported in both Table 3 and 7 are similar, there are differences in the distribution and the rank order. Gone from Table 7 are the Dublin Unions, replaced by Roscommon and Waterford. This is not to say the Dublin excess mortality is gone, but the adjustment lowers the level of excess mortality to 3.48 and 5.88 per 1,000 in Dublin North and 6.48 and 6.37 per 1,000 in Dublin South in the years 1879 and 1880 respectively. This is also likely an underestimate because the adjustment procedure assumed that death registration was complete in 1879 and 1880 when in reality it might have continued to have been underestimated but not as much as had been the case before.

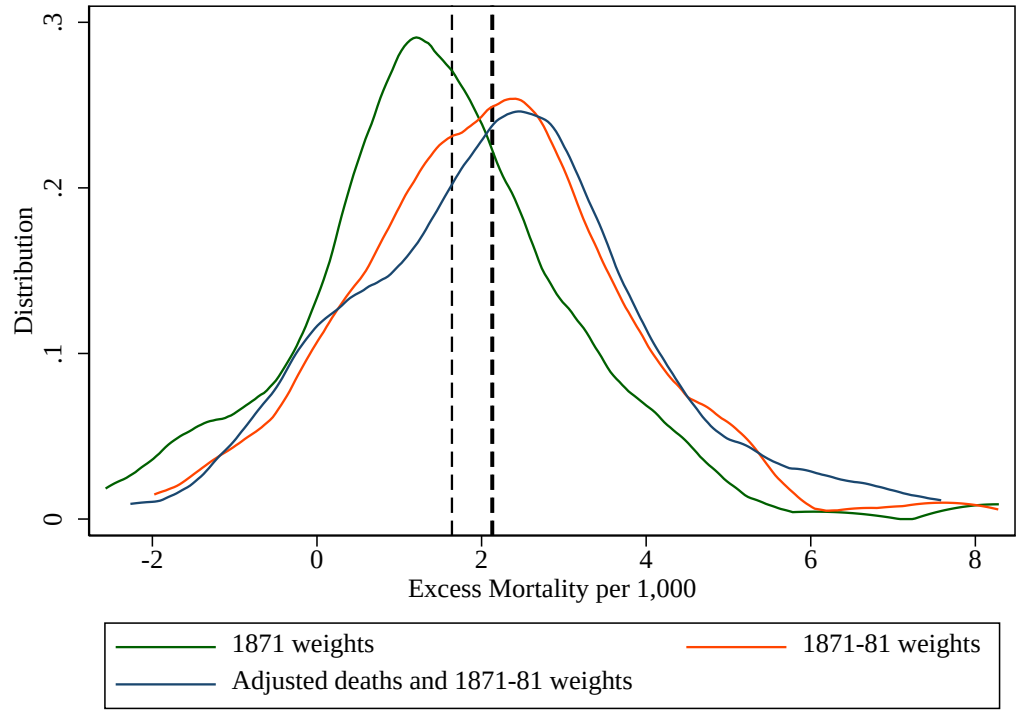
Table 7 Descriptive statistics of excess mortality after adjusting for over/under reporting of deaths

Year	Mean	Std. Dev.	Min	Max	Best Union	Worst Union
Excess Mortality rates per 1,000						
1877	0.11	1.56	-5.23	4.04	Castletown (Cork)	Urlingford
1878	1.37	1.99	-4.37	7.59	Killala	Lismore
1879	2.26	1.79	-2.27	7.59	Killala	Corrofin
1880	1.62	1.93	-2.95	6.60	Gort	Waterford
Age adjusted excess mortality per 1,000						
1877	0.15	1.46	-4.89	4.16	Castletown (Cork)_	Urlingford
1878	1.35	1.87	-3.80	7.45	Killala	Lismore
1879	2.12	1.63	-1.98	6.92	Balrothery	Roscommon
1880	1.59	1.90	-2.89	6.64	Gort	Waterford

Figure 14 highlights the differences in the distribution of the different estimation approaches utilised, one with constant 1871 weights, second with 1871-81 weights, and lastly with death registration adjustments and 1871-81 population weights. The major distinction relates to the

chosen denominator with an 1871 weighted excess mortality noticeably lower than the 1871-81 weighted estimates.

Figure 14: Distribution of age adjusted excess mortality by Poor Law Unions in 1879 by estimation approach



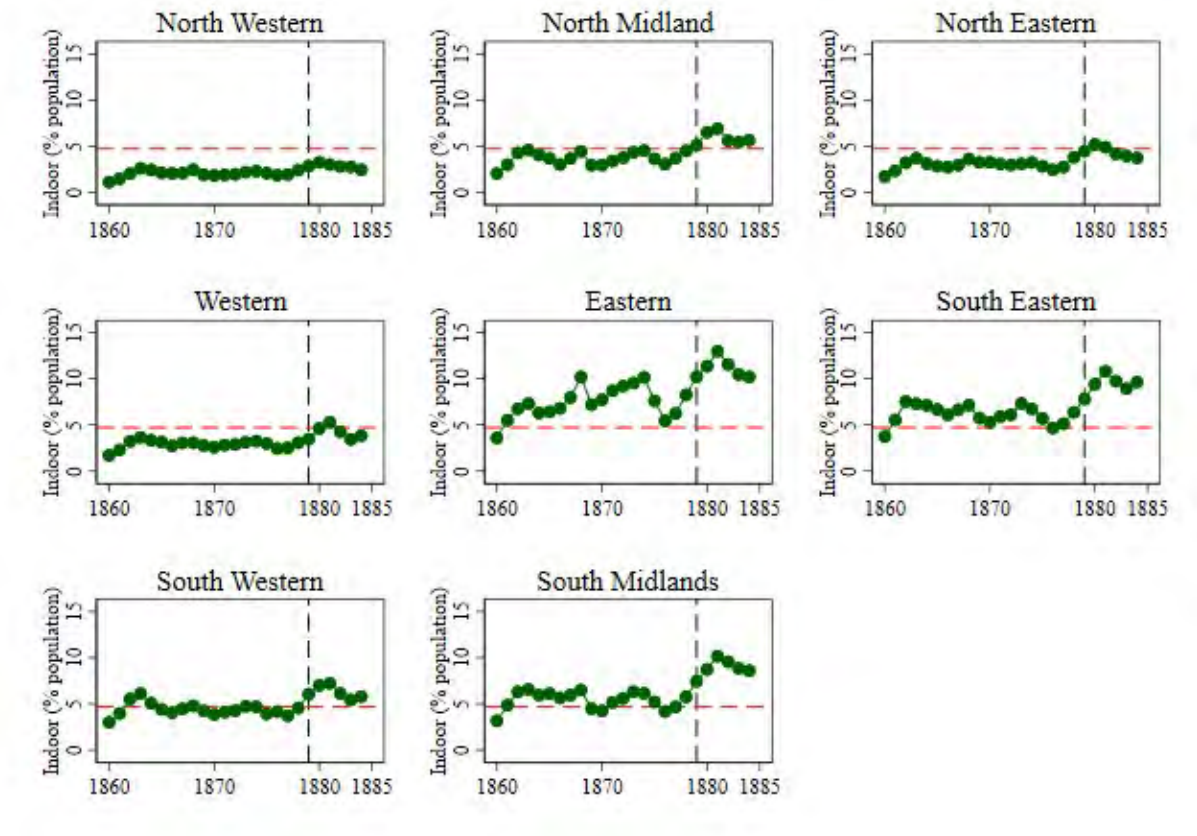
Note: Kernal distribution. Dashed vertical lines represent the mean from the samples.

6.1 Poor Law corroboration?

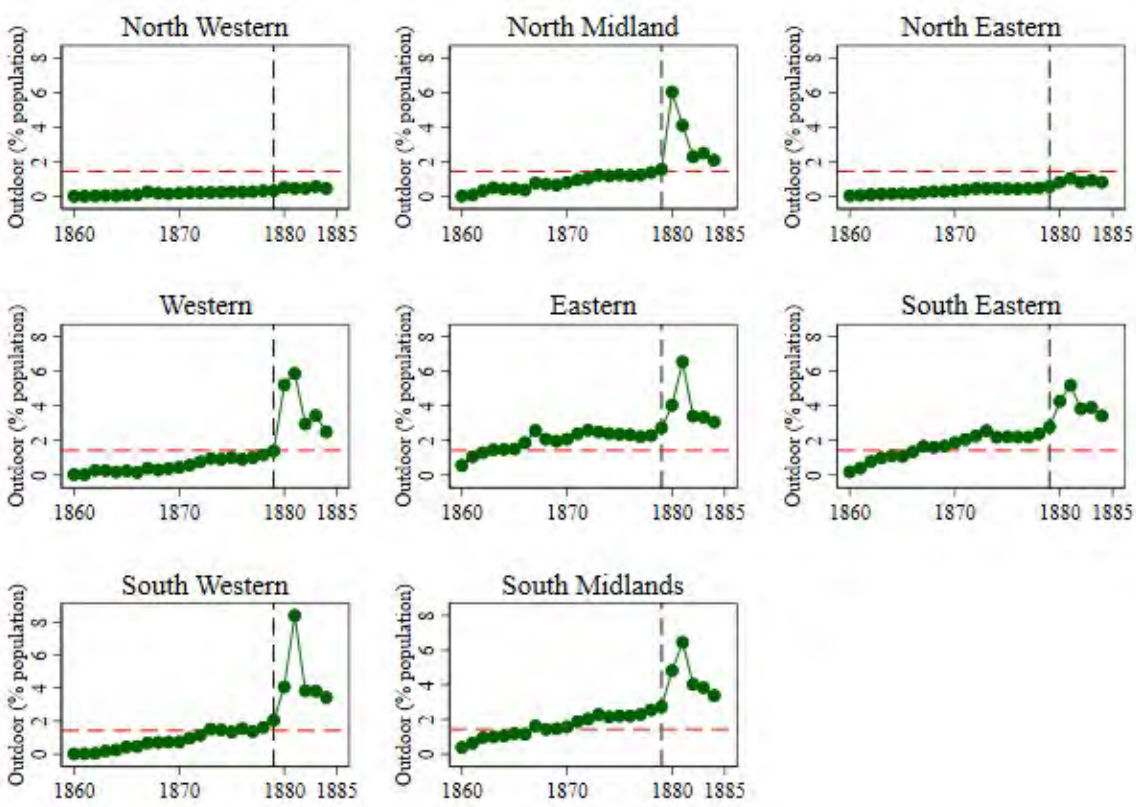
We utilise another source of information to assess excess mortality rates: poor law reports. Annual poor law reports provide information on usage of the poor law by union. This relief was comprised of either indoor – whereby those seeking relief were required to go inside the workhouse to receive food rations and/or clothing – or outdoor relief (where food rations were distributed externally). Indoor poor relief as a share of population is highlighted in Figure 15 panel a. While the figures do not show mortality, they show trends of usage of the workhouse relief system. These figures are unweighted means reported by the registration districts. The horizontal line in the figure represents the national average indoor relief as a share of population. From this it is clear that Eastern, South-Eastern, and South Midlands districts had a higher share of the population receiving indoor relief in the crisis years. In terms of outdoor relief, Figure 15 panel b shows that this was both a smaller share of the population in receipt of this form of relief but also that it too

showed an increase in the crisis years, with some large increases seen in the North Midlands and South-Western.

