Trinity College Dublin
Coláiste na Tríonóide, Baile Átha Cliath
The University of Dublin

SCHOOL OF POLITICAL

ENTITLEMENT APPROACH – AN EXAMPLE OF THE IRISH FAMINE, 1845 – 1851

Chenxi Li

23330541

AUGUST 12, 2024

School of Social Sciences and Philosophy, TCD

SUBMITTED IN PARTIAL FULFILMENT OF THE REQUIREMENTS FOR THE DEGREE OF

M.SC. APPLIED SOCIAL DATA SCIENCES

Declaration

I hereby declare that this Dissertation is entirely my own work and that it has not been submitted as an exercise for a degree at this or any other university.

I have read and I understand the plagiarism provisions in the General Regulations of the University Calendar for the current year, found at
`http://www.tcd.ie/calendar`.

I have also completed the Online Tutorial on avoiding plagiarism 'Ready Steady Write' and located at
`http://tcd-ie.libguides.com/plagiarism/ready-steady-write`.

Signature: 

Date: August 12, 2024

Acknowledgements

I would like to thank my supervisor, **Prof. Martina Kirhberger**, for her guidance through each stage of this dissertation.

Abstract

Contents

List of Figures

List of Tables

Chapter 1 | Introduction

"October playing a symphony on a slack wire paling.
Maguire watches the drills flattened out
And the flints that lit a candle for him on a June altar,
Flameless".
— "The Great Hunger" by Patrick Kavanagh. (Kavanagh and Quinn, 2006)

The Irish Great Famine (1845 – 1851) reshaped the entire history of Ireland. Before the Great Famine, according to the 1841 census, the population of the Ireland had close to 8.5 million [1] . In 1851, when the Irish Great Famine had not yet ended, census noted that about 1 million people had died for hunger, and a similar number had gone into overseas exile [2]. In 1926, as a result of the Irish independence 5 years earlier, the Central Statistical Office was capable to integrate historical documents since famine and showed the fact that the population was decline of roughly 22% [3] in the 10 years from 1841 to 1851. Using parish baptism data, some scholars have estimated that in the year 1847 alone – which is also known as black'47 in Ireland history – there existed counties with a nearly 70% reduction in baptisms in Munster province in the south of Ireland (Cousens, 1960), especially from southwest Cork and including north and east Clare [4] , while it was not the worst hit by the famine compared to the province of Connacht in the west [5] . Apart from these quantitative explorations, the Great Famine is equally pivotal in Irish cultural history and ethnography. From Joseph O'Connor's fiction "Star of the sea" to W. B. Yeats's "The Countess Cathleen", together they expressed that the Great Famine not only pointed to the corpses of the dead, but also to a black hole of identity, naming and meaning (Luchen, 2019).

1 1841 Census of Ireland, Last accessed: 13 May, 2024
2 1851 Census of Ireland, Last accessed: 2 May, 2024
3 1926 Census of Ireland, Chapter II, Last acceseed: 9 May, 2024
4 RTE, How "a truly modern famine" devastated Ireland, Last accessed: 11 May, 2024
5 Wesley Johnston: The Famine: The Summer of Black'47, Last accessed: 13 May, 2024

The effects of the Great Famine were far-reaching, and reflected in the long-term population development, land institution structure and attitude to the UK government directly. It was not until 120 years later, in the 1960s, that Ireland's population began to grow consistently due to large-scale emigration, late marriage and a high incidence of permanent celibacy no longer hold (Grada, 1979), but it was still nowhere near as large as it had been during the Great Famine [6]. This also makes Ireland one of the few countries in the world to suffer population decline over the past 170 years when the world's population has increased more than 6 fold [7]. Regarding the land, on the one hand, in the aftermath of the famine, there was a tendency in Ireland to shift from agriculture to livestock husbandry [8], and on the other hand, when the late blight back in the 1870s, the Land War, which was directed at the landowners and the government, took place at the same time, with a deep consequences for the land structure of Ireland. And finally, there raised hostility between Irish and UK government, which was described as "a bankruptcy of the British-Irish Union of 1800" (Gray, 2021).

But data on Ireland's food imports and exports show increases in specific commodities, even barley, oats and butter, that violate the characteristics of the Great Famine. In History Ireland magazine, Christine wrote:

> *Almost 4,000 vessels carried food from Ireland to the ports of Bristol, Glasgow, Liverpool and London during 1847, when 400,000 Irish men, women and children died of starvation and related diseases [...] The most shocking export figures concern butter [...] That works out to be 822,681 gallons of butter exported to England from Ireland.*[9]

Scholars pondered if potato blight was the root cause of the famine, and they have engaged in many discussions about the origin factor, like Catholic and religious behavior (Miller, 1975), anti-Irish racism (Waters, 1995), the poor law and colonial bio-politics (Nally, 2008) and, typically, the potato blight (Bartoletti, 2001), etc.

---

6 2022 Census of Ireland – Summary Results, Last accessed: 8 May, 2024

7 Blog by Ambassador Mulhall on Black'47: Ireland's Great Famine and its after-effects, Last accessed: 9 May, 2024

8 CSO: Farming Since the Famine, 1847 - 1996, Last accessed: 12 May, 2024

9 Ireland's Great Hunger Museum: Learn About the Great Hunger, Last accessed: 13 May, 2024

Although to this day, we can be certain that the root causes of the Irish Great Famine were multiple regardless of the perspective used, historically, the academic discussion of the root causes of the famine changed (Henderson, 2005):

Table 1.1: Timeline of Great Famine Root-Cause Academic Discussion

Timeline	Root Cause Summary	Reference
1845 – 1852: famine	Few food importation and opposition in poor law	1850/01/05 The Illustrated London News[a]
1852 – 1920: neglected	— [b]	(Kinealy, 2017)
1920 – 1960: nationalist	Key grouping, like landlord class or the UK government	(Smith, 2005)
1960 – 1980: revisionism	Focus on history and event itself, ignore outside force	(Daly, 2006)
1980s: post-revisionist	Emotional description also blame UK government	(Hamera, 2011)
1980s: diverse	Malthus population theory	(O'Flynn, 2009) & (McGregor, 1989) & (Weir, 1991)
	Anti-Malthus theory	(Ó Gráda, 1983) & (Mokyr, 1980) & (Guinnane, 1994)
	Blight biological analysis	(Donnelly, 2011)
	Foucault's bio-politics and colonial perspective	(Nally, 2008) & (Kennedy, 2020) & (Madden, 2016)

[a] The original newspaper mentioned: *Free importation of corn into this union is essentially necessary – [...] any attempt to re-impose a duty on the importation of food can only [...] tend to the starving of the people. Poor law [...] relieves the struggling farmer of a heavy burden he had hitherto.* (McNamara, 1850)

[b] The famine literature few. The quantity and quality of work on the famine sparse: *The two standard books of the Great Famine, [...] the chapters were uneven in quality and lacked coherence (some lacked footnotes, some were lost).* (Kinealy, 2017)

Famine narrative travel along the path of Irish history. When nationalism was high, there was a tendency to external attribution; then when the economy and society stabilized, revisionism was born. As Hu Shih, a Chinese philosopher of the 1900s, put it, *Reality, like a block of marble in our hands, is carved into whatever likeness we choose*.

What these strands of history described is that while food shortages are an objective fact, there are nonetheless other causes that conspire to drive famine – as Amartya Sen's rights approach asserts.

Based on the theoretical structure described above, this paper would like to reject some of the established theories on the famine **(Chapter 2.1)** and propose an Amartya Sen entitlement approach perspective on the Irish Famine **(Chapter 2.2)**. Then this paper will discuss the data used in this paper and its collection process **(Chapter 3)**, present the RDD regression methodology employed **(Chapter 4)** and then verify the applicability of the rights approach to this scenario **(Chapter 5)**. Finally, a conclusion will be presented **(Chapter 6)**.

Chapter 2 | Literature Review

"Hunger roared up in him like a hopeless lust.
He walked the ship as though following a chart. Up. Down. Across. Back. Stem. Port. Stern. Starboard. The churning of the waves.
The ropes clanking on the masts. The blind of salt water. The wind ripping at the sails."
— "Star of the Sea" by Joseph O'Connor

2.1 A Brief Famine Outline

The Irish lumper potato with its excellent ability to grow in poor and wet soils, was the predominant potato variety in pre-famine Ireland. It was introduced to U.K. around 1806 (Tucker, 2016), and rapidly replacing almost all other varieties in the recipes of the poor. Usually, on account of its intolerance of frost, the farmer sows in March or April, and the first early potatoes will be harvested in June, followed by the second early potatoes in July, and the third not later than October. With a 1.32 % growth in lower class per year in Ireland from the centennial before 1841, in 1845 about 32% of the arable land in Ireland was already under potato cultivation (Solar, 2015).

The first record of late blight on potatoes in Ireland is thought to be Dr Lindley's letter in September 16, 1845, with his concern words, he wrote: "The potato murrain has unequivocally declared itself in Ireland, where will Ireland be in the event of a universal potato rot"? (Kelly, 1995). Things were getting worse in 1846, a government documents collection book recorded that: "the poor Irish lost their potatoes again" (1 September, 1846) so that "Many, full many, must this winter leave their homes, and traverse the country in quest of work" (15 September, 1846). Government employee pointed out a fact, "to maintain Ireland's population, her agriculture must be greatly improved" (31 October, 1846). Next year, due to a change in the Poor Law, "the poor-

est peasantry were draught to the shore of America" (18 January, 1847), but didn't seems to release the effect of famine. Later, in newspaper's leading article, reporter wrote: "eye-witnesses of scores and hundreds of poor creatures actually dying for want a meal" (8 March, 1847) and all "landlord, tenure and peasant were in a miserable situation" (13 March, 1847). Reflection was raising and people started to realized a serious famine come back since 1741 because "the food that suffered in both years was the same" (14 April, 1847). Till November, the exodus of the population was getting worse and caused the "disorder in Ireland" (November 13, 1847). Finally, because of sharply decrease population, Ireland faced a situation "Labour is the first price" (December 30, 1847) (The Times Office, 1880).

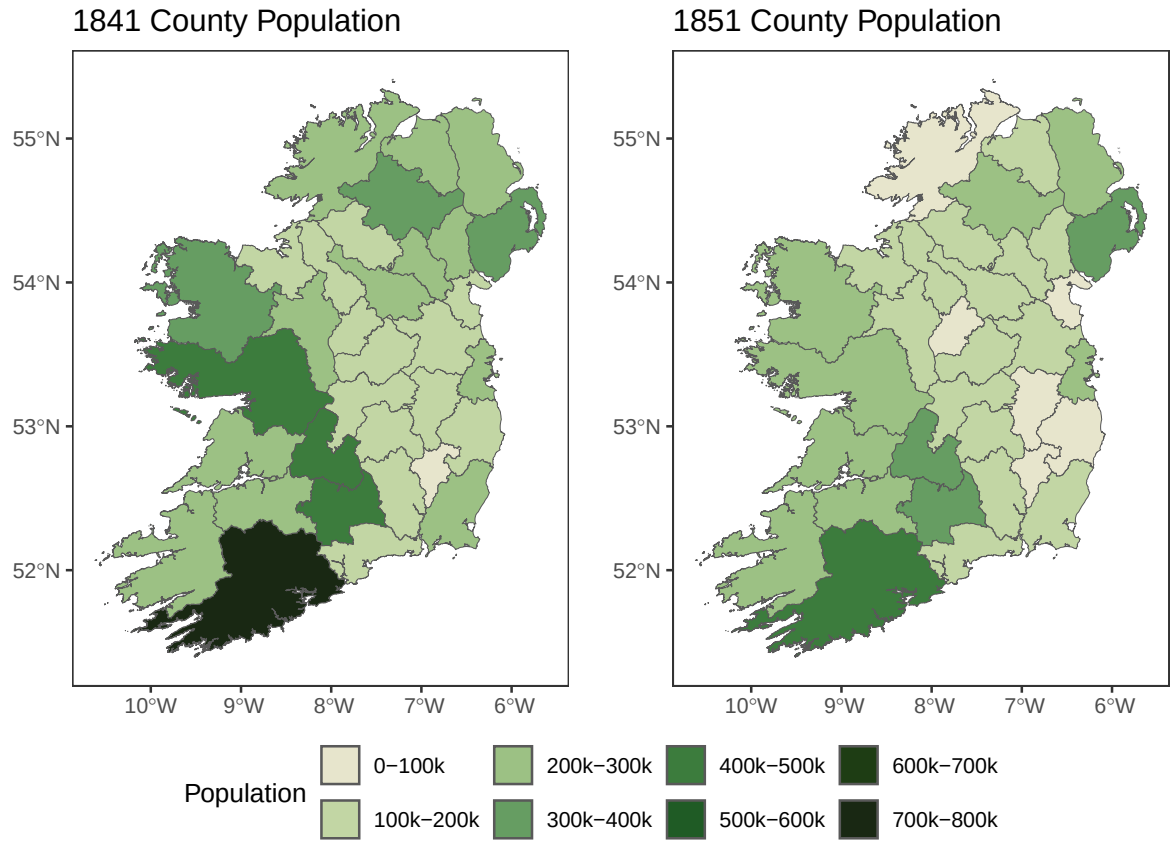
Throughout the history of the famine and pre-famine period, the role of the Poor Law cannot be ignored. The Poor Law was introduced in Ireland in July 1838 with the blueprint of the Poor Law in England and Wales, and provided for the establishment of 130 trade unions throughout Ireland, where the poor were to be relieved and regulated by the guardians of the trade unions (O'Brien, 1985). However, in January 1847, the government pushed for reform of the Poor Law, which exacerbated the ravages of famine in Ireland – particularly in the south and west of Ireland. The most significant consequence of the reforms was the almost complete transfer of responsibility and financial pressure for poverty alleviation to local government finances, which in the context of the famine resulted in the complete collapse of the local poverty alleviation system. It is very difficult to objectively assess the role of poverty law, which on the one hand does provide relief to many poor people (McHugh, 1986), but on the other hand is also characterized by Foucault's theory of power genealogy like "micro-power" and the operation of "bio-politics", as the 1847 letter reads:

> *It is true we have been careful not to put forward a poor-law as a mean to supply, but have claimed for it only a place among the means of distributing supplies – of promoting employment, and of enforcing upon poverty the care and protection of the labour. Still, if that surplus of unfilled mouths is to be always in front of us, it must be confessed that very little good, after all, will be accomplished.* (Spedding, 1847)

After 1847, the rate of depopulation slowed and the most difficult period was over. Some scholars have pointed out that the cause of death of the population during this period was more due to diseases brought about by the famine, including dysentery, diarrhea, tuberculosis, fever, and swelling (Mokyr and Gráda, 2002). The 1851 census showed the population declined by approximately 1.62 million after the famine.