Figure 15 Poor relief per person, 1860-1885
Panel a indoor relief as a share of population, 1860-1885



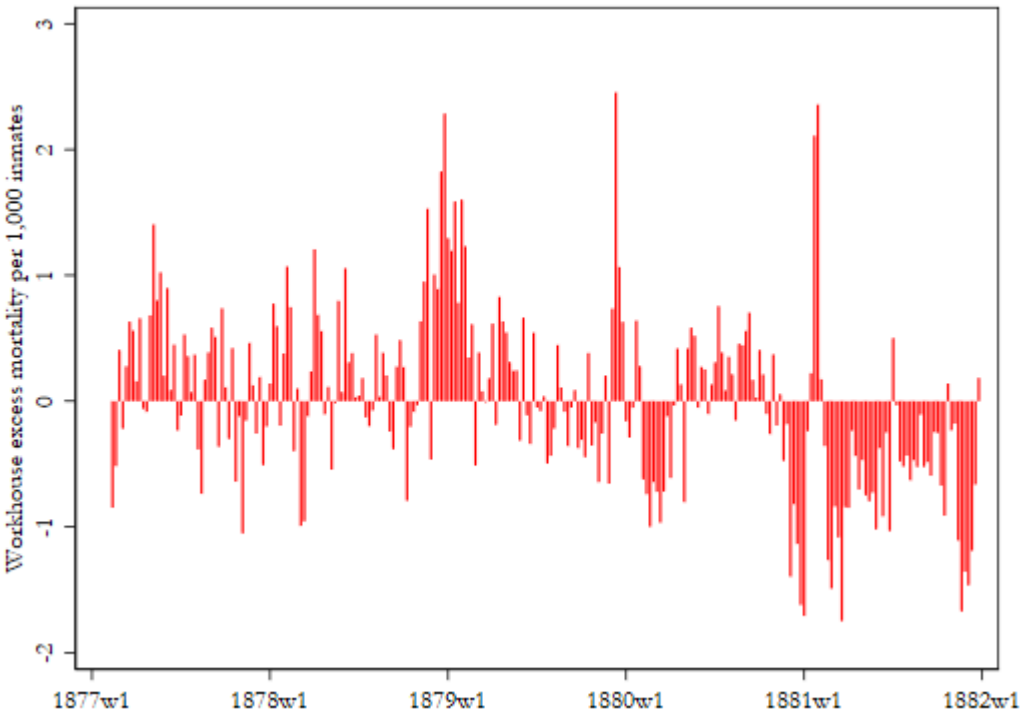
Panel b outdoor relief as a share of population



Sources: Outdoor and Indoor relief from Laragy, G., et al. 'Welfare Regimes'; Population from Crawford et al. 'Database'.

The annual reports of the Local Government Board also provided information on the weekly workhouse population (shown in Figure A7) and included information on deaths in the workhouse. The workhouse tended to be used by the elderly population and there were deaths consistently recorded in these reports. The workhouse population steadily increased during the period of crisis before falling thereafter. As the weekly workhouse population increased, so did the number of workhouse recorded deaths. In the years pre-Land War crisis the annual total number of deaths in the workhouse across the island was 11,123, in 1877 the total number of deaths in the workhouse was 11,018, this increased to 12,431 in 1878, 13,243 in 1879, and fell in 1880 to 12,972. The excess deaths in the workhouse are illustrated in Figure 16 which compares the workhouse death rate, expressed as a share of the workhouse population, with the preceding 5 years. The workhouse recorded deaths corroborate the story presented above that the years 1877-80 were crisis years in terms of excess mortality.

Figure 16 Excess Workhouse Deaths, 1877w7-1881week52 (per 1,000 workhouse population)



Sources: *Local Government Board for Ireland*, 1870-1881.

We further utilise some Dublin-specific sources of information. The *Weekly Returns of Births and Deaths in Dublin* provide weekly (and annual) information and commentary on deaths registered in the city. In 1878 it was reported that the annual death rate in Dublin was 29.5 per 1,000, while in 1879 the reported annual deaths had increased to 35.7 per 1,000; 36.9 on the North of the city and 38 in the South of the city.[52] These figures were compared unfavourably with 23 per 1,000 in London and 23.4 per 1,000 in Glasgow in 1878; similar figures reported for both cities in 1879 (23.6 per 1,000 and 22.1). Weekly returns for Dublin city are presented in Figure 17. Given the discussion surrounding the incomplete registration of deaths in Dublin (see above), where figures were ten per cent lower pre-1878, an adjusted series of excess mortality which increases the pre-1878 deaths by 10 percent is also presented. This adjustment makes little meaningful difference to the analysis of the trend. This fact was also noted by the weekly registration in the Dublin District, which noted that an annual figure for 1879, even if deducted by ten percent to make it comparable

[52] The corresponding figures for other Irish cities in 1878 were: Belfast 28 per 1,000, 32 per 1,000 in Waterford, and 27 per 1,000 in Cork and Limerick respectively. In 1879 the figures had also increased in these cities to: Belfast 31 per 1,000, 25 per 1,000 in Waterford, and 29 per 1,000 in Cork and 31 per 1,000 in Limerick. Figures were given for Galway and Sligo towns in 1879, these were 26 and 21 per 1,000 respectively.

with previous years, 'represents a higher rate of mortality than had ever before been experienced in Dublin since death registration commenced in the year 1864'.[53]

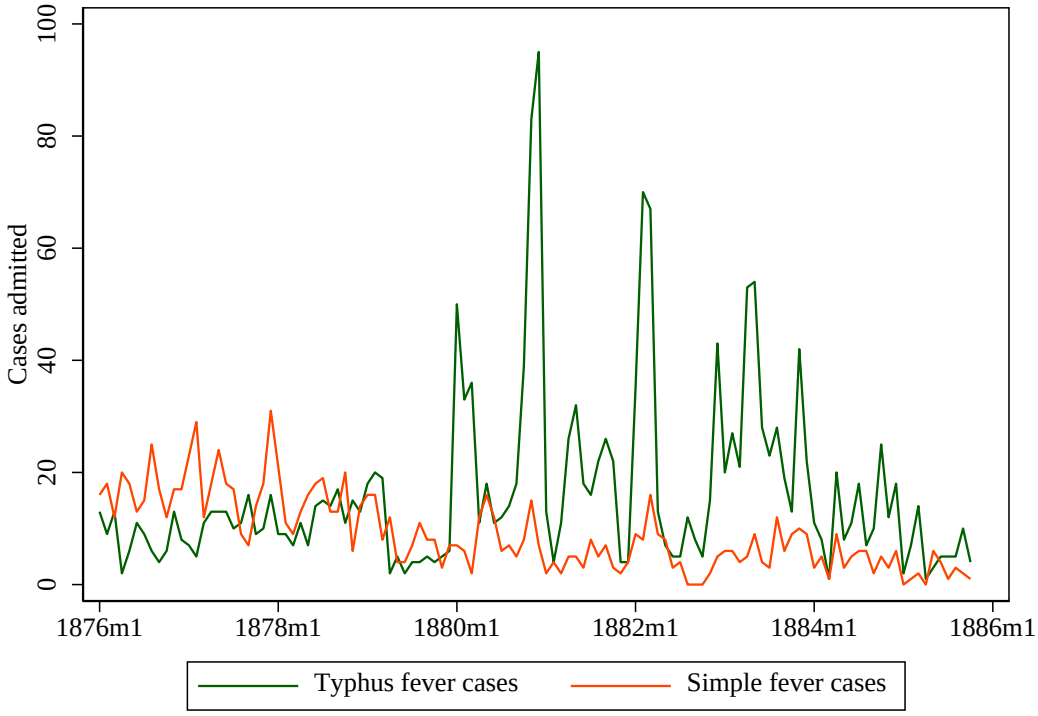
Figure 17 Weekly Excess Deaths registered in Dublin, 1877-1880

Note: Excess deaths compare recorded deaths in each year(t)week(w), from 1877w1 to 1880w52, with the same week averaged over the previous 10 year period (1866-1876). For the adjusted series, the average series for the years 1866-1876 is increased by 10 percent.

Lastly, some further corroborating evidence comes from the Cork Street Fever Hospital in Dublin, which received an increase in admissions in 1880. In King's history of typhus fever in Ireland, the 1880s were the first time since the Great Famine that there had been a major typhus epidemic. King attributed the rise in cases in 1880 to the effects of the land war with the rise in evictions and an 'ill-nourished population moving from town to town in an unsuccessful search for work or a new place in which to settle.'[54] The concentration of people in workhouses and other institutions undoubtedly facilitated the spread of such communicable diseases.

[53] Yearly Summary of the Weekly Returns of Births and Deaths in Dublin, 1879.
[54] King, 'The epidemiology of typhus fever in Ireland'.

Figure 18 Monthly Fever cases at the Cork Street Fever Hospital in Dublin, 1876 to 1885



7 Contemporary Understandings of the crisis.

Singular explanations for the increasing excess mortality in these years are not readily identifiable, but different contemporary observers provided a range of perspectives. The Land League declared the crisis was an inevitable result of high rents, evictions, and the systemic failures of landlordism, which impacted the west of Ireland the most. For the Land League leader Michael Davitt, Mayo 'had suffered more from the manifold evils of the landlord system than any other Irish county', so it was no surprise that it 'possessed a greater number of people on the border-line of starvation'.[55] Through primarily focusing on the rural west, the Land League was blinded to island wide dimensions of the crisis. Anna Parnell, leader of the Ladies' Land League, saw a cruel coincidence of factors behind the crisis: 'a downright bad harvest, the sudden fall in prices, and the great falling off in the contributions from the self-sacrificing young people who were working themselves to death in America to keep their relations at home alive, all happening at the same time, swept away the living margin of the majority of the tenants'.[56] In 1878 the *Freeman's Journal* observed that 'for the last couple of years emigration has been more than balanced by immigration'.[57] George

[55] Davitt, *Fall of Feudalism*, p. 144.
[56] Parnell, *Tale of a Great Sham*, pp. 49-50.
[57] *Freeman's Journal*, 2 July 1878.

Sigerson, a physician who investigated distress, believed that 'The depression of trade in America and Britain, lessening the demand for labour, deprived [rural western communities] of much assistance from wage-earning kinsfolk'.[58] For many contemporary observers, Ireland experienced a perfect storm in the late-1870s.

The Registrar General himself, Thomas W. Grimshaw, sought to downplay the sharp rise in mortality. He maintained that 'much of this increase' was due to the 'improved registration' of deaths following the 1878 Public Health Act, an explanation that was repeated in parliament by the Chief Secretary for Ireland, and which has featured in subsequent scholarship.[59] Yet this is an unsatisfactory explanation for the reasons we have already outlined. The previous Registrar General, William Malachy Burke, who died in August 1879, advanced another argument, that the rising deaths in 1879 were 'chiefly attributable to the inclement weather in the earlier months of the year'.[60] Globally, 1877-78 was a strong El Niño which affected weather patterns globally. Looking at Irish meteorological returns, late 1878 and the first half of 1879 stand out as being exceptionally cold. It was observed by J. W. Moore that November 1878 was the coldest November observed since 1807 and was 6 degrees Fahrenheit below the average for the preceding twelve years. December 1878 'was also an inclement month' with snow on the ground from the 8-27 of the month. This pattern continued into the early months of 1879.[61] These weather fluctuations also make an unfavorable comparison with modern averages for these months, making this period stand out in historical context – see Figure A8 and Figure A9.[62]

The series of bad harvests that resulted from the climatic volatility of 1877-79 increased malnourishment in the population and made many groups, particularly older people, more susceptible to serious illness and death. This explanation is familiar for the west of Ireland, but excess mortality rates indicate that it must be considered across the island. While the crisis has been understood in a rural context, it also reached into urban areas that were dependent on the agricultural economy, affecting access to food and fuel, and increasing the circulation of infectious diseases in multiple locations. The annual registration reports from these years reveal a variety of causes of death throughout Ireland, including upturns in zymotic and enteric diseases, respiratory illnesses, and localized outbreaks of smallpox and measles. Yet the categories of illness referred to

[58] 1881 MHC Report, p. 42.
[59] *Seventeenth Annual Report*, 14; *Sixteenth*, 15; Hansard, HC Debate 11 June 1880, Vol. 252, c. 1758. Mary Daly, *Dublin*, p. 242.
[60] *Sixteenth Report*, 15.
[61] Meteorological Observations, *Agricultural Statistics of Ireland for the year 1879*, pp 15-16.
[62] Historical climate observations can be affected by selection bias, as indicated by Murphy et al. The meteorological observations are for Dublin and measurements were taken at 40 Fitzwilliam-Square, Dublin. Comparison between the 1870s and modern periods therefore must not be taken with this caveat in mind. Murphy et al., 'Multi-century trends to wetter winters and drier summers in the England and Wales precipitation series explained by observational and sampling bias in early records.' .

are often ambiguous or 'catch-all', complicating the picture of what precise illnesses led to high excess mortality.

Some of the more detailed reporting on the crisis was compiled by the Mansion House Committee, a relief body established in 1879 by Edmund Dwyer Gray MP, the nationalist Lord Mayor of Dublin and proprietor of the daily *Freeman's Journal*. The committee raised over £180,000. In 1880 they published a report by doctors George Sigerson and Joseph Kenny (and republished with additional details in 1881), that largely focussed on the west, particularly Mayo and Galway. This report, as Cecil Woodham-Smith observed in her classic study of the Great Famine, used 'words that might have been written in 1846'.[63] Sigerson strongly linked the spread of disease to malnutrition, arguing 'that fever would supervene upon starvation'.[64] Reports of 'famine fever' resonated deeply with memories of the Great Famine, with the Mansion House Committee maintaining that 'when we recall the ravages caused by it in 1847, this manifestation of the disease naturally gives rise to the most grave apprehensions'.[65] Sigerson claimed government officials were hesitant to use the term 'famine fever' and they sought to downplay the spread of disease and its causes by maintaining 'it was merely an outbreak of typhus' that had 'no relationship to the prevailing distress'. Regardless of the label used, Sigerson stressed, illnesses that included typhus, typhoid fever and enteric fever were killing people and were the direct consequences of 'deficient alimentation'.[66] Fever hit women harder in his view: when adult men left to seek employment elsewhere, 'the mothers have to work at agricultural labour, with debilitated constitutions'. He also noted that 'large numbers of children and young people' were ill.[67]

The relationship between malnutrition and disease featured strongly in other contemporary reports. J. A. Fox noted thousands of people 'on the verge of starvation' in Mayo, with high rates of typhus there.[68] The English philanthropist James Hack Tuke, who toured the west and north-west in 1880 recorded how locals in Donegal recounted how 'the potatoes were gone, and but for the "Relief Funds" many would be starving'. Fox similarly emphasised the importance of relief in saving lives. Fever was noticeably prevalent among those receiving this relief, but they were not dying of starvation. Alongside the spread of Typhus, dependence on 'Indian' meal or maize may have led to the spread of Pellagra, a vitamin-deficiency disease, which had some similar symptoms to Typhus. [69] These contemporary reports focused on the west and north west, but they

[63] Woodham-Smith, *The Great Hunger*, p. 407
[64] Sigerson and Kenny, *Report of the Medical Commission of the Mansion House Committee*, p. 1.
[65] Sigerson and Kenny, *Report of the Medical Commission of the Mansion House Committee*, p. 2.
[66] Ibid, pp. 9-11, 41.
[67] MHC Report 1881, pp. 46-47.
[68] Fox, *Reports on the Condition of the Peasantry of the County of Mayo During the Famine Crisis of 1880* , p. 14.
[69] Tuke, *Irish Distress and Its Remedies: The Land Question*, p. 5; Fox, *Reports on the Condition of the Peasantry,* p. 24; MHC Report 1881, pp. 7, 44; Crawford, 'Indian Meal and Pellagra', pp. 128-9.

occasionally indicated distress in other regions. Initial reports of fever arrived from Munster. As the 'fever epidemic' spread, it claimed fatalities among two doctors in Cork, as well as two in Galway.[70] Aside from disease, death from starvation also occurred, adding to the sense of extant famine. Reports from Castletownbere, Co. Cork, recounted that 'several farmers were starving, and others trying to eke out life on garbage'.[71] In New Pallas, Tipperary, the Board of Guardians received a report from a local doctor in February 1880 that 'whole families were in actual starvation', and that a 'young man aged 21, died of starvation…The poor fellow was on a bed in a dark cabin, with a cup of water beside him. He had no clothes on him.' In the same month, three other cases of starvation were reported from Tipperary and Galway.[72]

Detailed contemporary investigations of the crisis focussed on the west, yet the pain was felt more collectively in Ireland, with the highest excess mortality rates outside of that region. There is a lack of sources for other regions, urban areas in particular, but it seems likely that the relationship between malnourishment, unusually bad weather, and the spread of disease that contemporaries observed in the west can be applied to the island more broadly to understanding the sharp rise in mortality. That the worst areas were found in the east, particularly Dublin, are suggestive of the effectiveness of the humanitarian relief that was primarily directed towards western regions. However, because of contemporary understandings, official and unofficial, that the crisis was confined to the west, the lack of public and private relief efforts in other regions may have contributed to higher mortality.

8 Conclusion

The lens of excess mortality allows us to rethink an important period of Irish history. While the attention of scholars in recent times has been on high profile pandemics such as the 1918-19 Spanish flu, the evidence presented here shows that the public health crisis associated with the Land War, when measured by excess mortality, was the worst in modern Irish history since registration began. Comparison of excess mortality in 1879, the worst Land War year, with the 1918-19 and the Covid-19 pandemic show that there was a distinctly different age profile of excess mortality during the land war with higher excess mortality in the under 5's and over 65s than the other more high profile pandemics (Figure 1).[73] In fact, excess mortality during the Covid-19 pandemic was negative (total mortality in 2020 and 2021 was lower than in the previous 5 years) which may be attributed to the widespread use of mitigation measures.

[70] *MHC Report* 1881, p. 1.
[71] *Report of the Medical Commission of the Mansion House Committee* (Dublin, 1881), p. 1.
[72] *MHC Report* 1881, p. 4.
[73] In the 1918-19 pandemic the 25-35 age cohort were unusually the hardest hit. Milne, *Stacking the Coffins*.