From the census data of 1841 and 1851, we can calculate the change in population of the different provinces after the famine, which showed the result that the west and south suffered far more from famine than the east and north (Figure 2.1). The five counties with the greatest decreases in population are: Donegal, Connaught, in the west, 279,601; Cork, Munster, in the south, 209,822; Galway, Connaught, in the west, 125,026; Tipperary, Munster, in the south, 103,986, and Roscommon, Connaught, in the west, 80,155. The *The freeman's journal* similarly supports this conclusion in its April 27, 1847 article documenting the damage to parishes including Killedy, Toomavara, Abbey, Lorha and Dorrow, etc (Newell et al., 1847).

Figure 2.1: County Population 1841 – 1851



2.2 Rebut Food Availability Decline (FAD) Theory

We must respond to Food Availability Decline (FAD) theory that is tit-for-tat with entitlement approach – "*the most common approach to famines is to propose explanations in terms of food availability decline (FAD)*" (Sen, 1982) – In the Irish famine, where the FAD theory contains two aspects: (1) potato late blight; (2) monocultural structure of Irish diet. For a long time it was believed that these two were the root of the famine. In historical fact, while the existence of both is undeniable, their impact is not decisive.

Firstly, potato late blight. During the middle 19th century, late blight and famine have the most intuitive visual connection, so farmers, governments, and scholars have attributed famine to the potato blight. Native Irish farmers have a set of folk myths about this, believing that fairies in the sky were fighting over the potatoes, or that Fear Liath, the fog man, which led to the blight and famine (Bartoletti, 2001). Also, references in correspondence with the British government mentioned the relationship between late blight and death in potatoes:

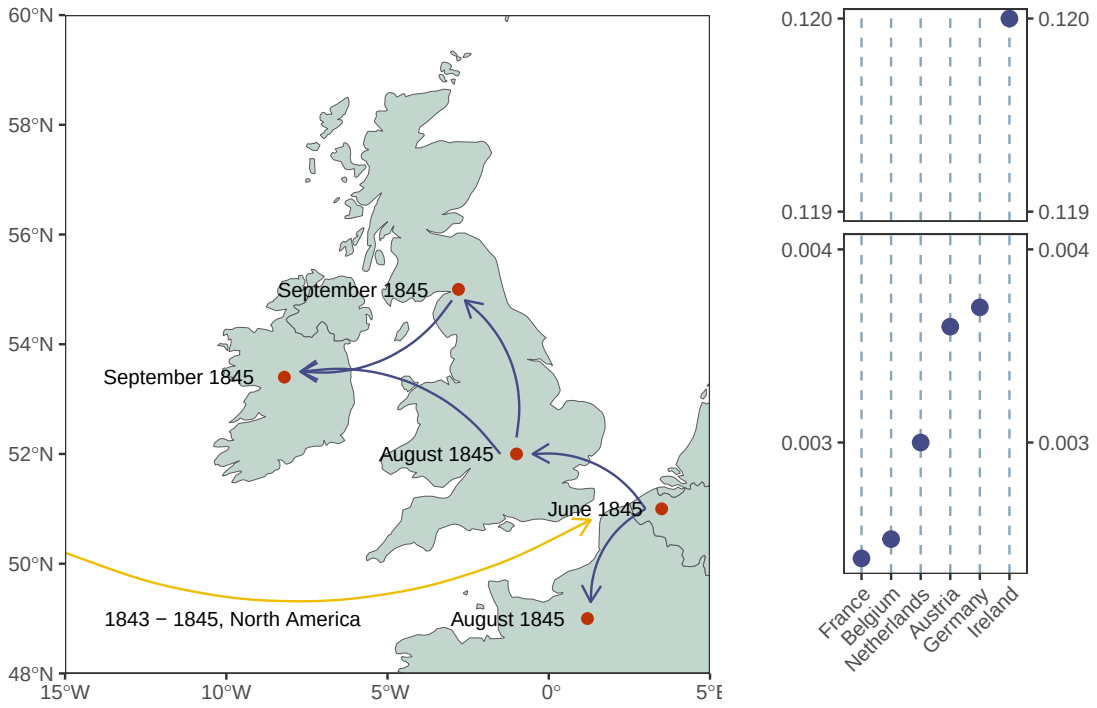
> *"In 1845, about the month of July or the beginning of August, the potatoes withered and decayed all over the country like what you have seen on the watersides with early frost, [. . .] poor families were badly off and striving to live on bran".* (McClure, 1848)

> *"When they came back home, there was not a potato in what they dug but was infected [. . .], it is the whole cry among the people".* (Blackwell, 1845)

One group of scholars, based on potato production data or biological research, attributes the Famine to late blight, such as Kinealy, who discusses poorhouses, potatoes, and death; (Kinealy, 1990); or Dowley, who focuses on the relationship between climate and blight fungus (Dowley, 1997); also Ristaino, who analysis the DNA structure of the fungus in the famine period (Ristaino, 2006); as well as scholars working to biologically analyze the uniqueness of the Irish Late Blight strain worldwide and how it led to the famine (Goss et al., 2014); and the rampant late blight attributed to faulty planting practices (Lidwell-Durnin, 2020).

However, as many scholars opposed to this view have asked, why did Ireland alone suffer such a significantly famine when the late nineteenth-century epidemics swept across the globe (Gray, 2006, Kelly and Gráda, 2015, Mokyr, 2013, Oleksy, n.d., Solar, 2015)? Scholars have ample biological and historical evidence to prove that late blight did not originate in Ireland, and that it has suffered much less elsewhere than in Ireland (Zadoks, 2008). A Nature article (Bourke, 1964) on the traceability of potato late blight stated that in the 19th century it was first detected in 1843 in port cities on the east coast of the United States, and then spread to the western part of the Americas. In Europe, the first case of late blight was detected in Belgium in June 1845, before spreading to France, the United Kingdom and Ireland (Figure 2.2).

Figure 2.2: Potato Blight Pathway & Death Rates, 1843 – 1845



There is thus sufficient evidence against the first argument. Since the late potato blight did not strike Ireland first, and since all the other countries afflicted by the blight did not suffer such a great loss of population, the famine directly caused by the late potato blight can not be justified.

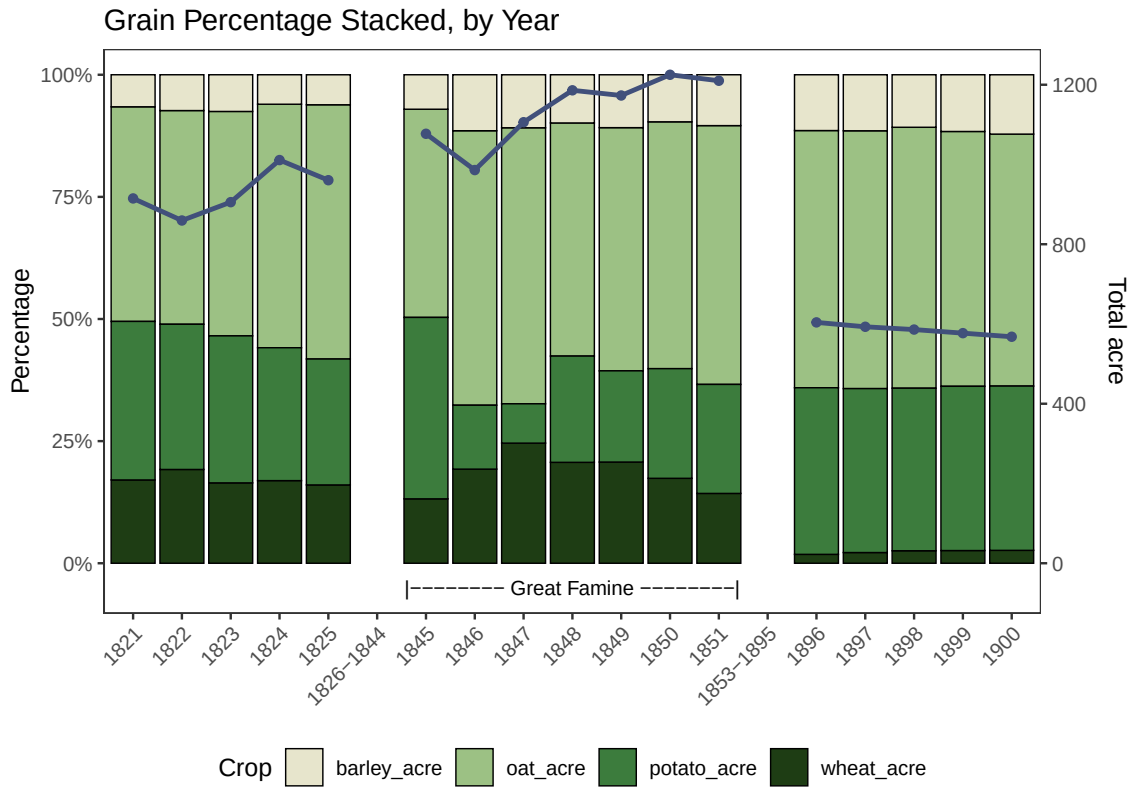
Secondly, the monocultural structure of the Irish diet. A strict distinction must be made between the concepts of dietary structure and cropping structure, since the former relates to daily nutritional intake, while the latter relates to the country's agricultural economy at the macro level. When we say "the potato has become almost the only staple food for the poor", we are actually referring to the former. Ireland in the 19th century was not a country where the potato was almost the only crop, and also there were more than one variety of potato, the lumper. In 1834, when William Cobbett visited the country, he recorded:

> *"When men or women are employed, at six-pence a day and their board, to dig Minions or Apple-potatoes, they are not suffered to taste them, but are sent to another field to dig Lumpers to eat".*(Gráda et al., 1995)

For scholars who argue that a monolithic diet led to the famine, they have in fact recognized that Ireland has a diverse cropping structure, it is just that the impoverished poor do not have access to a diverse diet (Braa, 1997, De Nie, 1998, Kinealy, 2006, Nally, 2008), which coincides with the entitlement approach that we will address later. And from biological analysis of human proteins (Beaumont, 2014, Beaumont et al., 2013), as well as historically documented import and export data (Fairlie, 1965), it is actually clear that the famine victims were given a certain amount of corn as a supplement to potatoes after the famine.

For scholars who argue that a monolithic planting structure led to the famine (Bartoletti, 2001, Turner, 2002), they are ignoring the real historical data, which shows that Ireland was not actually a monoculture potato country at the time. As Popkin rebutted Scott, Irish farmers appear statistically to have been more like rational peasants, and in fact they cut back on potatoes in response to the blight in 1847, shifting to more wheat and oats (O'Neill, 1952) , which led to a change in the country's overall cropping structure (Clarkson and Crawford, 2001). Data on Irish cropping structure shows that the country was not as dependent on potatoes as people image, and potato plants proportion at the end of 19th century was more than before famine (Figure 2.3).

Figure 2.3: Grain Agriculture Structure 1820 – 1900



In addition to this, there are a number of explanations that are not directly related to FAD theory but still do not point to the core of the famine, including the problem of poverty in Ireland (Gilleard, 2016, Gray, 2010), the bad quality of the land (Whelan, 2012) or the cyclical cycle of the famine, but they have corresponding counter arguments respectively, such as studies of Irish immigrants' bank deposits proving that they weren't as poor as they could have been (Wegge et al., 2017), the study of the relationship between land quality and Malthusian metrics (Donnelly Jr, 2002), as well as the British government's ability to cope with famine (Kelly and Gráda, 2015), etc.

From this we can make the inferences: (1) since potato blight did not originate in Ireland, but was imported via North America, Belgium, and Britain, and since famine losses in other countries were significantly smaller, potato blight was not a central cause of famine; and (2) since the structure of Irish agriculture was not actually entirely monoculture potato, planting structure was not a central cause of famine.

The FAD theory is refuted. Sen's entitlement approach will be discussed next.

2.3 Entitlement Approach Theory

The most widely publicized statement about Amartya Sen's entitlement approach is people are hungry not because they do not have food, but because they are unable to obtain it. There are many other scholars who hold similar views, including Susan George, who discusses emotional indifference, equalization of resources, and unequal systems that led to the famines of the 1980s (George, 1990); Also Michael Watts interpret famine from a social justice angle (Watts, 2013); and Amrita Rangasami, continue with Sen's entitlement approach, discussed famine in a social welfare, transactions within a community unit like village or family (Rangasami, 1985), etc. Ultimately, Amartya's theory was chosen in this paper, not only because of its widely disseminated, but also for its operationalization level.

Amartya defines the entitlement approach in these four aspects: *(1) Trade-based entitlement, (2) Production-based entitlement, (3) Own-labour entitlement, (4) Inheritance and transfer entitlement* (Sen, 1982). In fact past studies of the Irish famine have addressed this four aspects, but often lacked a coherent system of entitlement approach.

Firstly, trade-based entitlement. This essentially involves the exchange of a set of ownership pools and market pools, with failure situations consisting of either a deficiency in the ownership pools or a deficiency in the market pools. For food, the former is the sum of the grains within a dietary system, specifically oats, wheat, potatoes and barley in 19th century Ireland, while the latter refers to a market price level. Studies of prices during the famine are common, for example Daniel (Daniel Cassidy, 2021) and Vamplew (Vamplew, 1980) focused on oat price, Kennedy and Dowling (Kennedy and Dowling, 1997) researched on potato prices, as well as Clark (Clark, 2004) in barley price field and Turner's (Turner, 1987) paper on a general price index during 19th century. All these papers pointed to price volatility during the famine, which – or, using the concepts of entitlement approach, the impairment of trade-based entitlement – led to a sharp decline in the market available for Irish, and finally the famine.

Secondly, production-based entitlement. The place of land as an important means of production in the 19th century in the process of granting entitlement to peasants cannot be ignored. Scholars agreed Ireland's 19th century situation as colonial politics (Cairns and Richards, 1988, Duffy, 2017, Nally, 2008) precisely because of the widespread rise of absentee landlords, which created a sharply delineated hierarchy between Ireland and Scotland or England, i.e., the pattern of peasant – attendance landlord – absence landlord (Braa, 1997). The fact that the relationship between peasants and landowners is obscure and ambiguous probably relates to the wider topic of rural sociology, which, in terms of specific literature, has both an idyllic aspect, such as the peaceful coexistence documented by Brown (Brown, 1953), as well as a rhapsodic-like conflict and revolt, such as the land wars of the second half of 19th century.

The uncertainty of the peasant-landlord relationship makes it necessary for this paper to turn its attention to other indicators-namely, taxes and land rents to quantify production-based entitlement. Much of the research on taxation has focused on the tithe, which was enacted from 1823, adjusted in 1838 and finally abolished in 1869. For the first stage (1823 – 1838), scholars have focused on the widespread oppression it inflicted on peasants (Shaw, 2015, 2018), including its also taxed non-Catholic peasants, which led them angry. For the second phase (1838 – 1869), although the government transferred the peasants' tithes to the landowners, evidence suggests that the landowners actually passed them back to the peasants (Brynn, 1970), and that the peasants' situation was not substantially improved. Regarding the land rents research, in addition, focused on Irish economic history (Guinnane and Miller, 1996, M Solar and Hens, 2013), and this paper will use this data to support the production-based entitlement argument as well in the latter chapters.

Thirdly, own-labour entitlement. Depending on which sector they worked in, people received different forms of income, and while farmers made up a large proportion of those affected by the famine, it is also important to consider the forms of income received by people in industries other than farming. In this case, the most intuitive indicator is wages.

Using economic models, researchers have explored the relationship between wage cuts and deaths during famines (O'Rourke, 1994), some scholars hold opposing views, for example, Geary and Stack (Geary and Stark, 2004) believe that famine is the time when the ratio of wages to prices is most reasonable. In addition, some scholars (Guinnane, 1994) have tried to infer wage data throughout the 19th century from the perspective of historical documents and price levels.

Lastly, Inheritance and transfer entitlement. Poor Law is used as a validation indicator for this aspect, and its importance and evaluation are summarized in Section 2.1 and will not be repeated here. Although there are indeed atlases of land and estate transfers, or of the details of food grants, we need to note that these small-scale exchanges of entitlement are not amenable to a more macro-level analysis of the state. Another approximation is the data on imports and exports, but there are several problems: firstly, for imports data, there is no way of ascertaining the flow of imported food, on the one hand, they may reach the market and become part of the trade-based entitlement, and on the other hand they may be distributed by the state as relief food, constituting to the inheritance and transfer entitlement. Secondly, for export data, it is extremely easy to get caught up in a kind of dichotomy between nationalism and revisionism in Irish history (Cairns and Richards, 1988), and then to lose objectivity between these debates. Therefore, for import and export data, rather than being the key independent variable, it should be included as control variables. This paper will elaborate further on the control variables later in the regression methodology.

For most of research with entitlement approach, they propose various indicators to measure the failure of entitlement during the 19th century famine in Ireland. Fraser (Fraser, 2003), following Amartya Sen's framework, analyzed the failure before famine due to the squeeze on handicrafts, rent increases and tensions in tenancy relations, agricultural transformation, and debt. Similar to Fraser, Fitaptrick (Fitzpatrick, 1995) is more concerned with the comparison of entitlements between different classes, such as small shopkeepers, handicraftsmen, and farmers, etc., and tried to point out why famine has a more serious impact on some classes than others.

In fact, there is a consensus in academia on the applicability of entitlement approach to the Irish famine, including Flaherty's verification of the direct and indirect entitlement of people during the famine from the perspective of public resources (Flaherty, 2021), Kennedy and MacRaild used potatoes and class conflict to demonstrate the applicability of the entitlement approach (Kennedy and MacRaild, 2022), while McGregor and Cantley uses probability density and chi-square tests based on famine data through statistical and mathematical reasoning (McGregor and Cantley, 1992). Scholars even used the entitlement approach to analyze an earlier famine, the Great Irish Famine of 1741, which developed the FVAM model to better illustrate how the failure of rights is independent of environmental and climatic factors (Engler et al., 2013).

In recent years there has been a tendency for the entitlement approach to be discussed a wider range, i.e., not simply as a famine mechanism, but as a development and demographic mechanism. Li pointed out how the entitlement approach, as a developmental mechanism, has been deliberately withheld in underdeveloped countries, thereby hindering development (Li, 2017). Gist, using data from the recent past and modern times, demonstrates that there is a relationship between demographic development and entitlement development (GIST, 2008). In the post-21st century, in addition to analyzing recent modern phenomena, scholars have begun to use the rights approach to look back to more ancient periods basing on historical data set, such as Rome (Jongman et al., 2006), Maya (Barrett, 2004), and Greece (Gray, 2011).

The causal relationship between entitlements and development status has been recognized in a number of studies, most notably in another book by the author of the entitlement approach, Amartya Sen: *Development as Freedom*. The use of freedom, or the feasible scope of a collection of rights, to assess the state of development transforms these two philosophical concepts into directly measurable dimensions (Sen, 2014). There is ample evidence that entitlements and state of development are positively correlated, i.e., the more entitlements people have, the better overall social development (Chauffour, 2011); and in the classical demographic model, the more entitlements people have, the more overall population increases (Żemojtel-Piotrowska et al., 2015).

However, the entitlement approach also has its flaws. As Amartya himself admits (Sen, 1982), the definition of entitlement will be blurred, especially under the influence of capitalist factors – or pre-capitalist factors, as they were called when we consider 19th century Ireland – the definition of entitlement can be even more ambiguous. And there are also flaws including the plunder of entitlement beyond the legal framework, such as the transfer of entitlements caused by infringement and robbery, and the actual food set and cultural conflicts. Lastly and more inevitably but always occurring, in the later stages of a famine people die because of epidemics rather than the famine itself, but it is difficult to distinguish the two in the actual analysis.

Currently, papers that use the entitlement approach to analyze the Irish famine are prone to three wrong situations. Firstly is to use pure economic terms and methods, such as the concepts of entitlements and exchange, market set and individual set, and combine the supply and demand curve analysis to demonstrate the applicability of the entitlement approach. The secondly is to focus on a social culture level, but abandon quantitative methods and use historical or archaeological methods instead. And thirdly, they focus only on the years of the Great Famine, rather than considering it in the context of the entire history of the nineteenth century. In these wrong situations, scholars either focusing on statistical modeling or forgetting the whole history of Ireland before the famine or the stigma of Ireland after the famine.

Therefore, this paper is innovative in that it is based on historical data on the one hand, and on the other hand, it also uses mathematical modeling in economics and statistics, and at the same time, it applies the rights approach to the whole history of the 19th century as a developmental mechanism for discussing the changes in Ireland.

Chapter 3 | Data

"Malone: Me father died of starvation in Ireland in the Black 47. Maybe you've heard of it.
Violet: The Famine?
Malone: No, the starvation. When a country is full of food, and exporting it, there can be no famine. Me father was starved dead; and I was starved out to America in me mother's arms".
— "Man and Superman" by George Bernard Shaw

The Irish famine should be examined in the context of the entire 19th century history, rather than discussing the years of the famine alone, which on the one hand would lead to an excessively small sample size and thus ineffective statistics modeling, and on the other hand would lead to a entitlement approach that cannot be analyzed in the context of both positive and negative scenarios of population growth and population decline. Therefore, in collecting data, this paper adopts the strategy of collecting data from 1821 to 1900, where 1821 is the year of the first Irish census with complete documentation, and 1900 marks the end of Ireland's troubled 19th century.

In addition, this paper used population change – more specifically, the difference between current year's population and previous year's population – as the dependent variable to measure the impact of the entitlement approach on population gap, whether it be pre-famine or post-famine sustained growth or decline, thus realizing out the causal inference between entitlement approach and population change.

The dataset consists of 25 variables, including continuous variable population, various cereal prices, various cereal acreage, various cereal imports and exports, land tax, wages and categorical variables of if government taxed tithe and poor law status, also constructed variables, including cereal prices summed up except potatoes, cereal acreage summed up, and the difference in cereal imports and exports. Each year is an observation, totaling 80 observations from 1821 to 1900.

3.1 Data Sources

The data come from several primary sources, including (1) census data, (2) economic history research papers, and (3) original archival material from the National Library Ireland. Many materials only covered a few years, so this paper filled in the data by combining various materials. For example, regarding the price of oats, the data from 1821 to 1828 were obtained from Daniel's 2021 research, the data from 1829 to 1859 were obtained from Vamplew's 1980 research, and the data from 1850 to 1900 were obtained from Tuner's 1987 research.

When splicing material from different sources, this paper performs cross validation between the data to ensure accuracy. For example, when both D'Arcy and Bisshop documented wage conditions in 19th century, this paper verified the consistency of the overlapping data from the two papers, and only spliced the data after ensuring.

Below are all the variables and their sources:

Table 3.1: Data and Sources

Data	Details	Time	Sources
Population	Population	1821, 1831, ...	Irish Census [a]
		Remain years	Estimated population [b]
Wage	General Wage	1821 – 1900	(D'Arcy, 1989) & (Bishop, 1915)
Ground Rent	Ground Rent	1821 – 1829	(M Solar and Hens, 2013)
		1830 – 1849	(Geary and Stark, 2004)
		1850 – 1885	(Guinnane and Miller, 1996)
		1886 – 1900	NA
Tax	Tithe Status	1821 – 1900	(Brynn, 1970) & (Shaw, 2015)
Poor Law	Poor Law Status	1821 – 1900	Historical Record
Grain Price	Oat	1821 – 1828	(Daniel Cassidy, 2021)
		1829 – 1859	(Vamplew, 1980)
	Potato	1821 – 1845	(Kennedy and Dowling, 1997)
	Wheat	1824 – 1837	Southampton library

Continued on next page

Table 3.1: (Continued)

Data	Details	Time	Sources
	Barley	1821 – 1828	(Clark, 2004)
	O. P. W. B. [c]	1840 – 1900	(Barrington, 1926)
	O. P.	1821 – 1850	(Kennedy and Dowling, 1997)
	Agriculture index	1850 – 1900	(Turner, 1987)
Plant Acre	Potato	1821 – 1846	(Kenny et al., 2023) [d]
	O. W. B.	1821 – 1846	Estimated from Price Index
	O. P. W. B.	1847 – 1900	CSO agriculture report
Import	O. W. B.	1821 – 1838	NA
	O. W. B.	1839 – 1900	(Brunt and Cannon, 2004)
Export	Wheat	1821 – 1828	(Tennent, 1840)
	O. W. B.	1829 – 1838	(Vamplew, 1980)
	O. W. B.	1839 – 1900	(Brunt and Cannon, 2004)
	O. B.	1821 – 1828	NA

[a] *Irish census through history can be found in CSO. In 1851 census, there is a chapter discussing the differences between 1841 and 1851 to show the influence of famine.*

[b] *Base on Documenting Ireland: Parliament, People and Migration. This article estimates the population in non-census years based on Irish immigration, mortality, and mid-year population data.*

[c] *O = Oat, P = Potato, W = Wheat, B = Barley, the following abbreviations are the same*

[d] *The potato data in this section are estimated from the agricultural stock situation during this period. Unfortunately, due to the lack of specific yields and the fact that grain yields per hectare are changing, for example, in 1837, the barley yield could reach 24.9 cwt, but the yield from 1847 to 1851 was only 18cwt.*

In addition, there are a number of missing values, including the ground rent from 1886 to 1900, the imports of oats, barley, and wheat from 1821 to 1838, and the exports of barley and oats from 1821 to 1828. Considering that these missing values may be related to other variables, the `mice` package in `R` is used to fill these missing values with multiple imputation. Since the data in this article come directly from previous research and historical archives, there is no need to deal with outliers.