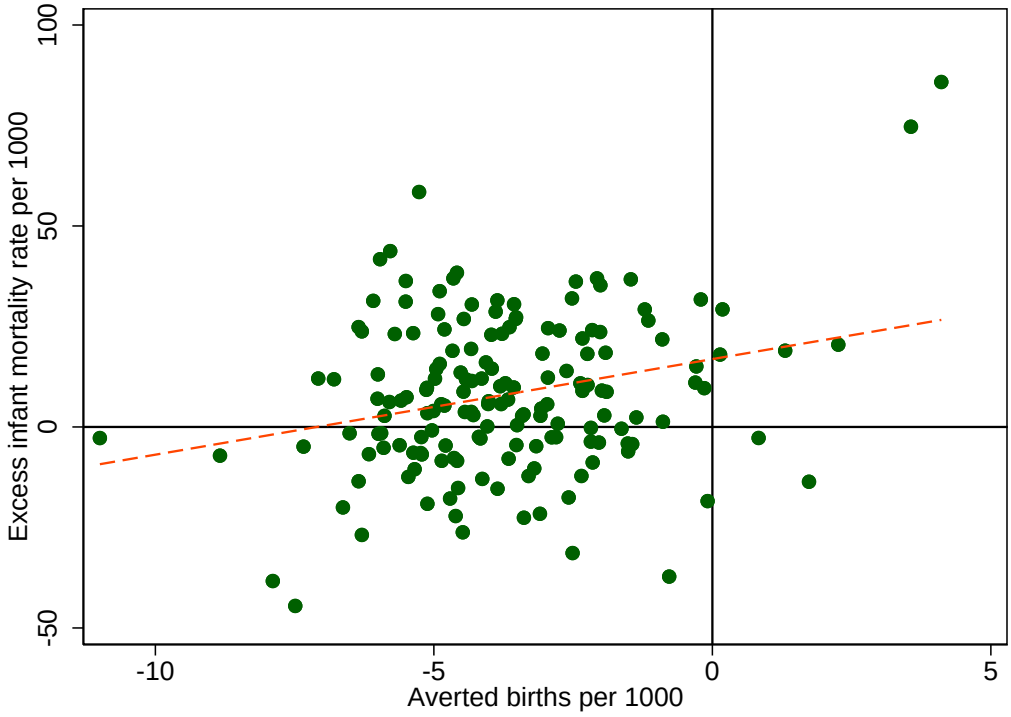
Contemporary officials downplayed the extent of the crisis. This can perhaps be explained as a deflection tactic, denying the extent of the crisis and casting doubt on the newly introduced registration of vital statistics could reduce the need for government action. The efforts to obfuscate the extent of the crisis has cast doubts about the reliability of the underlying source material, the Registrar General Reports. While these reports are clearly not 100 percent accurate, they are at the worst 90 percent accurate and closer to 95 percent in most cases. Discarding the source material as unreliable effectively meant throwing the baby out with the bathwater and blinded scholars to an obvious crisis that was hidden in plain sight. For example, while Kennedy and Clarkson were quick to dismiss Irish mortality trends as being afflicted by 'less efficient' registration, the means to correct for this perceived inefficiency bias was available to researchers who availed of the census death survey.

The Land War was the most notable event since the advent of vital registration on the island of Ireland (from 1864-2022). Being in the shadow of one of the worst tragedies in Irish history therefore hid what was the worst public health crisis in post-Famine Irish history. Seen in this light, the term 'Land War' and periodisation of 1879-1882 are ill-fitting because they emphasise a political timeline and mask the severity of a public health crisis that was most intense from 1878-1880. With a mean excess mortality rate of 0.2 per cent in 1879, this places the Land War excess mortality rates in a similar league as late twentieth century famines such as Ethiopia (1972-73, 0.2 per cent) and Bangladesh (1974-75, 0.5 per cent), rather than contemporaneous famines in China (1877-79, 3 per cent) and India (1876-79, 2 per cent).[74]

A final note relates to the concept of excess mortality used in this study and those used in studies of the Great Famine. One aspect of excess mortality that is not dwelt on here, but which is undoubtedly important is the issue of 'averted births', when birth rates fall as a consequence of the crisis (Figure 19). Figures of averted births are sometimes included in the 1845-52 excess mortality estimates. Future work can attempt to tease this issue out, for example the rising infant mortality rates seen in the period is partly a reflection of the rising infant mortality and falling infant births.

[74] Ibid, table 3.

Figure 19 Excess infant mortality rate and averted births



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Appendix

Appendix 1: Accuracy of birth registration

There has been greater scrutiny of birth registration than of death registration. This is evident in two prominent articles published in the *Economic History Review*.[75] In contrast to death registration, Cousens concluded that births were over registered as 'it was possible for him [the local registrar] to add to his stipend by making fictitious entries' highlighting the particular case of Castlebar.[76] Walsh, in his study of births and fertility, compared the registered county births with the 1871 census and found 'considerable inaccuracies in the registration data for 1871 and 1911', in particular Walsh highlighted the over-registration of births at the county level, and referred back to Cousens' cynical observations vis-à-vis supplementing stipends with fictitious entries.[77]

A comparison between registration and the census can illuminate this issue. The census contains information on the population under 1 years of age at the time it was conducted, on 2 April 1871. Therefore, the number of registered births in the previous year, minus those under 1 that died, should, in principle, be an approximate match for the census figures. While a clean comparison would be ideal, the challenge is that the registrations only report age by death annually, making it difficult to account for infant mortality that occurs in the first quarter of the year to April. Figure A1 below compares registered births and deaths of those under 1, in 1870 and 1871, against the 1871 census number of the population under one years of age. It also compiles an

[75] For later critical scrutiny, see Coward, 'Birth under-registration in the Republic of Ireland during the twentieth century' and de Bromhead et al., '175 Years of Mismeasuring Ireland?'.
[76] Cousens, 'The Regional Variations', p. 305.
[77] Walsh, 'Marriage Rates and Population Pressure'.

estimate of the registration of births and infant deaths for the last three quarters of 1870 and the first quarter of 1871 and compares this with the 1871 census. This is the most realistic scenario in terms of overlap, but the estimation assumes infant deaths occur at the same quarterly frequency as all mortality. As can be seen in Figure A1, the figures are skewed by a few outliers. This is highlighted again in Table A1, which compares the mean ratio across different sub-samples. For all Poor Law Unions, the mean ratio is 1.035 implying there is only a 4% discrepancy between registration and the census. Restricting the sample to those Unions between +/- 10% shows that 145 were within this range and the mean is 1.025, and 76 unions were between +/- 5%. On the upper end, only 5 unions had ratio over 15%, the highest was Ballymahon at 17% over, and on the lower end, only one union, Dublin South, had a ratio below 10%. Overall this shows a remarkable degree of accuracy of the registration figures.

This is a drastically different picture to that presented by Walsh, who compared county births in 1870 with the 1871 Census enumerated infants.[78] Walsh found an average ratio of 1.120, with a higher standard deviation, across thirty two counties with the ratio ranging from 0.738 in Westmeath to 1.450 in Longford. While Walsh discussed biases from not accounting for infant mortality, his figures did not adjust for infant deaths during 1870 making the difference between registration and census reporting appear more severe than they would with a more careful analysis. Including infant deaths from 1870 reduces the mean ratio of registration to census births from Walsh's reported 1.12 to 1.01. Establishing these figures at the poor law level reveals both lower variation and a lower mean from those estimated by Walsh. While the figures still indicate some over-reporting of births, overall the problem does not appear to be anything as drastic as has been implied.

[78] Walsh, 'Marriage Rates and Population Pressure', Table 3.

Figure A1: Comparison of Registration of Births (1870, 1871, & 1870-71) to 1871 Census enumeration

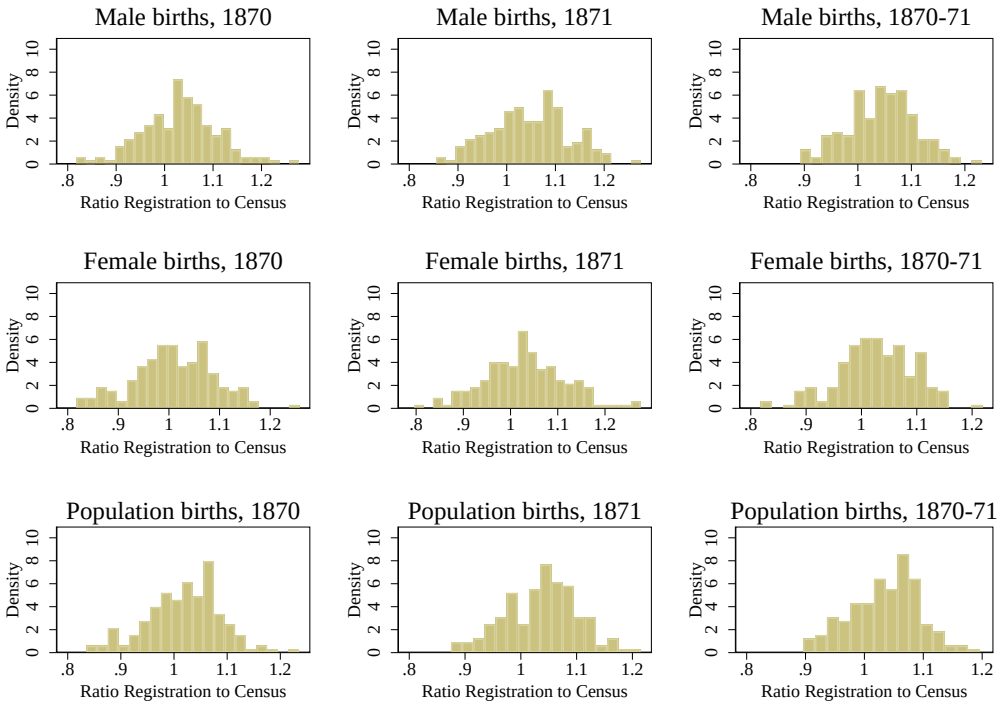


Figure A2: Registration of Births to 1871 Census enumeration

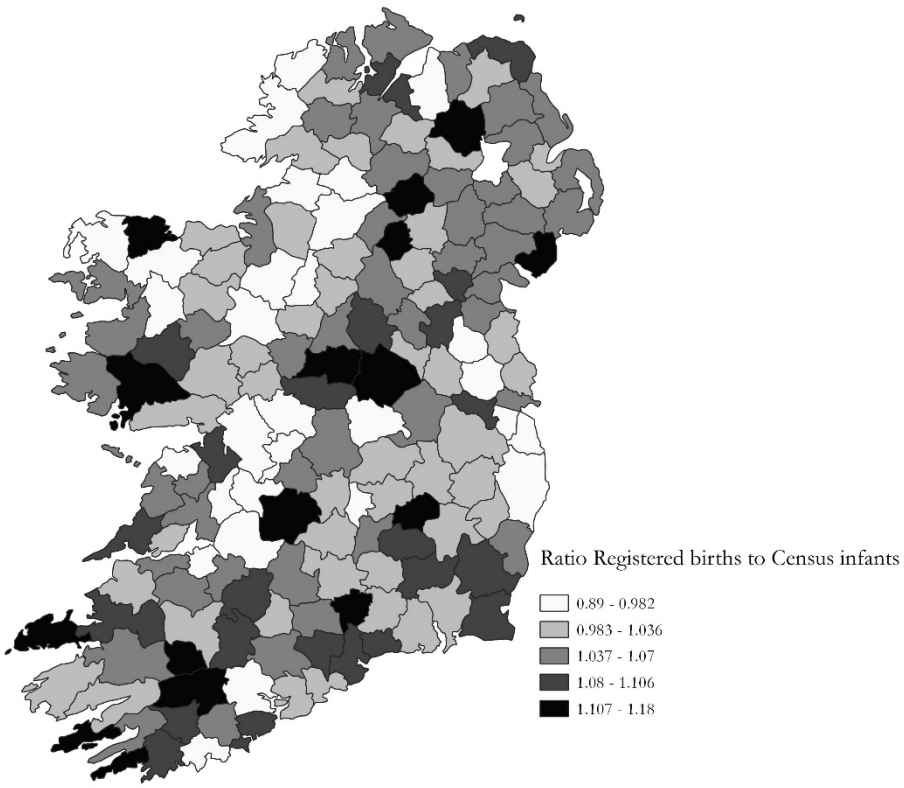


Table A1 Comparison of the Ratio of Birth Registration (1870-71) to 1871 Census enumeration

	Number of unions	Mean	Standard Deviation	Minimum	Maximum
All Unions	163	1.035	0.058	0.896	1.177
Unions with ratio +/- 10%	145	1.025	0.049	0.903	1.097
Unions over 10%	17	1.131	0.023	1.103	1.177
Unions over 15%	4	1.167	0.100	1.154	1.177
Unions under 10%	1	0.896	-	0.896	0.896
Counties (Walsh 1972)	32	1.120	0.168	0.738	1.450
Counties (1870 births minus 1870 infant deaths)	32	1.013	0.149	0.675	1.327

Given the discussion of registration, a pertinent question is whether the identified reporting issues are systematic across Poor Law Unions. Figure 5 examines this by comparing the ratio of death registration/census to birth registration/census, this indicates some weak correlation between both. Table A2 explores this more systematically by regressing these ratios on each other and including the registration district controls with controls for poor law area, population, and valuation controls, as well as controls for the outliers in death and birth registrations. We see that the biases in recording of births are correlated with the misreporting of deaths and vice versa. We also see some district over-reporting of deaths in the North-Eastern by 5% but there is no systematic misreporting across all districts. While for births, these are overestimated in North-Eastern by 4%, in South-Eastern and South-Western by 5%. Controlling for outlying districts for births and deaths has no effect on the death registration/census ratio, but outlier birth registration districts have a much more sizeable impact on the birth registration/census ratio.

Table A2 Regression of Registered Deaths/Census and Registered Births/Census

	(1)		(2)	
	Deaths		Births	
Population density	-0.02	-0.03	0.01	0.02
	(0.029)	(0.031)	(0.025)	(0.025)
Area	-0.00	-0.00	0.00	0.00
	(0.000)	(0.000)	(0.000)	(0.000)
Poor Law Valuation £	-0.0003	0.001	-0.003*	-0.003*
	(0.002)	(0.002)	(0.002)	(0.001)
Poor Law Valuation £ (10,000)	-0.02	-0.03	0.01	0.02
	(0.029)	(0.031)	(0.025)	(0.025)
Birth Registration/Census		0.01***		
		(0.002)		
Death Registration/Census				0.002***
				(0.000)
	Registration Districts			
Eastern	Reference			
North-Eastern	0.09***	0.05**	0.06***	0.05***
	(0.020)	(0.023)	(0.014)	(0.014)
North Midland	0.04*	0.03	0.02	0.01
	(0.026)	(0.027)	(0.017)	(0.017)
North Western	-0.01	-0.01	-0.01	-0.01
	(0.035)	(0.033)	(0.019)	(0.017)
South Midland	0.02	0.01	0.02	0.02
	(0.028)	(0.024)	(0.017)	(0.015)

South-Eastern	0.02	-0.01	0.05***	0.05***
	(0.027)	(0.025)	(0.013)	(0.012)
South-Western	0.05**	0.02	0.06***	0.05***
	(0.024)	(0.023)	(0.014)	(0.014)
Western	0.01	0.01	-0.01	-0.01
	(0.031)	(0.030)	(0.018)	(0.018)
Death registration/census outliers	-0.01	0.00	-0.02	-0.02
	(0.026)	(0.026)	(0.012)	(0.011)
Birth registration/census outliers	0.00	-0.04	0.08***	0.08***
	(0.061)	(0.065)	(0.024)	(0.027)
Constant	0.99***	0.40**	1.02***	0.86***
	(0.026)	(0.189)	(0.016)	(0.049)
Observations	163	163	163	163
R-squared	0.11	0.19	0.32	0.38

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

Appendix 2: Supplementary Tables and Figures

Table A3: Excess mortality trends in Ireland, England & Wales, and Scotland, 1864-2021

	Ireland	England & Wales	Scotland
1864-2021			
Mean	-0.37	0.47	-0.41
Min	-2.50	-2.57	-2.36
Max	2.37	3.04	1.68
Structural break	1901	1929	1927
Annus horribilis	1879	1918	1940
Pre-1901			
Mean	0.22	-0.860	-0.810
Min	-1.54	-2.57	-2.36
Max	2.37	1.06	1.51
Annus horribilis	1879	1891	1891
1902-1950			
Mean	-0.57	-0.64	-0.59
Min	-2.50	-2.47	-2.26
Max	1.40	3.04	1.68
Annus horribilis	1918	1918	1940
1951-2021			
Mean	-0.47	-0.21	-0.15
Min	-1.90	-0.99	-1.4
Max	0.41	1.25	1.29
Annus horribilis	2020	2020	2020

Table A4: Death rate per 1000 by province

Year	Total Deaths	Leinster	Munster	Connacht	Ulster
1874	91,961	19.2	16.6	13.3	17.3
1875	98,114	20.7	17.9	14.6	19.1
1876	92,324	20.1	17.0	13.8	17.3
1877	93,543	20.5	17.2	14.0	17.3
1878	99,629	21.8	19.1	15.1	17.6
1879	105,089	22.9	19.4	15.7	19.2
1880	102,906	23.3	19.5	15.3	20.0
1881	90,035	20.1	17.2	13.3	17.5
1882	88,500	20.4	16.5	12.6	17.3
1883	96,228	21.8	17.0	15.1	19.1
1884	87,154	20.0	16.9	13.1	16.3

Table A5 Age Distribution 1871 and 1881

Age (years)	1911	1960	Ireland	Eastern	North Eastern	South Eastern	North Midland	South Midland	Western	North Western	South Western
	Standard World		*1871 Census Ireland*								
0-4	0.11	0.12	0.12	0.11	0.12	0.11	0.12	0.11	0.13	0.12	0.13
5-9	0.11	0.10	0.12	0.11	0.12	0.11	0.12	0.11	0.13	0.12	0.13
10-14	0.10	0.09	0.12	0.11	0.12	0.11	0.12	0.11	0.13	0.12	0.12
15-19	0.09	0.09	0.10	0.10	0.10	0.09	0.10	0.09	0.10	0.10	0.09
20-24	0.09	0.08	0.08	0.09	0.08	0.08	0.08	0.09	0.07	0.09	0.08
25-34	0.16	0.14	0.13	0.15	0.13	0.14	0.13	0.14	0.12	0.13	0.12
35-44	0.12	0.12	0.10	0.11	0.10	0.10	0.10	0.10	0.09	0.10	0.09
45-54	0.10	0.11	0.09	0.09	0.09	0.10	0.08	0.10	0.08	0.08	0.08
55-64	0.07	0.08	0.08	0.08	0.07	0.09	0.08	0.09	0.08	0.08	0.08
Over 65	0.06	0.07	0.06	0.06	0.07	0.06	0.07	0.07	0.06	0.07	0.06
	Standard World		*1881 Census Ireland*								
0-4	0.11	0.12	0.11	0.11	0.11	0.11	0.11	0.10	0.12	0.11	0.12
5-9	0.11	0.10	0.12	0.11	0.12	0.12	0.12	0.12	0.13	0.12	0.13
10-14	0.10	0.09	0.12	0.11	0.12	0.11	0.12	0.11	0.13	0.12	0.13
15-19	0.09	0.09	0.11	0.10	0.11	0.10	0.11	0.10	0.11	0.11	0.11
20-24	0.09	0.08	0.09	0.09	0.09	0.09	0.09	0.09	0.09	0.09	0.09
25-34	0.16	0.14	0.12	0.13	0.12	0.12	0.11	0.12	0.10	0.12	0.10
35-44	0.12	0.12	0.10	0.12	0.11	0.11	0.10	0.11	0.09	0.11	0.10
45-54	0.10	0.11	0.08	0.09	0.09	0.09	0.09	0.09	0.08	0.08	0.08
55-64	0.07	0.08	0.07	0.07	0.07	0.08	0.07	0.08	0.07	0.07	0.07
Over 65	0.06	0.07	0.07	0.06	0.07	0.07	0.07	0.07	0.07	0.07	0.06

Table A6 descriptive statistics of excess mortality, 1877-1880 (1871 denominator)

Year	Mean	Std. Dev.	Min	Max	Best Union	Worst Union
Excess Mortality rates per 1,000						
1877	-0.25	1.53	-5.44	4.48	Castletown	Urlingford
1878	0.84	1.84	-5.35	6.87	Killala	Lismore
1879	1.64	1.78	-2.82	7.88	Killala	South Dublin
1880	0.93	2.02	-3.63	10.52	Gort	North Dublin
Age adjusted excess mortality per 1,000						
1877	-0.23	1.46	-5.13	5.10	Castletown	Urlingford
1878	0.81	1.73	-5.02	6.65	Killala	Lismore
1879	1.50	1.72	-2.57	8.29	Killala	Dublin North
1880	0.89	1.98	-3.38	11.21	Gort	North Dublin

Table A7 Tests for spatial dependence

	Age standardised excess mortality, 1871 weights		Age standardised excess mortality, 1871-81 weights	
	Moran Test	Moran's I	Moran Test	Moran's I
1877	0.69	0.074***	0.51	0.098***
1878	0.8	0.118***	1.95	0.168***
1879	0.34	0.063***	0.14	0.055***
1880	0.41	0.113***	0.25	0.148***

Note: Moran test based on post estimation test 'moran' in Stata; Moran's I derived from Kondo (2021).