3.2 Research Hypothesis

The first part of this paper hypothesizes to focus on the trade-based entitlement, and based on the previous discussion, this entitlement consists of grain prices.

H_1**: A damage in trade-based entitlement, more specifically, an increase in the price of oats, wheat, barley, and potatoes lead to a decrease in population compared with last year.**

And when people received harm on their production-based entitlement, such as an unaffordable tax or land rent, that will also leads to a population decrease.

H_2**: A damage in production-based entitlement, more specifically, an increase in the ground rent and to tax the tithe, lead to an decrease in population compared with last year.**

The third is labor and the rewards received for labor, and, as noted earlier, while farmers' incomes were almost never derived from income compared to citizens, it is also necessary to examine the situation of income.

H_3**: A damage in own-labour entitlement, more specifically, an decrease in the wage, lead to an decrease in population compared with last year.**

The status of Poor Law is used to see the entitlement in inheritance and transfer.

H_4**: A damage in inheritance and transfer entitlement, more specifically, the lack of Poor Law will lead to an decrease in population compared with last year.**

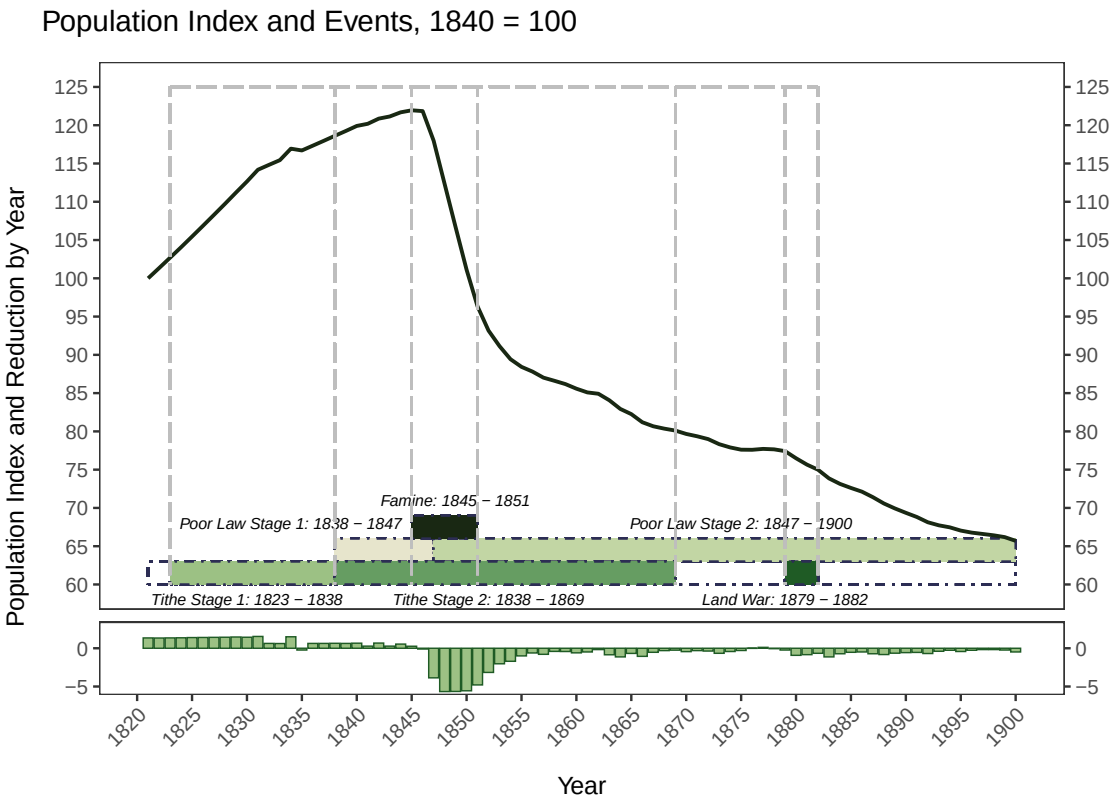
And a final hypothesis test to refute the FAD theory that population decline should not be blamed on acreage or acreage-related yield issues.

$H_{5a/5b}$**: There is no relationship between planting acreage and the increase or decrease of population compared with last year. / There is not enough evidence to suggest that larger planting acreage lead to an increase in population compared with last year.**

3.3 Statistical Description

The first step was to perform descriptive statistics on the dependent variable. The dependent variable is represented in the data as popgap, which is calculated using the current year's population minus the last year's population and describes the trend of the population compared to the last year, i.e., it includes both natural and mechanical growth, as well as the number of deaths due to starvation in the case of the famine. The curve in Figure 3.1 represents the change in population over time, with the lower-middle timeline marking the major historical events of the nineteenth century that had an impact on population, while the bar chart at the bottom records the change in population within the year.

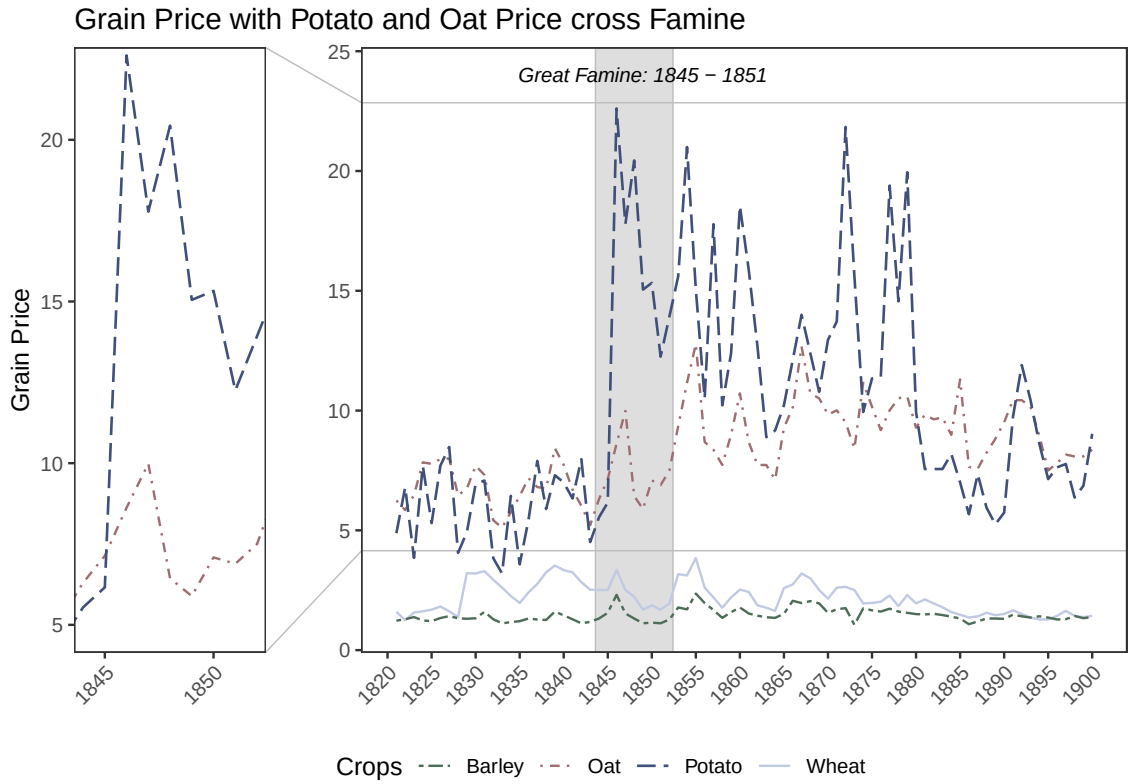
Figure 3.1: Population Index, Decrease and Evens, 1821 – 1900



The first point in time when population growth slowed down was in 1838, when the reform of the tithe and poor laws took place; the second point was the period of famine, when the population began to decline significantly.

Figure 3.2 depicts the movement of cereal prices throughout the 19th century, especially during the famine, which helps us to visualize the subsequent regression model. When we correspond to the price curves and the population change curves in Figure 3.1, it appears we can see a link between peaks in price and peaks in population decline, for example, the peak in the price of potatoes and oats in 1879, coupled with the effects of the Land War, and the correspondingly rapid decline in population. While at 1882, the decline in population slowed down after the Land Wars, and also related to the relatively smoother society and prices.

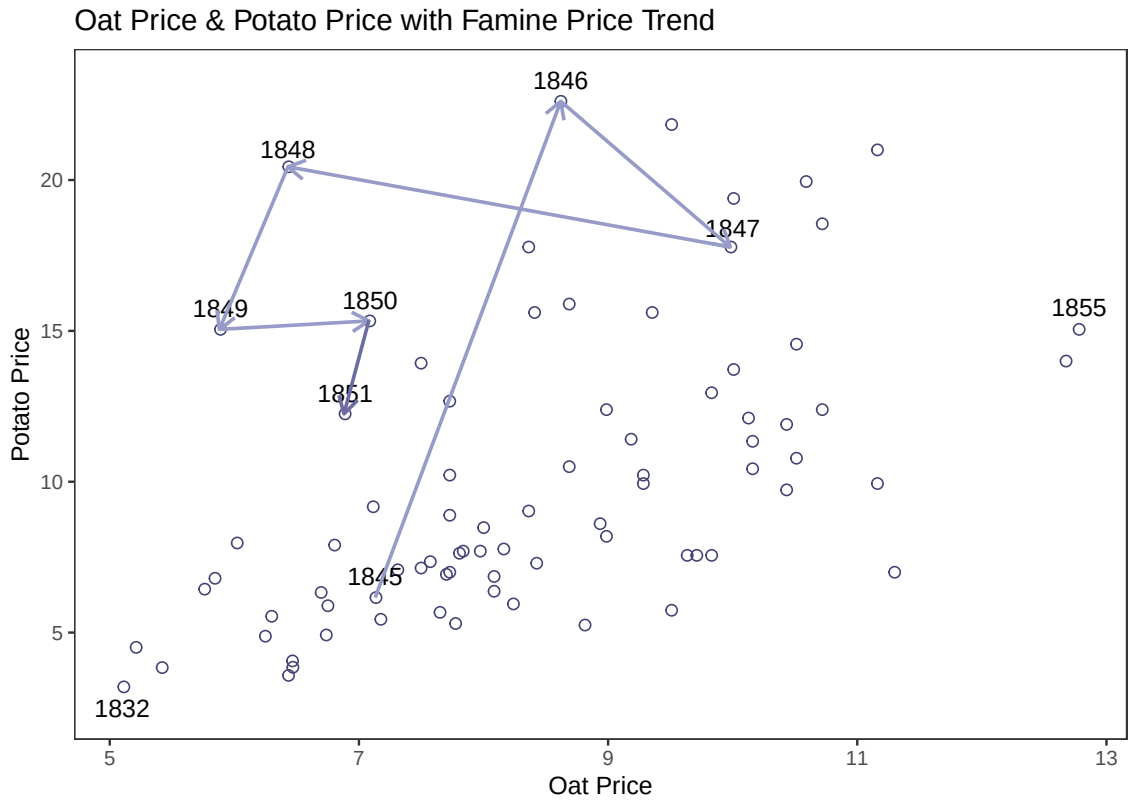
Figure 3.2: Grain Price, 1821 – 1900



Also we must pay attention to theory of substitution. Potatoes and oats, as the dominant Irish crops of the 19th century and in the Irish diet, should have been substitutes for each other. The relationship between their prices can be seen in Figure 3.3.

The arrows describe the price trends of the two grains during the famine, and the suddenly rise in the prices of both grains in 1846 may be directly related to the severe disaster of 1847, i.e., as stated earlier, an impairment of trade-based entitlement. While

Figure 3.3: Potato Price & Oat Price, 1821 – 1900



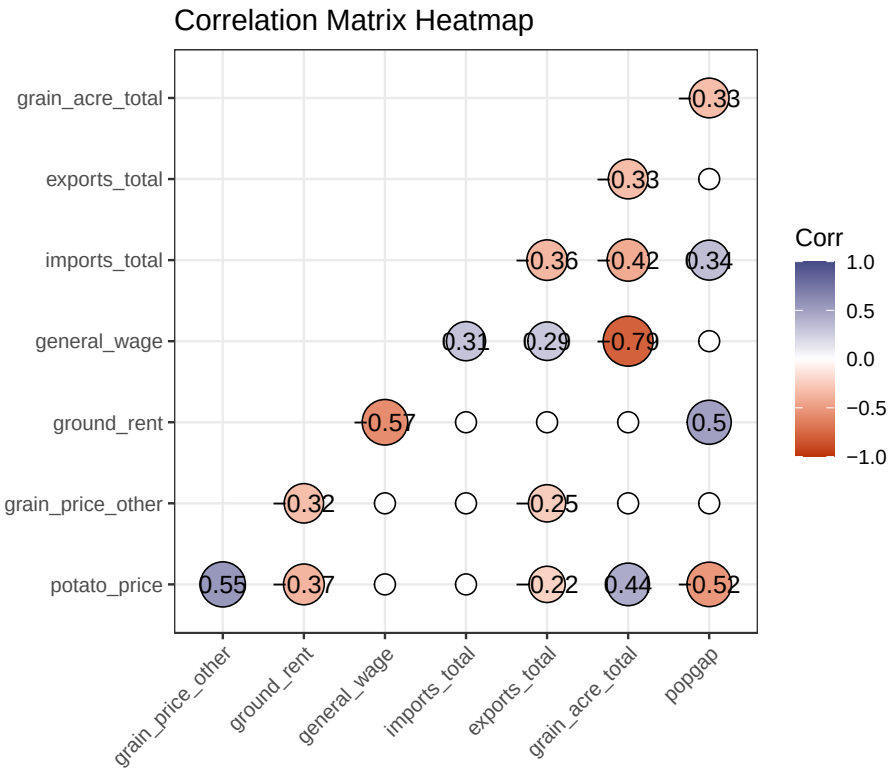
at the same time the sustained increase in the price of potatoes but the decrease in the price of the substitute oats from 1847 to 1848, as well as subsequent fluctuations in the prices of both, seem to foreshadow the famine and it was fading.

For Figure 3.3, there are two other noteworthy points in time, 1832 and 1855, where the coordinates for 1832 show that both potato and oat prices were at extremely low levels, corresponding to well-established farmers' trade-based entitlements, and historically, a period of rapid population growth in Ireland. But in 1855, when the famine had already passed, it can be noted that the price of oats in 1855 was abnormal, however, the fact that famine did not continue in 1855 was largely due to prices of other grains, including potatoes, wheat, barley, etc., did not rise in the same year, and the existence of substitutes compensated for the farmers' impaired trade-based entitlement.

Before proceeding with the regression, it is necessary to review the relationship between the variables. Figure 3.4 depicts the relationship between the independent variables and between the independent and dependent variables, where the gaps indi-

cate insignificant correlation coefficients. The correlations between the independent variables are not repeated here because they are largely consistent with empirical inferences, e.g., the moderate correlation between potato prices and the prices of other cereals, the weak negative correlation between volume of imports and exports, etc. Also there is no high correlation between the independent variables.

Figure 3.4: Regression Correlation Matrix



More noteworthy is the relationship between independent and dependent variables in Figure 3.4. The dependent variable `popgap` is significantly related to `potato_price`, `ground_rent`, `grain_acre_total` and `imports_total`. However, non-significant correlation coefficients do not directly lead to the conclusion that they should be excluded from the regression model — this tends to lead us to ignore non-linear relationship in nature. This paper will further explore these potential nonlinear relationships in the next chapter, along with a discussion of the regression methods used.

3.4 Replication

All the replication file can be found in this website:

`https://github.com/chxiii/Dissertation_Summer2024`

Chapter 4 | Methods

– "Open the gates now. Private, lower your weapon".

– "Not till we feed these people. Court martial me, sir. Do whatever you want with me but not till those people are fed".

— "Black 47" by Lance Daly

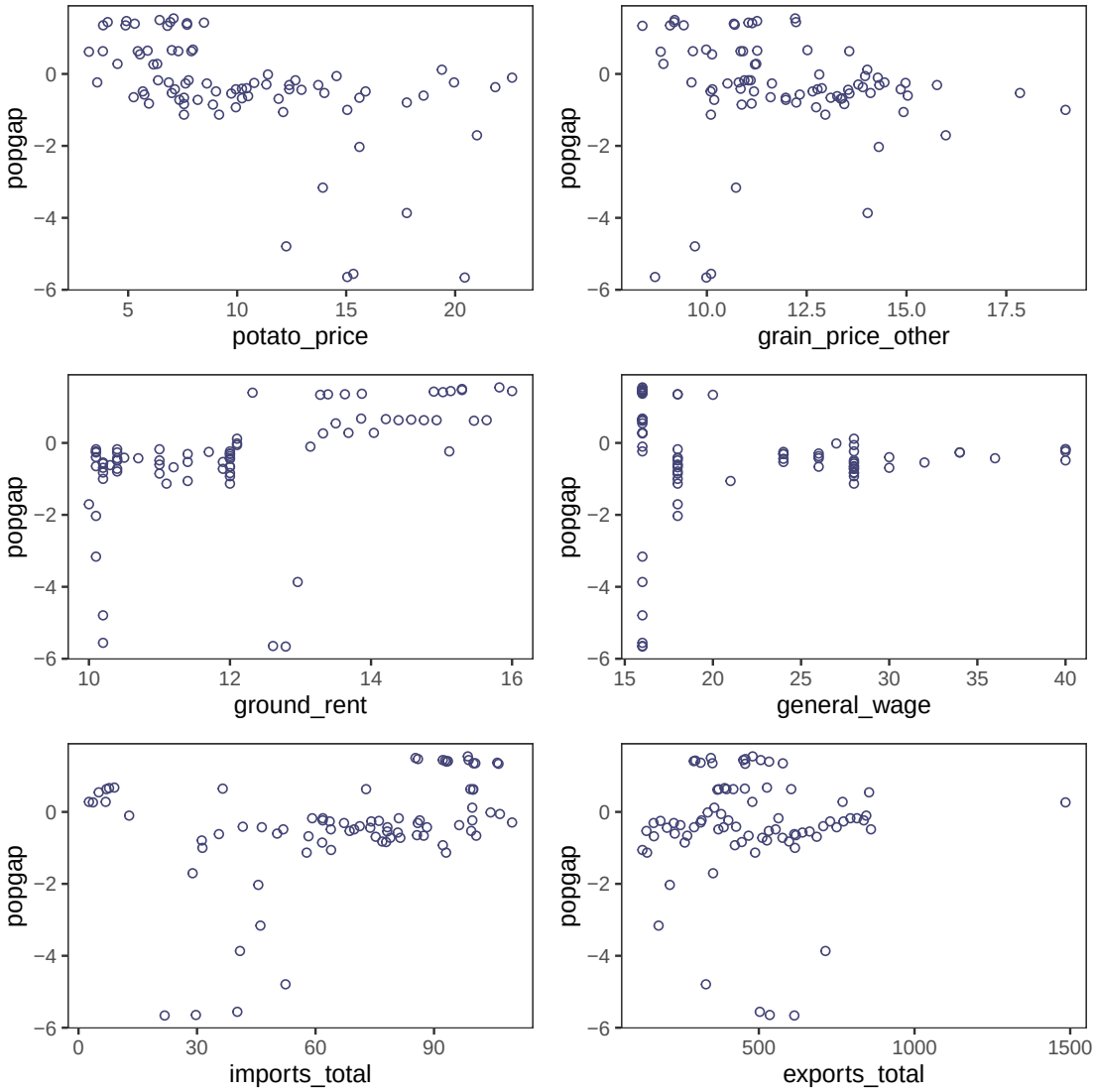
4.1 Generalized Additive Model

Due to the difficulty in capturing the non-linear relationship, it is necessary to use scatter plots to observe what the non-linear relationship between the independent and dependent variables is. Figure 4.1 provides an overview of the relationship between independent and dependent variables. The three scatter plots in the first column represent three sets of independent and dependent variables with significant linear relationships, while the three scatter plots in the second column represent three sets of non-significant linear, or non-linear, relationships.

Based on the theory of the entitlement approach mentioned earlier, it is indeed possible that there is a non-linear relationship between the independent and dependent variables, for example, when the price of cereals rises marginally, farmers may grow as a result of this profit, whereas when the price of cereals rises significantly, the farmers' trade-base entitlement is consequently jeopardized, and the population of the year ends up declining. According to this logic, linear regression is not a very good choice here and it is necessary to take other forms of non-linear regression for analysis.

In the scatter plot of Figure 4.1, a non-linear trend can be observed for all three variables in the second column, for example, for wages, it seems that the initial rise was very beneficial for the farmers' production-based entitlement, and as it continued to rise there was a diminishing marginal benefit in economic theory.

Figure 4.1: Regression Scatter



Therefore, generalized additive model was used as the main approach in this paper since it is efficient in solving non-linearly relationship from variables by using smooth functions. Wood demonstrates the usability of the GAM method in non-linear data and reduces the risk of over-fitting by introducing penalty coefficients in corresponding calculations (Wood, 2001). Recent studies in the demographic have shown the GAM approach possesses a more significant performance than the GLM approach in fitting regressions (Potts and Rose, 2018). In addition, there are scholars who used GAM for entitlement analysis (Ardyanto, 2006), and also performed a good fit between GAM and entitlement research.

Variables in regression included: `potato_price`, `grain_price_other`, `ground_rent`, `if_tithe`, `general_wage`, `poorlaw`, `imports_total`, `exports_total`. The second regression model includes the variables `grain_acre_total`. Based on the observation of scatter and correlation matrix, a smoothing function was added to the variables `grain_price_other`, `general_wage`, and `exports_total`.

Imports and exports data was used as control variable due to literatures that can be examined. This data during famines have always been a focus of debate among different schools, because differences in views will directly lead to the division between nationalism and revisionism — to put it more bluntly, it determines whether scholars will target 19th century's British government.

> *"During all the famine year, Ireland actually producing sufficient food, and wool and flax to feed and clothe not nine, but eighteen millions of people".* (Mitchel, 1905)
>
> *"At least, historians of Ireland, even the native-born ones, taking them as a group, were not as revisionist in their perspective".*(Donnelly Jr, 1996)

The first advantage of using this part of data as a control variable is that it maintains what Weber called value neutrality. Not using import/export data to validate the hypothesis is essentially stepping outside the discourse of the nationalism/revisionism debate and using the precondition of "in the presence of consistent import/export data" to examine changes in the entitlements. Secondly, the imports and exports amount will directly related to the domestic economic, as scholars (Tennent, 1840) pointed out in 19th century with a research in the transactions between Ireland and UK, in turn, create a chain reaction on everyday life in terms of price indices, market coverage, etc, as well as having an impact on the population and cultivation of the country (Solar, 2015). To summarize, both from a neutral point in view of the theoretical and from a precise point in the view of analysis, imports and exports data should be controlled when discussing people's entitlements.

The formulation of the regression model is written below, including the assumptions represented by each variable, smooth term and control variables:

$$
\begin{aligned}
\texttt{E(popgap)} = \beta_0 &+ \beta_1 \times \texttt{potato\_price} + f_1(\texttt{grain\_price\_other}) \ldots \textit{(H1)} \\
&+ \beta_2 \times \texttt{ground\_rent} + \beta_3 \times \texttt{factor(if\_tithe)} \ldots\ldots \textit{(H2)} \\
&+ f_2(\texttt{general\_wage}) \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots \textit{(H3)} \\
&+ \beta_4 \times \texttt{factor(poorlaw)} \ldots\ldots\ldots\ldots\ldots\ldots\ldots \textit{(H4)} \\
&+ \beta_5 \times \texttt{imports\_total} + f_3(\texttt{exports\_total}) \ldots \textit{Controlled} \\
&+ \epsilon
\end{aligned}
$$

$$
\begin{aligned}
\texttt{popgap} = \beta_0 &+ \beta_1 \times \texttt{grain\_acre\_total} \ldots\ldots\ldots\ldots\ldots\ldots (\textit{H5a/5b}) \\
&+ \beta_5 \times \texttt{imports\_total} + + \beta_6 \times \texttt{exports\_total} \ldots \textit{Controlled} \\
&+ \epsilon
\end{aligned}
$$

4.2 Assumptions Test

This paper fits two regression model. The first regression model is a GAM model, which is used to prove *H1*, *H2*, *H3* and *H4*; the second regression model, due to the linear relationship between variables `grain_acre_total` and `popgap`, is a linear regression, which is used to prove *H5*. In fact, for the second regression model, the linear regression and the GAM model have the same AIC, and to follow the modeling principle of simplicity, linear regression is used for fitting.

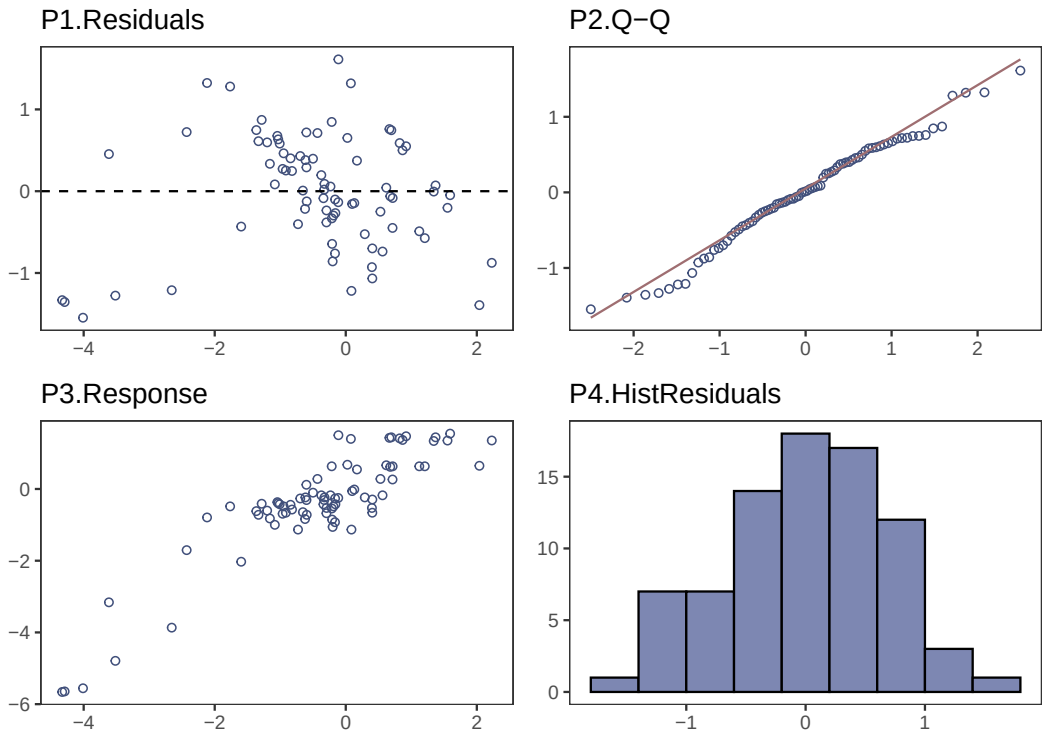
The necessity and feasibility for the use of the GAM must be justified before proceeding with the regression analysis. The first is the test of multicollinearity. Although GAM is not as sensitive to multicollinearity as linear regression due to the introduction of the smoothing function, however, excessive correlation between independent variables can still lead to errors in stability and explanations ability in the regression results, so the corresponding VIF test is necessary. The results of VIF test shows in Table 4.1, which indicates independence among the variables of the regression model is satisfied and there are no highly correlated independent variables.