Table A8 Table Spatial regression of age standardised excess mortality in 1879

	(1)	(2)	(3)
Average mortality 1871-76	0.01	-0.15**	-0.00
	(0.045)	(0.065)	(0.078)
Spatial lag Age standardised excess	0.16*	0.07	0.09
	(0.092)	(0.091)	(0.065)
Age standardised excess mortality (t-1)	0.26**	0.28***	0.41***
	(0.108)	(0.089)	(0.084)
Spatial lag Age standardised excess (t-1)	-0.14	-0.06	0.01
	(0.122)	(0.150)	(0.137)
Population density		1.48**	1.62**
		(0.722)	(0.632)
Valuation 1872		-0.00	-0.00***
		(0.000)	(0.000)
Constant	1.48	3.65***	2.23***
	(1.455)	(0.836)	(0.704)
Observations	163	163	163
R2	0.09	0.21	0.32
District FE	N	N	Y

Clustered standard errors in parentheses, *** p<0.01, ** p<0.05, * p<0.1; errors clustered following Colella et al. (2019) arbitrary clustering using latitude and longitude.

Figure A3 Ratio Registered Deaths to Burials in Dublin, 1864-1870

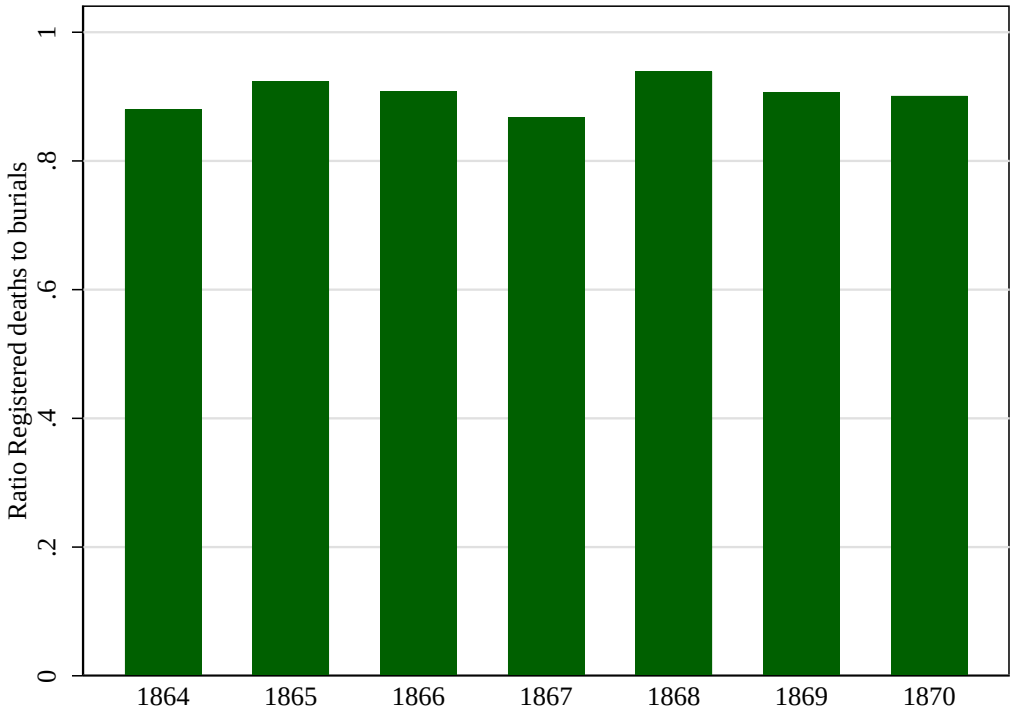


Figure A4 Quarterly Excess Deaths 1875q1 to 1920q4

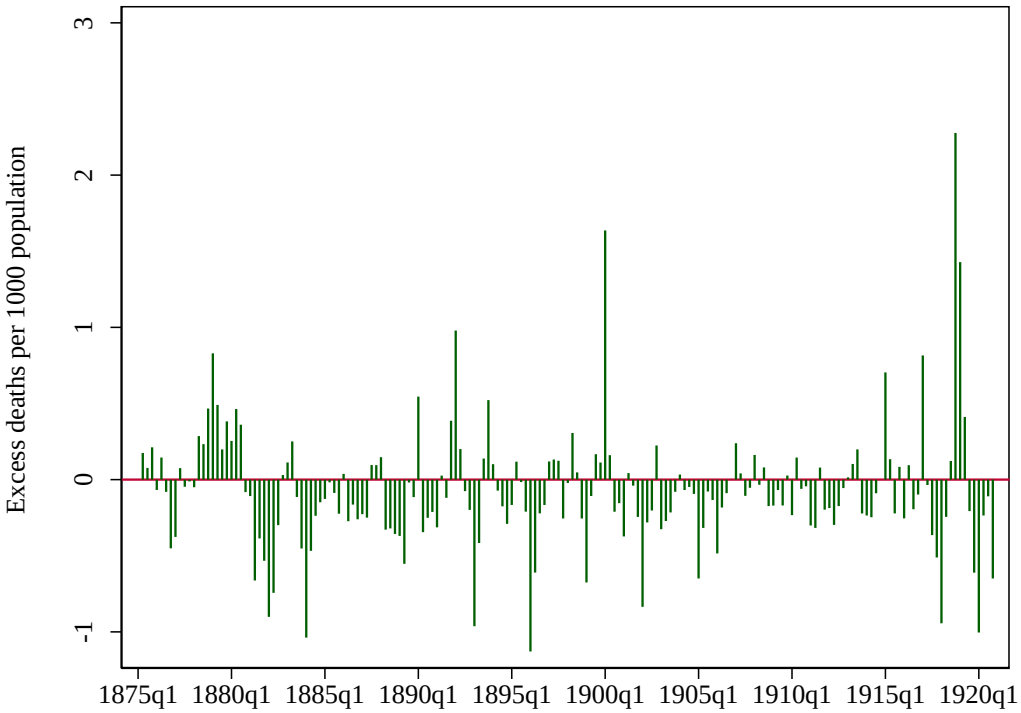
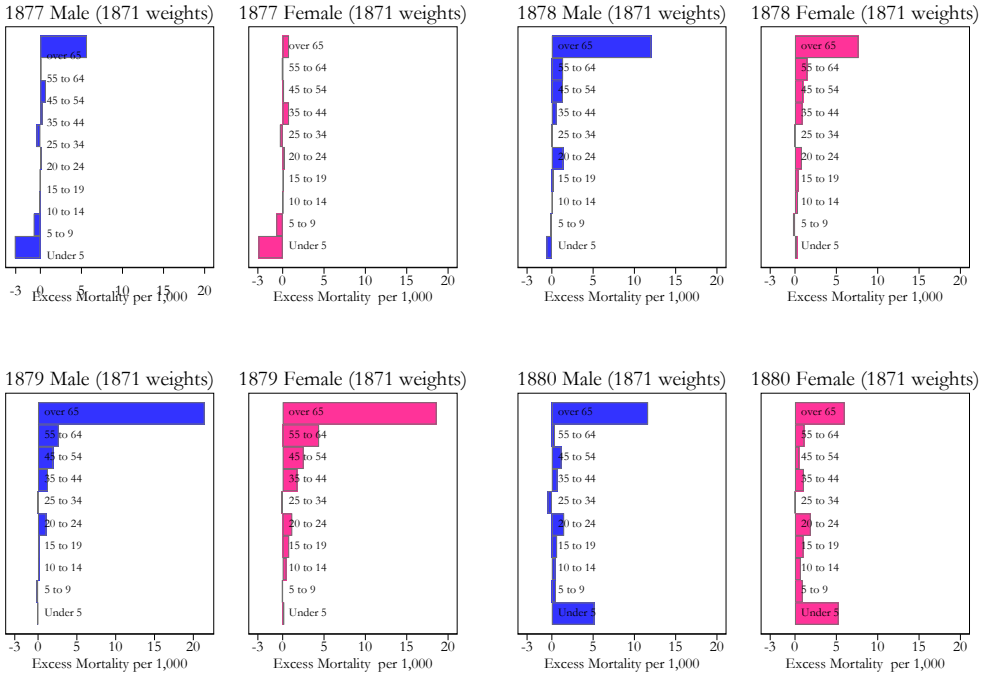


Figure A5: Excess mortality rates, 1877-80

1871 weights



1871-81 weights

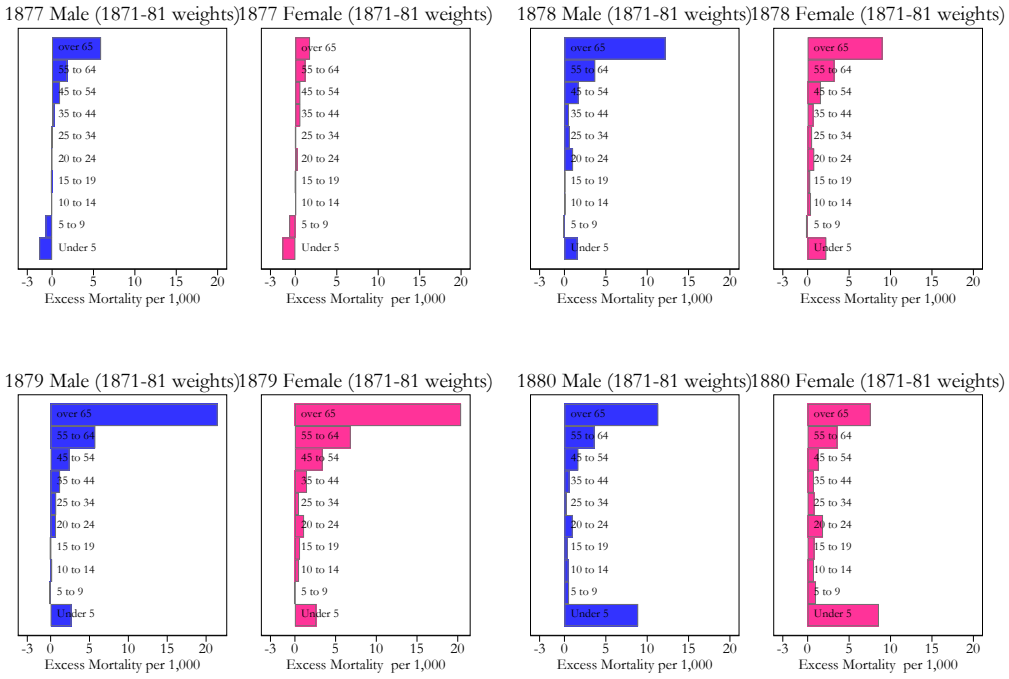


Figure A6 Excess Mortality, 1877-1880

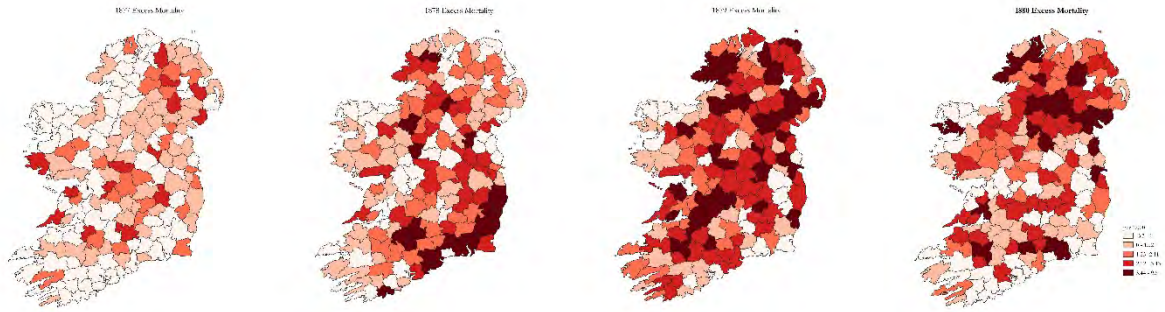
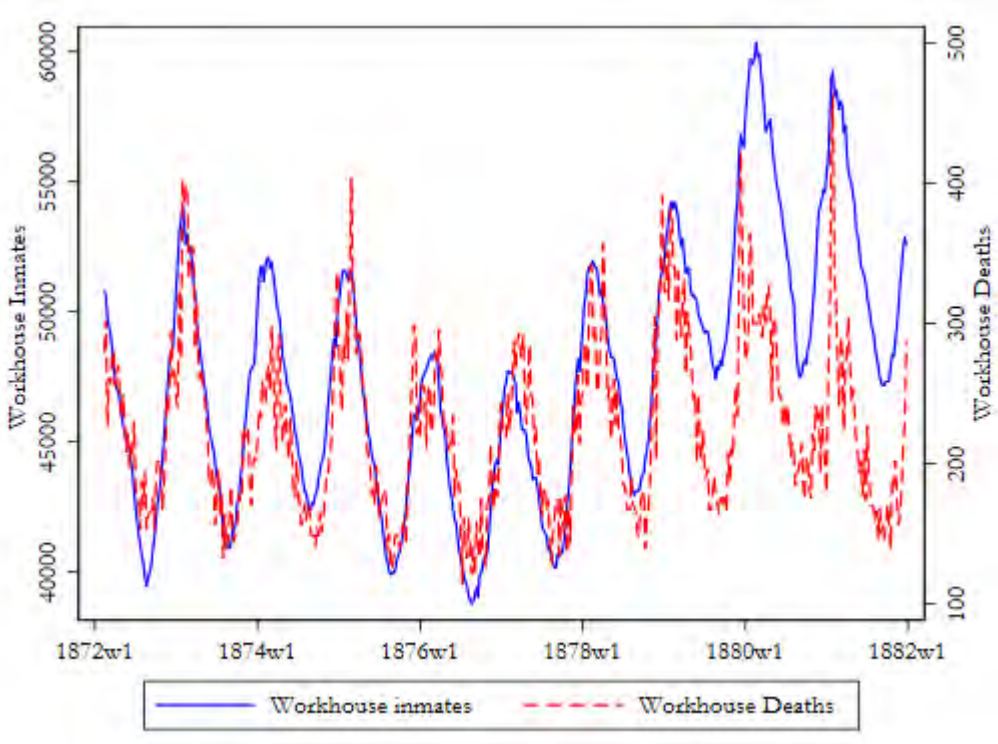
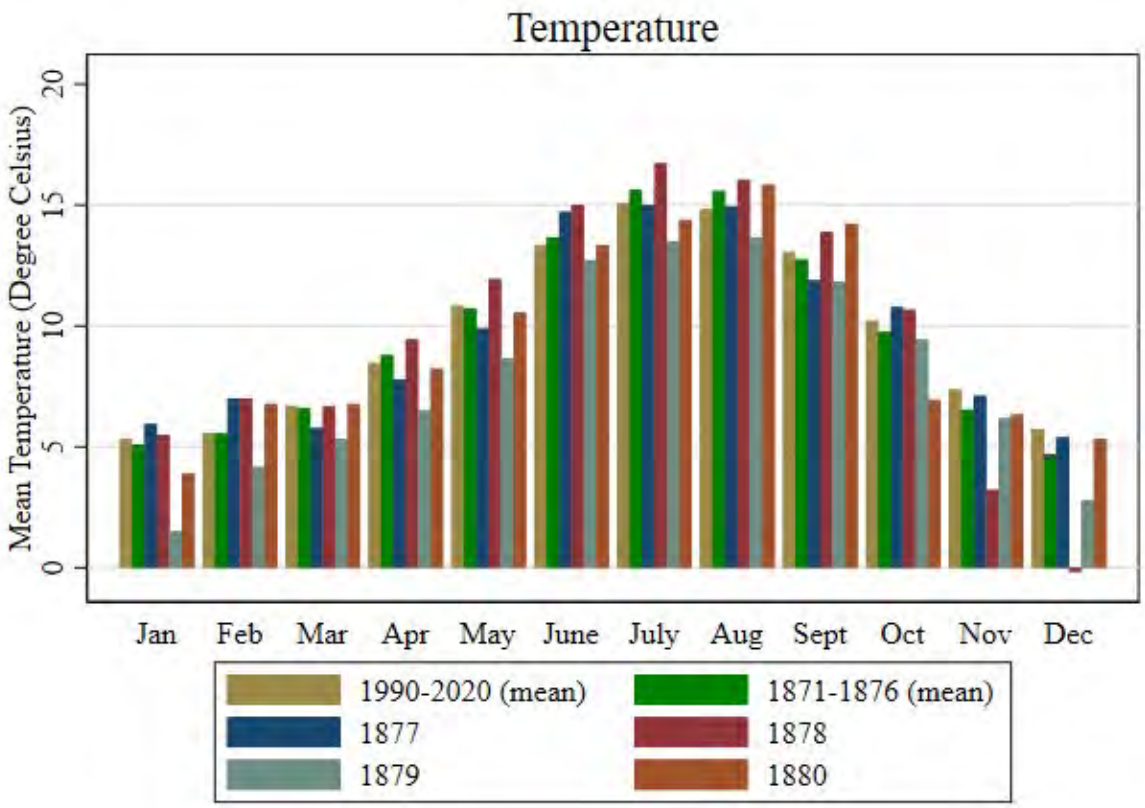


Figure A7 Weekly workhouse inmates and workhouse deaths



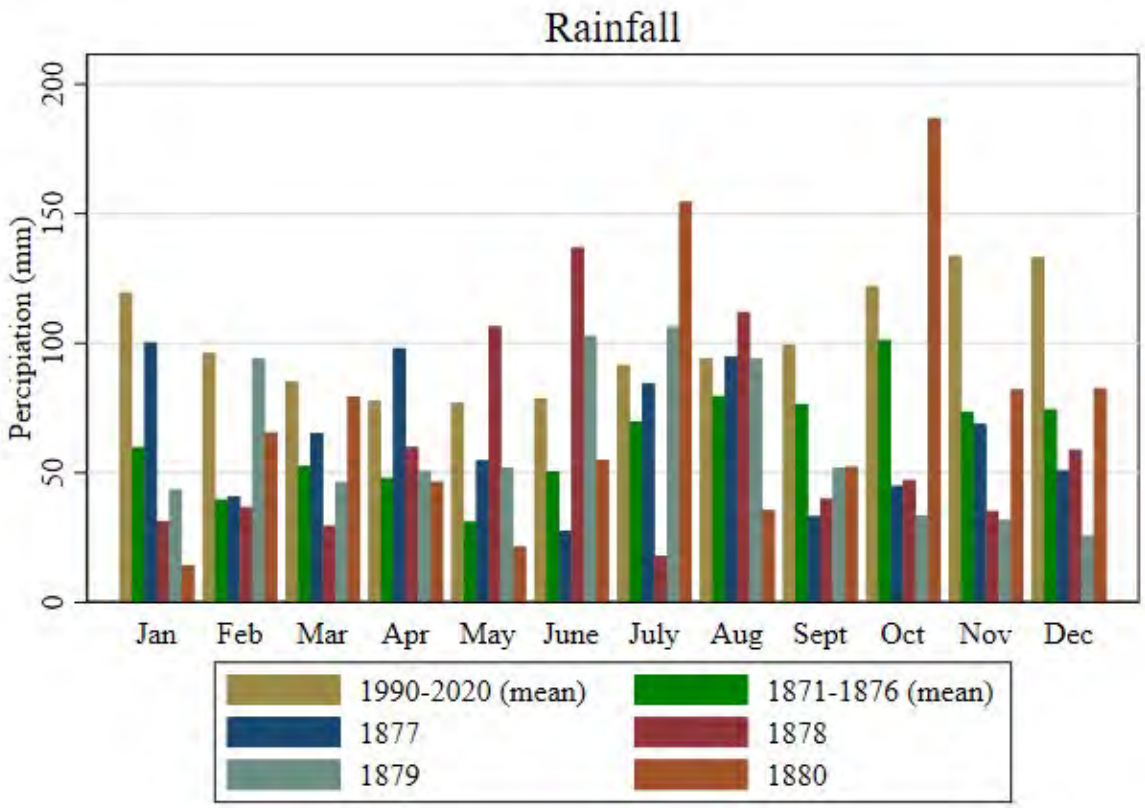
Sources: *Local Government Board for Ireland*, 1870-1881.