Table 4.1: Model Variance Inflation Factors (VIF)

Variable	VIF	Variable	VIF
potato_price	2.044	general_wage	5.390
grain_price_other	1.739	imports_total	6.844
ground_rent	3.716	exports_total	1.918
factor(if_tithe)1	5.666	factor(poorlaw)1	4.606

The model was tested with `gam.check()` in `R`, returning results in Figure 4.2.

Figure 4.2: Regression Check



From $P1$, it appears that the distribution of the residuals revolves around the $Y = 0$ line with a mean approximately equal to 0 and no pattern can be found; whereas the Q-Q plot of $P2$ indicates a normal distribution structure of the data; $P3$ also shows a uniform and random distribution between the response value and fitting value; and finally, the residuals indicated by $P4$ show a normal distribution.

It is also important to state the advantages of using GAM over using LM for the data format of this study. GAM was found to have a significantly higher R-squared and a lower AIC compared with LM. Figure 4.2 shows the details:

Table 4.2: Regression Results: GAM and Linear

	Dependent variable:	
	popgap	
	GAM	LM
Coefficients are omitted to save space and will be shown in next Chapter		
Observations	80	80
Adjusted R^2	0.741	0.570
AIC	201.470	235.916
Residual Std. Error		0.990 (df = 71)
F Statistic		14.115^{***} (df = 8; 71)
Note:		*p<0.1; **p<0.05; ***p<0.01

4.3 Regression Results

Based on regression results (Table 4.3, row GAM), we can interpret the coefficients: in terms of the trade-based entitlement, an 1 unit increase in the price of potatoes, the population change within a year is associated with an average increase of -7%; In terms of the production-based entitlement, an 1 unit increase in the ground rent, the population change within a year is associated with an average increase of 34%, but maybe due to `if_tithe` use a binary form to describe the effect between tithe and population change and the year of compulsory tithe is not many during century, so the coefficient is not significant ($p = 0.424$); In terms of the own-labour entitlement, there is a significant relationship between wage and population change can be observed, and it will be more clear explained in the smooth term interpret part; In terms of the inheritance and transfer entitlement, years with Poor Law will have an average 36% increase in population change compared with years without Poor Law.

A description of the control variables reveals that an 1 unit increase in the imports amount, the population change within a year is associated with an average increase of 4%, which is fit to the empirical knowledge and as well as part of the transfer and inheritance entitlement. But there is no significant relationship be observed between the exports grain amount and population change,

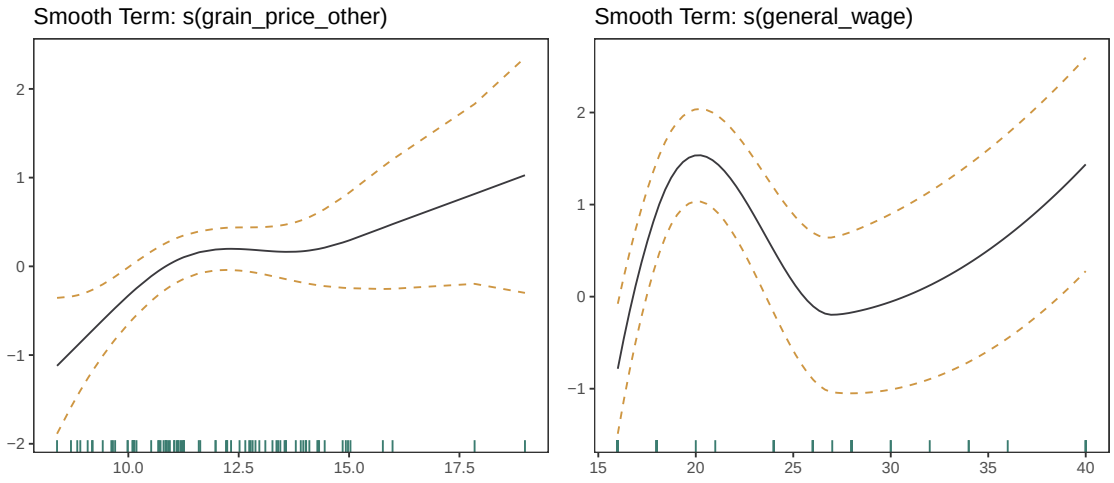
Further data-based rebuttals to the FAD theory can be made here. The only significant coefficient under 10% confidence level in the model is grain import amount ($p = 0.055$), and regarding grain planting acreage and export amount, they are all non-significant, i.e., there is no relationship between planting acreage and population change, as well as export food amount, which prove *H5*: **There is not enough evidence to suggest that larger planting acreage lead to an increase in population compared with last year**.

Table 4.3: GAM, FAD LM, and General LM

	Dependent variable: popgap		
	GAM	FAD LM	General LM
potato_price	-0.079^{***}		-0.107^{***}
	(0.028)		(0.033)
grain_price_other			0.179^{**}
			(0.069)
grain_acre_total		-0.002	
		(0.001)	
ground_rent	0.342^{***}		0.082
	(0.118)		(0.119)
factor(if_tithe)1	0.450		1.159^{**}
	(0.559)		(0.535)
general_wage			0.050
			(0.037)
factor(poorlaw)1	3.616^{***}		3.103^{***}
	(0.617)		(0.752)
imports_total	0.044^{***}	0.014^{*}	0.042^{***}
	(0.008)	(0.007)	(0.010)
exports_total		0.0003	0.001
		(0.001)	(0.001)
Constant	-7.420^{***}	-0.072	-7.751^{***}
	(1.391)	(1.686)	(1.964)
s(grain_price_other)	**		
s(general_wage)	***		
s(exports_total)			
Observations	80	80	80
Adjusted R^2	0.741	0.127	0.570
AIC	201.470		235.916
Residual Std. Error		1.412 (df = 76)	0.990 (df = 71)
F Statistic		4.827^{***} (df = 3; 76)	14.115^{***} (df = 8; 71)
Note:			*p<0.1; **p<0.05; ***p<0.01

Figure 4.3 visualizes the smooth term and describes the relationship between smooth term and population change. The smooth term `exports_total`, due to it is imported to model as control variable firstly, and not significance secondly, is not showed:

Figure 4.3: Significant Smooth Term Plot



Regarding the relationship between other grain price and population, we can see a positive relationship from approximately 8.5 to 12, then stable till 15, and then positive again. A possible explanation would be when grain price grows in lower price interval, it related to the profit of peasant, which makes a increase in population, while when it grows in high price interval, it related to a price index increase due to the development of the whole society. As for middle price interval, with price rise there is a no or even negative correlation between dependent and independent variables.

Regarding the relationship between wage and population, we can see a positive relationship from 16 to 21, then negative relationship from 21 to 26, finally appears to positive again. This paper argues this trend change is also due to the fact that the people benefit at the beginning when wages increase, and that the increase in the middle range of wages is perhaps linked to inflation, while the increase in the high range is the general development of the society.

4.4 Robustness Test

The GAM of this paper is tested for robustness, and the main methods include replacing the model, adding independent variables, changing the sample range, and changing the treatment of missing values. The results are presented in Table 4.4.

Firstly, as mentioned earlier, the robustness of GAM is tested using a linear regression model (Model 2). Compared to GAM, the LM shows differences in the coefficient assignments of $H2$, mainly the insignificant coefficient of land rent and the significant coefficient of tithe. This difference is acceptable because both are used to describe production-based entitlement, and therefore small differences in the coefficients in the same hypothesis are not sufficient to indicate that the model is not robust. Otherwise, all other coefficients of LM are generally consistent with the GAM.

Secondly, variable `year` is put into the model (Model 3) to exclude the influence between year and population, e.g., industrial revolution, land war, etc. The coefficients are stable after adding variable `year`.

Thirdly, due to the mechanism of population change maybe different during time, which is suggested by typical Modernization theory (Tipps, 1973) in development field, and Ireland may be considered as a pre-modern society before famine and development rapidly at the end of 19th century, so it is necessary to cut half observations to clear the influence if it exist (Model 4). The results also shows a similar coefficient, except the coefficient of potato price appears a stronger negative trend than standard GAM due to the effect of famine is enlarged in the first half of 19th century.

Lastly, as mentioned before, this paper use multiple imputation to deal with missing value in ground rent, import and export data, and to valid the robustness of GAM, regression imputation will be conducted to create a new model to compare. Also, similar coefficients are appeared after changing imputation method.

In a word, the robustness of the GAM receives support from multiple models, which means the conclusion of GAM has a good credibility.

Table 4.4: Robustness Test

	Dependent variable: popgap				
	Model 1 *standard*	Model 2 *linear*	Model 3 *year*	Model 4 *half*	Model 5 *mice*
potato_price	−0.079***	−0.107***	−0.096**	−0.133**	−0.063*
	(0.028)	(0.033)	(0.028)	(0.050)	(0.025)
grain_price_other		0.178*			
		(0.069)			
ground_rent	0.342***	0.082	0.306*	0.266·	0.323**
	(0.118)	(0.119)	(0.123)	(0.155)	(0.111)
factor(if_tithe)1	0.450	1.159*	0.905	1.999·	0.924·
	(0.559)	(0.535)	(0.610)	(1.086)	(0.509)
general_wage		0.050		1.021***	1.021***
		(0.037)		(0.261)	(0.261)
factor(poorlaw)1	3.616***	3.103***	2.867***	3.832***	3.812***
	(0.617)	(0.752)	(0.664)	(0.901)	(0.523)
imports_total	0.044***	0.042***	0.032***	0.049***	0.056***
	(0.008)	(0.010)	(0.009)	(0.012)	(0.008)
exports_total		0.001			
		(0.001)			
year			-0.004*		
			(0.017)		
s(grain_price_other)	**		**	*	***
s(general_wage)	***		***		***
s(exports_total)					
Observations	80	80	80	40	80
Note:					*p<0.1; **p<0.05; ***p<0.01

During the creating of different models, the influence of potato price, as well as the smooth term, is significant in every models, which gives a strong evidence of the relationship between the trade-based entitlement and population change. The secondly common significance appears in the Poor Law, and this also makes a comprehensive conclusion that Poor Law increase peoples' entitlement in transfer and inheritance. General wage shows the similar situation and can be found significance in either regular term or smooth term either. As for ground rent, after adding variable `year`, in Model 3 and Model 4 it is losing significance, which is caused by the history events caused by history like land war or related laws.

4.5 Research Design

Before further discuss the findings, it is necessary to review the research logic.

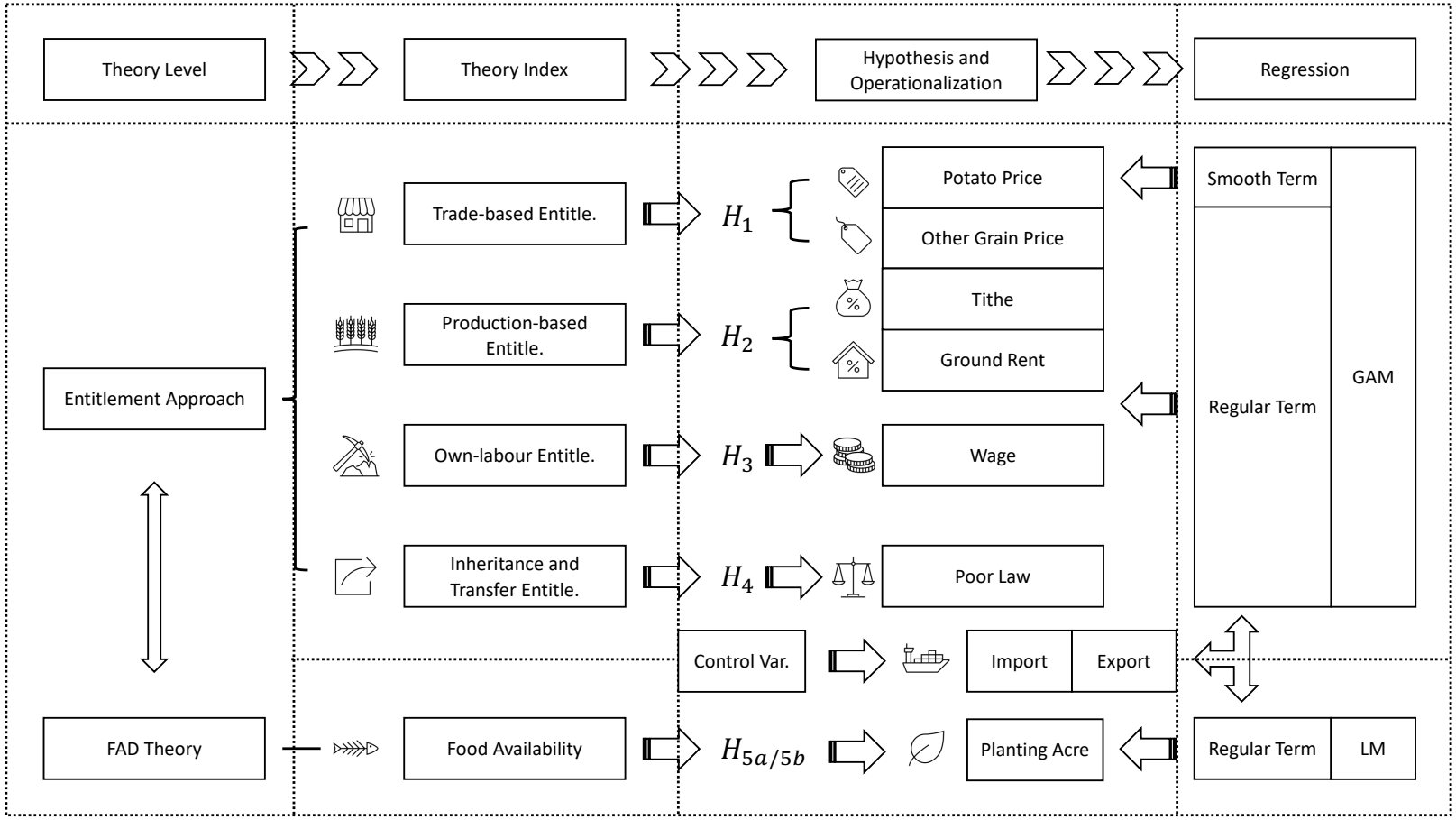
Firstly is the theoretical framework: (1) entitlement approach used by Amartya Sen in his book "Poverty and Famine", and (2) refutation of the FAD theory. According to Sen's construct, the entitlement approach consists of the following four indicators: trade-based entitlement, production-based entitlement, own-labour entitlement and Inheritance and transfer entitlement; while the FAD theory includes one indicator, the area under food cultivation. This paper generalizes the entitlement approach as a demographic and developmental mechanism based on the literature and attempts to explore if the changes in people's entitlements, which is the independent variable, will affect population change within the year, which is the dependent variable.

Further, hypotheses are made base on these indicators, with each indicator corresponding to a hypothesis and each hypothesis corresponding to more specific variables in the dataset. $H1$ corresponds to price of grains, $H2$ corresponds to ground rent and presence or absence of tithing, $H3$ corresponds to general wage, $H4$ corresponds to the Poor Law, and $H5$ corresponds to the grain planting acreage. Import and Export amount were used as control variables into regression model.

The GAM was used in this study for a number of reasons, including (1) there is no significant linear relationship between some independent variables and the dependent variable, but there is an observable nonlinear relationship and theory supports the existence of such a nonlinear relationship, and (2) the introduction of a smoothing function in the GAM can predict this nonlinear relationship in a good way. Relative examines have been performed before formally discussing the regression, including the VIF test for multicollinearity, AIC and R-square comparisons for linear regression, the residual randomness and normality test, and robustness test. All of the results identify the GAM as a reasonable regression model under this data.

Figure 4.4 visualizes the framework of the entire research.

Figure 4.4: Research Design



Chapter 5 | Discussion

"– Those dying generations – at their song,

The salmon-falls, the mackerel-crowded seas,

Fish, flesh, or fowl, commend all summer long

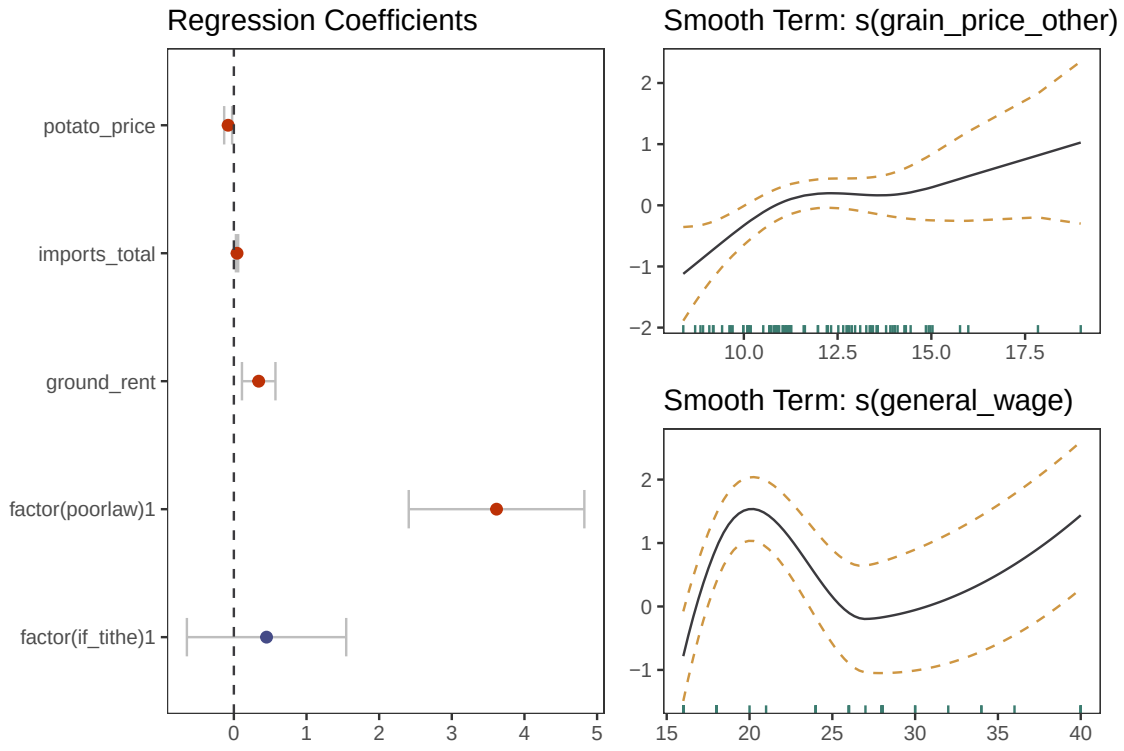
Whatever is begotten, born, and dies".

— "Sailing to Byzantium" by William Butler Yeats

5.1 Entitlements and Population

Through the visualisation of coefficients of regular and smooth term, the positive or negative relationship between variables is clearly showed. The first step is to review the hypothesis which are made before and to see the significance.

Figure 5.1: GAM Coefficients Summary



$H1$ describes a status between trade-based entitlement and population change, which can be proved with the coefficient of potato price but not with the smooth term trend of other grain price. This result responds to the main crop of the famine, which is the potato. As discussed earlier, the fluctuation in the price of potatoes, the most important food for livelihoods, points directly to changes in population, i.e., when the price rises, there is a significant decrease in population. However, there is a lack of consideration that the price could have a natural change with the times. Currency reforms, structure of production shifts, demographic or dominant cultural changes may directly lead to price anomalies. Anything, when related to currency and time series, should be drew conclusions carefully. Thus, $H1$ only can be partly proved with the data of potato price, that is, **A damage in people's trade-based entitlement, especially when the entitlements to get the most dominant food in diet structure is hurt, will lead to a decrease in population in a year.** As for other grain, acting as substitute products, the raise of their prices may not related to a damage in people's trade-based entitlements, or effect population less compared with the dominant food.

In fact, variables directly related to currency can be discussed together, which are other grain price, general wage and ground rent. In Ireland, price goes high because of multiple positive or negative reasons, including relationship between peasant and landlord, UK market or urbanization (Kennedy and Solar, 2014). However, the significance positive coefficient of the ground rent, plus a non-significant coefficient in tithe, anyway, suggest our $H2$ is fail to prove, that is, **We do not find enough evidence to prove the casual relationship between production-based entitlement and population change.** One possible reason for this is the gap between country and urban of Ireland, more specifically, when we discuss the famine and the construction of the entitlement approach, we are in fact looking primarily at the countryside, whereas the variable of ground rent, especially when we use currency as the scale, is likely to be more associated with urban dwellers. With the rapidly urbanization of Ireland in the 19th century (Graham and Proudfoot, 1992), it is quite possible that an increase in land rent was instead positively associated with an increase in people's entitlements.

Following the logic, the $H3$, which focus on wage is a good example to interpret. The smooth term of wage is divided into three sections obviously, and it follows the logic we use previously totally. In the first section, the raise of the wage shows a huge effect on population increase, which prove the $H3$ perfectly, while the second section suggest the interference from inflationary or other factors, with the increase of wage population decrease, and finally, a positive relationship can be observed again. Due to we confirm the existence of interference factors, $H3$ can be proved totally, that is, **A damage in people's own-labour entitlement, or the decrease of wage, will lead to a decrease of population.** In addition, when considering the distinguish of the groups, classes or times, the difference in curvature of the curve at low and high wages is also worth to analysis. Literature shows that there is a diminishing marginal effect of wages (Li, 2012), i.e. for peasants with lower wages, or in the early part of the nineteenth century, the population increase from a small wage gain was huge, whereas for the rest of the population with higher wages, or in the later part of the nineteenth century, when wages were generally higher, the stimulus of a wage increase to the population would have been much smaller.

Lastly is the Poor Law represented by $H4$, which also presents the largest positive coefficient within the key variables.

5.2 Limitation

Chapter 6 | Conclusion

"– Those dying generations – at their song,

The salmon-falls, the mackerel-crowded seas,

Fish, flesh, or fowl, commend all summer long

Whatever is begotten, born, and dies".

— "Sailing to Byzantium" by William Butler Yeats

Bibliography

Ardyanto, D. S. (2006), 'Granting autonomy as a conflict resolution between the government of indonesia and free aceh movement (gam)'.

Barrett, J. W. (2004), *Constructing hierarchy through entitlement: Inequality in lithic resource access among the ancient Maya of Blue Creek, Belize*, Texas A&M University.

Barrington, T. (1926), *A review of Irish agricultural prices*, Statistical and Social Inquiry Society of Ireland.

Bartoletti, S. C. (2001), *Black potatoes: The story of the great Irish famine, 1845-1850*, Houghton Mifflin Harcourt.

Beaumont, J. (2014), An isotopic and historical study of diet and migration during the great Irish Potato famine (1845-1852). High-resolution carbon and nitrogen isotope profiling of teeth to investigate migration and short-term dietary change at the Union workhouse, Kilkenny and Lukin street, London., PhD thesis, University of Bradford.

Beaumont, J., Geber, J., Powers, N., Wilson, A., Lee-Thorp, J. and Montgomery, J. (2013), 'Victims and survivors: stable isotopes used to identify migrants from the great irish famine to 19th century london', *American Journal of Physical Anthropology* **150**(1), 87–98.

Bishop, A. L. (1915), 'A history of the commercial and financial relations between england and ireland from the period of the restoration'.

Blackwell, M. (1845), 'Letter from mr. blackwell regarding the potato crop distemper', Unpublished letter. Detailed in other letters to be auctioned. Describes the infection of the potato crop across the estate.

Bourke, P. A. (1964), 'Emergence of potato blight, 1843-46.'.

Braa, D. M. (1997), 'The great potato famine and the transformation of irish peasant society', *Science & Society* pp. 193–215.

Brown, T. N. (1953), 'Nationalism and the irish peasant, 1800–1848', *The Review of Politics* **15**(4), 403–445.

Brunt, L. and Cannon, E. (2004), 'The irish grain trade from the famine to the first world war', *The Economic History Review* **57**(1), 33–79.

Brynn, E. (1970), 'Irish tithes in british politics', *Historical Magazine of the Protestant Episcopal Church* **39**(3), 295–306.

Cairns, D. and Richards, S. (1988), *Writing Ireland: colonialism, nationalism, and culture*, Manchester University Press.

Chauffour, J.-P. (2011), 'On the relevance of freedom and entitlement in development: new empirical evidence (1975-2007)', *World Bank Policy Research Working Paper* **5660**.

Clark, G. (2004), The price history of english agriculture, 1209–1914, *in* 'Research in Economic History', Emerald Group Publishing Limited, pp. 41–123.

Clarkson, L. and Crawford, M. (2001), *Feast and famine: food and nutrition in Ireland 1500-1920*, OUP Oxford.

Cousens, S. H. (1960), 'Regional death rates in ireland during the great famine, from 1846 to 1851', *Population Studies* **14**(1), 55–74.

Daly, M. (2006), Revisionism and irish history: The great famine, *in* 'The Making of Modern Irish History', Routledge, pp. 71–89.

Daniel Cassidy, B. (2021), Irish exchange rates 1698–1826: credit, market integration, and international trade, PhD thesis, School of Business and Economics, National University of Ireland, Galway.