Figure A8 Monthly average temperatures 1877-80, and mean temperatures for 1990-2020 and 1871-76



Sources: *Agricultural Statistics of Ireland*, 1877-1880; modern data from World Bank Climate database: https://climateknowledgeportal.worldbank.org/country/ireland/climate-data-historical

Figure A9 Monthly average precipitation 1877-80, and mean precipitation for 1990-2020 and 1871-76



Source: *Agricultural Statistics of Ireland*, 1877-1880; modern data from World Bank Climate database: https://climateknowledgeportal.worldbank.org/country/ireland/climate-data-historical

Figure A10 Testing for spatial autocorrelation

Figure A, Age standardised excess mortality, 1871 weights

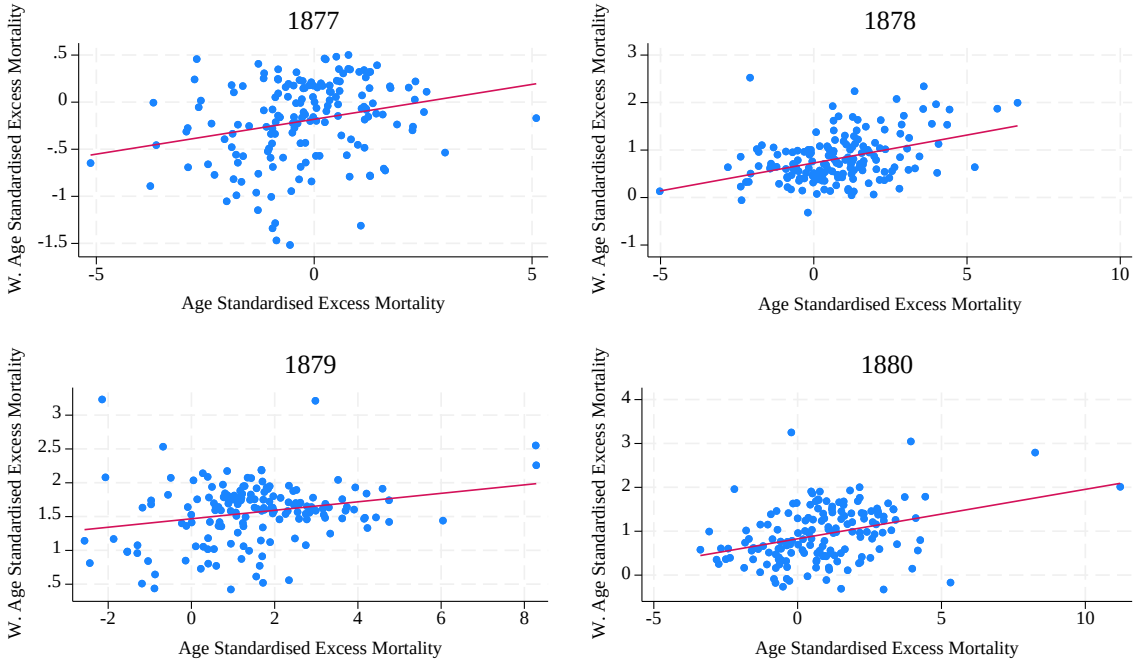


Figure b, Age standardised excess mortality 1871-81 population weights

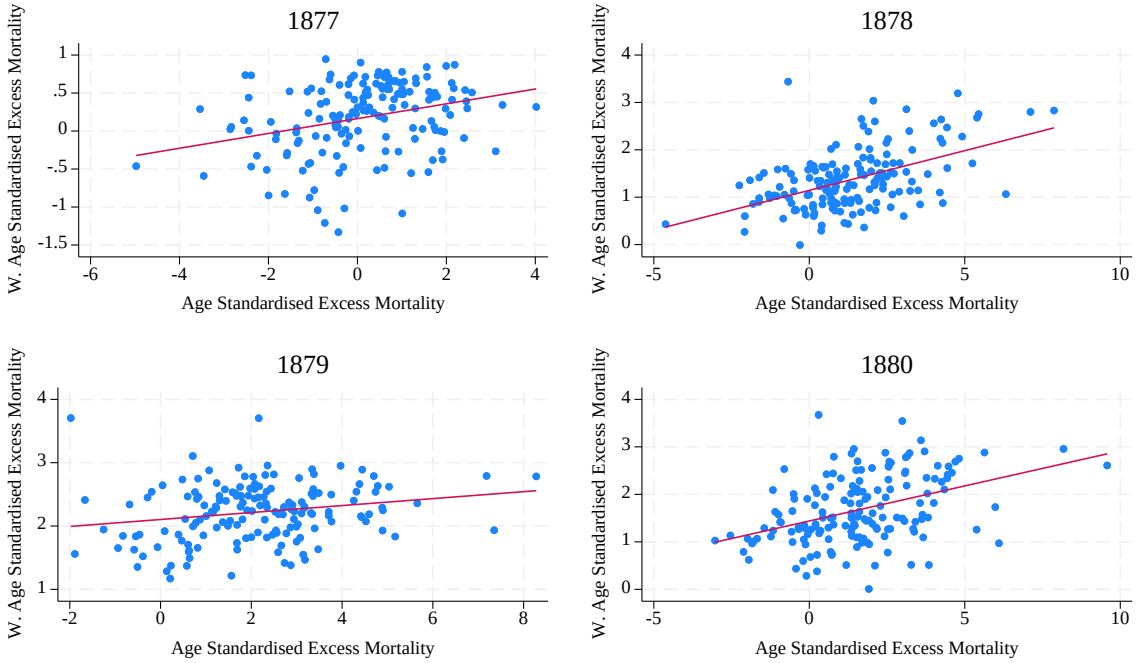


Table A9 Summary statistics of regression variables

Variable	Year	Obs	Mean	Std. Dev.	Min	Max
Age Standardised excess Mortality per 1000	1877	163	0.140	1.452	-4.974	4.021
Age Standardised excess Mortality per 1000	1878	163	1.334	1.873	-4.621	7.871
Age Standardised excess Mortality per 1000	1879	163	2.139	1.698	-1.977	8.278
Age Standardised excess Mortality per 1000	1880	163	1.610	1.974	-3.029	9.580
W.Age Standardised excess Mortality per 1000	1877	163	0.075	0.514	-1.443	1.321
W.Age Standardised excess Mortality per 1000	1878	163	1.013	0.724	-0.631	3.129
W.Age Standardised excess Mortality per 1000	1879	163	1.714	0.961	-0.108	5.199
W.Age Standardised excess Mortality per 1000	1880	163	1.318	1.008	-0.498	4.319
$\bar{M}_u$	1871-1876	163	15.593	2.862	10.260	28.263
Population density	1879	163	0.315	0.506	0.080	4.189
Valuation (£10,000s)	1879	163	8.178	7.480	1.095	58.524
Area (10000 acres)	1879	163	12.469	4.445	4.121	25.748
Under reporting from 1871 census	1869-70	163	1.002	0.084	0.702	1.261
Eastern	1879	163	0.117	0.322	0	1
Western	1879	163	0.190	0.394	0	1
NorthMidland	1879	163	0.110	0.314	0	1
NorthWestern	1879	163	0.104	0.307	0	1
SouthEastern	1879	163	0.098	0.298	0	1
SouthMidland	1879	163	0.104	0.307	0	1
SouthWestern	1879	163	0.153	0.361	0	1

Table A10 Temporal and Spatial regressions of 1878, 1879, and 1880 age standardised excess mortality

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
		1878			1879			1880	
Average mortality 1871-76	0.10*	0.16*	-0.14	0.01	-0.16**	0.01	0.10**	-0.01	0.08
	(0.050)	(0.083)	(0.087)	(0.045)	(0.068)	(0.079)	(0.050)	(0.080)	(0.095)
Spatial lag Age standardised excess	-0.04	0.14	0.13	0.36	0.23	0.23	0.85**	0.80**	0.78***
	(0.384)	(0.362)	(0.218)	(0.236)	(0.200)	(0.167)	(0.384)	(0.364)	(0.275)
Age standardised excess mortality (t-1)	0.24**	0.28***	0.26***	0.26***	0.29***	0.42***	0.48***	0.41***	0.37***
	(0.102)	(0.104)	(0.095)	(0.070)	(0.065)	(0.071)	(0.085)	(0.088)	(0.086)
L. Spatial lag Age standardised excess (t-1)	-0.42	-0.47	-0.30	-0.27	-0.17	-0.06	-0.46	-0.46	-0.51**
	(0.288)	(0.290)	(0.249)	(0.246)	(0.220)	(0.196)	(0.330)	(0.316)	(0.256)
Population density		-0.32	0.42		1.29**	1.34**		0.86	1.12*
		(0.643)	(0.588)		(0.539)	(0.536)		(0.634)	(0.652)
Valuation (£10,000s)		-0.01	0.02		0.01	-0.05		0.01	-0.04
		(0.052)	(0.049)		(0.043)	(0.045)		(0.050)	(0.053)
Area (10,000 acres)		0.04	0.07**		-0.02	-0.02		-0.00	0.03
		(0.038)	(0.035)		(0.032)	(0.032)		(0.037)	(0.038)
Under reporting from 1871 census	-1.98	-2.29	-0.43	-0.81	-0.05	-1.57	-1.32	-0.89	-1.18
	(1.733)	(1.745)	(1.599)	(1.534)	(1.445)	(1.437)	(1.697)	(1.672)	(1.734)
Constant	1.84	0.76	1.63	2.06	3.79**	3.82**	0.03	1.20	0.58
	(1.839)	(2.113)	(2.004)	(1.684)	(1.759)	(1.806)	(1.857)	(2.059)	(2.180)
Observations	163	163	163	163	163	163	163	163	163
Wald chi2	0.0716	15.58	82.45	18.14	43.55	79.23	51.94	59.09	83.23
Psuedo R2	12.48	0.0843	0.3359	0.0909	0.2089	0.316	0.2515	0.2495	0.2968
Wald test of spatial terms	0.01	0.14	0.34	2.36	1.27	1.88	4.89	4.79	8.05
District FE	N	N	Y	N	N	Y	N	N	Y