D'Arcy, F. A. (1989), 'Wages of labourers in the dublin building industry, 1667-1918', *Saothar* **14**, 17–32.

De Nie, M. (1998), 'The famine, irish identity, and the british press', *Irish Studies Review* **6**(1), 27–35.

Donnelly, J. (2011), 'The irish famine', *BBC: British History* **17**.

Donnelly Jr, J. S. (1996), 'The construction of the memory of the famine in ireland and the irish diaspora, 1850–1900', *Éire-Ireland* **31**(1), 26–61.

Donnelly Jr, J. S. (2002), *The great Irish potato famine*, The History Press.

Dowley, L. J. (1997), 'The potato and late blight in ireland', *Famine* **150**, 49–65.

Duffy, P. (2017), Colonial spaces and sites of resistance: Landed estates in 19th century ireland, *in* '(Dis) Placing Empire', Routledge, pp. 15–40.

Engler, S., Luterbacher, J., Mauelshagen, F. and Werner, J. (2013), 'The irish famine of 1740-1741: causes and effects.', *Climate of the Past Discussions* **9**(1).

Fairlie, S. (1965), 'The nineteenth-century corn law reconsidered', *The Economic History Review* **18**(3), 562–575.

Fitzpatrick, D. (1995), 'Famine, entitlements and seduction: Captain edmond wynne in ireland, 1846-1851', *English Historical Review* pp. 596–619.

Flaherty, E. (2021), 'Common-pool resource governance and uneven food security: Regional resilience during the great irish famine, 1845–1852', *Journal of Agrarian Change* **21**(2), 285–312.

Fraser, E. D. (2003), 'Social vulnerability and ecological fragility: building bridges between social and natural sciences using the irish potato famine as a case study', *Conservation Ecology* **7**(2).

Geary, F. and Stark, T. (2004), 'Trends in real wages during the industrial revolution: a view from across the irish sea', *The Economic History Review* **57**(2), 362–395.

George, S. (1990), *Ill fares the land: essays on food, hunger, and power*, Penguin Books London.

Gilleard, C. (2016), 'The other victorians: age, sickness and poverty in 19th-century ireland', *Ageing & Society* **36**(6), 1157–1184.

GIST, J. (2008), 'Population aging, entitlement growth, and the economy', *Boomer Bust? Economic and Political Issues of the Graying Society [2 volumes]: Economic and Political Issues of the Graying Society* p. 173.

Goss, E. M., Tabima, J. F., Cooke, D. E., Restrepo, S., Fry, W. E., Forbes, G. A., Fieland, V. J., Cardenas, M. and Grünwald, N. J. (2014), 'The irish potato famine pathogen phytophthora infestans originated in central mexico rather than the andes', *Proceedings of the National Academy of Sciences* **111**(24), 8791–8796.

Grada, C. O. (1979), The population of ireland 1700-1900: a survey, *in* 'Annales de démographie historique', JSTOR, pp. 281–299.

Gráda, Ó. et al. (1995), *Ireland: a new economic history 1780–1939*, Oxford University Press.

Graham, B. J. and Proudfoot, L. J. (1992), 'Landlords, planning, and urban growth in eighteenthand early nineteenth-century ireland', *Journal of Urban History* **18**(3), 308–329.

Gray, B. (2011), 'From exile of citizens to deportation of non-citizens: ancient greece as a mirror to illuminate a modern transition', *Citizenship Studies* **15**(5), 565–582.

Gray, P. (2006), 'Famine and land in ireland and india, 1845–1880: James caird and the political economy of hunger', *The Historical Journal* **49**(1), 193–215.

Gray, P. (2010), 'Irish social thought and the relief of poverty, 1847–1880', *Transactions of the Royal Historical Society* **20**, 141–156.

Gray, P. (2021), 'Was the great irish famine a colonial famine?', *East/West* **8**(1), 159–172.

Guinnane, T. W. (1994), 'The great irish famine and population: the long view', *The American Economic Review* **84**(2), 303–308.

Guinnane, T. W. and Miller, R. I. (1996), 'Bonds without bondsmen: Tenant-right in nineteenth-century ireland', *The Journal of Economic History* **56**(1), 113–142.

Hamera, P. (2011), 'An outline of irish famine historiography', *The Linguistic Academy Journal of Interdisciplinary Language Studies* p. 65.

Henderson, L. (2005), 'The irish famine: A historiographical review', *Historia* **14**, 133–140.

Jongman, W. et al. (2006), 'The rise and fall of the roman economy: population, rents and entitlement', *Ancient Economies, Modern Methodologies: Archaeology, Comparative History, Models and Institutions* **12**, 237.

Kavanagh, P. and Quinn, A. (2006), *Collected poems*, Penguin Books.

Kelly, J. (1995), 'This great calamity: The irish famine 1845-52'.

Kelly, M. and Gráda, C. Ó. (2015), 'Why ireland starved after three decades: The great famine in cross-section reconsidered', *Irish Economic and Social History* **42**(1), 53–61.

Kennedy, L. and Dowling, M. W. (1997), 'Prices and wages in ireland, 1700-1850', *Irish Economic and Social History* **24**, 62–104.

Kennedy, L. and MacRaild, D. M. (2022), 'Perspectives on the great irish famine'.

Kennedy, L. and Solar, P. (2014), Markets and price fluctuations in england and ireland, 1785–19131, *in* 'A History of Market Performance', Routledge, pp. 287–307.

Kennedy, S. (2020), 'Beckett, evangelicalism and the biopolitics of famine', *Beckett Beyond the Normal* pp. 62–78.

Kenny, S., Lennard, J. and O'Rourke, K. H. (2023), 'An annual index of irish industrial production, 1800–1913', *The Economic History Review* **76**(1), 283–304.

Kinealy, C. (1990), 'The irish famine 1845-52', *North Irish Roots* **2**(5), 158–161.

Kinealy, C. (2006), *This great calamity: the great Irish Famine: the Irish Famine 1845-52*, Gill & Macmillan Ltd.

Kinealy, C. (2017), *The Great Irish Famine: impact, ideology and rebellion*, Bloomsbury Publishing.

Li, T. M. (2017), 'After development: Surplus population and the politics of entitlement', *Development and Change* **48**(6), 1247–1261.

Li, Y. (2012), 'Capital mobility, diminishing returns and wage inequality', *The Journal of International Trade & Economic Development* **21**(3), 321–345.

Lidwell-Durnin, J. (2020), 'Cultivating famine: data, experimentation and food security, 1795–1848', *The British journal for the history of science* **53**(2), 159–181.

Luchen, W. (2019), 'The naming of identity: The famine narrative in joseph o'connor's star of the sea and the transatlantic diasporic writing', *Foreign Literature Studies* **41**(5), 123.

M Solar, P. and Hens, L. (2013), 'Land under pressure: The value of irish land in a period of rapid population growth, 1730–1844', *Agricultural History Review* **61**(1), 40–62.

Madden, E. (2016), 'Aids and the hunger: Fiction, biopolitics and the historical imagination', *The Irish Review (1986-)* (53), 60–73.

McClure, J. (1848), 'Letter from james mcclure to his daughter margaret mcclure', Unpublished letter. From Ireland to Warrnambool, Victoria, Australia. Margaret McClure married Thomas Usher in 1845.

McGregor, P. and Cantley, I. (1992), 'A test of sen's entitlement hypothesis', *Journal of the Royal Statistical Society Series D: The Statistician* **41**(3), 335–341.

McGregor, P. P. (1989), 'Demographic pressure and the irish famine: Malthus after mokyr', *Land Economics* pp. 228–238.

McHugh, N. (1986), 'Famine and distress in drogheda during 1847', *Journal of the County Louth Archaeological and Historical Society* **21**(2), 157–178.

McNamara, P. (1850), 'Condition of ireland. illustrations of the new poor-law. cabin of pat mcnamara, village of clear', *The Illustrated London News* .

Miller, D. W. (1975), 'Irish catholicism and the great famine', *Journal of Social History* **9**(1), 81–98.

Mitchel, J. (1905), *An Apology for the British Government in Ireland*, AMS Press.
URL: *https://books.google.ie/books?id=w1AiAQAAIAAJ*

Mokyr, J. (1980), 'Malthusian models and irish history', *The Journal of Economic History* **40**(1), 159–166.

Mokyr, J. (2013), *Why Ireland starved: a quantitative and analytical history of the Irish economy, 1800-1850*, Routledge.

Mokyr, J. and Gráda, C. Ó. (2002), 'What do people die of during famines: the great irish famine in comparative perspective', *European Review of Economic History* **6**(3), 339–363.

Nally, D. (2008), '"that coming storm": The irish poor law, colonial biopolitics, and the great famine', *Annals of the Association of American Geographers* **98**(3), 714–741.

Newell, T., Meogher, O'Gorman, Walsh, J., O'Brien, Borrisoleigh and O'Reilly, P. (1847), 'Tally of the number of deaths attributed to potato famine in various irish parishes', *Freeman's journal* .

Ó Gráda, C. (1983), 'Malthus and the pre-famine economy', *Hermathena* (135), 75–95.

O'Brien, G. (1985), 'The new poor law in pre-famine ireland: A case history', *Irish Economic and Social History* **12**(1), 33–49.

O'Flynn, M. (2009), 'Food crises and the ghost of malthus', *New Proposals: Journal of Marxism and Interdisciplinary Inquiry* **3**(1), 33–41.

Oleksy, J. (n.d.), 'Irish potato famine: the irish versus the english', *Bergen Scholarly Journal* **46**(3), 50–58.

O'Neill, T. P. (1952), 'Food problems during the great irish famine', *The Journal of the Royal Society of Antiquaries of Ireland* **82**(2), 99–108.

O'Rourke, K. (1994), 'The economic impact of the famine in the short and long run', *The American economic review* **84**(2), 309–313.

Potts, S. E. and Rose, K. A. (2018), 'Evaluation of glm and gam for estimating population indices from fishery independent surveys', *Fisheries Research* **208**, 167–178.

Rangasami, A. (1985), ''failure of exchange entitlements' theory of famine: A response', *Economic and Political Weekly* pp. 1797–1801.

Ristaino, J. B. (2006), 'Tracking the evolutionary history of the potato late blight pathogen with historical collections', *Outlooks on pest management* **17**(5), 228.

Sen, A. (1982), *Poverty and famines: an essay on entitlement and deprivation*, Oxford university press.

Sen, A. (2014), 'Development as freedom (1999)', *The globalization and development reader: Perspectives on development and global change* **525**.

Shaw, D. J. (2015), 'An economic perspective on the irish tithe war of 1831-1838', *The Journal of European Economic History* **44**(3), 91.

Shaw, D. J. (2018), 'The composition for tithes act of 1823: Its revenue risk impacts across ireland', *The Journal of European Economic History* **47**(1), 87–148.

Smith, M. E. (2005), *Reckoning with the past: Teaching history in Northern Ireland*, Lexington Books.

Solar, P. M. (2015), 'Why ireland starved and the big issues in pre-famine irish economic history', *Irish Economic and Social History* **42**(1), 62–75.

Spedding, T. S. (1847), *Letters on the Poor-Law*, London, UK.

Tennent, E. (1840), 'Importation of flour—(ireland)', *Hansard Commons* **52**.

The Times Office, London, U. (1880), *The Great Irish Famine of 1845-1846: a collection of leading articles, letters and parliamentary and other public statements*, The Times Office, London.

Tipps, D. C. (1973), 'Modernization theory and the comparative study of national societies: A critical perspective', *Comparative studies in society and history* **15**(2), 199–226.

Tucker, R. E. (2016), 'A potato glossary', *Tucker Farms, Inc* .

Turner, M. (1987), 'Towards an agricultural prices index for ireland 1850-1914', *Economic and Social Review* **18**(2), 123–36.

Turner, M. (2002), *After the famine: Irish agriculture, 1850-1914*, Cambridge University Press.

Vamplew, W. (1980), 'A grain of truth: the nineteenth-century corn averages', *The Agricultural History Review* **28**(1), 1–17.

Waters, H. (1995), 'The great famine and the rise of anti-irish racism', *Race & Class* **37**(1), 95–108.

Watts, M. J. (2013), *Silent violence: Food, famine, and peasantry in northern Nigeria*, Vol. 15, University of Georgia Press.

Wegge, S. A., Anbinder, T. and Ó Gráda, C. (2017), 'Immigrants and savers: A rich new database on the irish in 1850s new york', *Historical Methods: A Journal of Quantitative and Interdisciplinary History* **50**(3), 144–155.

Weir, D. R. (1991), Malthus's theory of population, *in* 'The World of Economics', Springer, pp. 401–406.

Whelan, K. (2012), 'Clachans: landscape and life in ireland before and after the famine', *At the anvil: essays in honour of William J. Smyth* pp. 453–75.

Wood, S. N. (2001), 'mgcv: Gams and generalized ridge regression for r', *R news* **1**(2), 20–25.

Zadoks, J. (2008), 'The potato murrain on the european continent and the revolutions of 1848', *Potato Research* **51**(1), 5–45.

Żemojtel-Piotrowska, M. A., Piotrowski, J. P., Cieciuch, J., Calogero, R. M., Van Hiel, A., Argentero, P., Baltatescu, S., Baran, T., Bardhwaj, G., Bukowski, M. et al. (2015), 'Measurement of psychological entitlement in 28 countries', *European Journal of Psychological Assessment* .