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

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M.SC. APPLIED SOCIAL DATA SCIENCES

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Abstract

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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In 1926, as a result of the Irish independence 5 years earlier, the Central Statistical Office was capable to integrate historical documents since famine and showed the fact that the population was decline of roughly 22% [3] in the 10 years from 1841 to 1851.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.

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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).

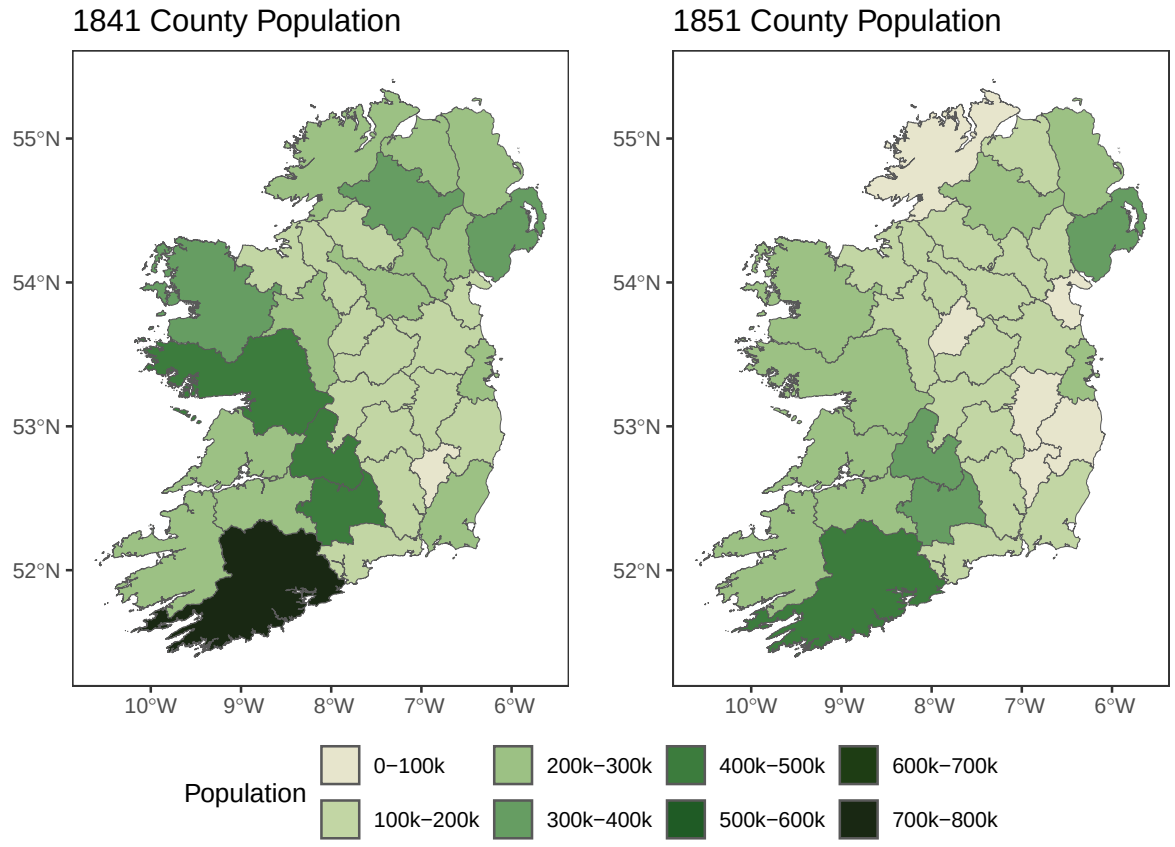
Throughout the history of the famine and pre-famine period, the role of the Poor Law cannot be ignored. The Poor Law was introduced in Ireland in July 1838 with the blueprint of the Poor Law in England and Wales, and provided for the establishment of 130 trade unions throughout Ireland, where the poor 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:

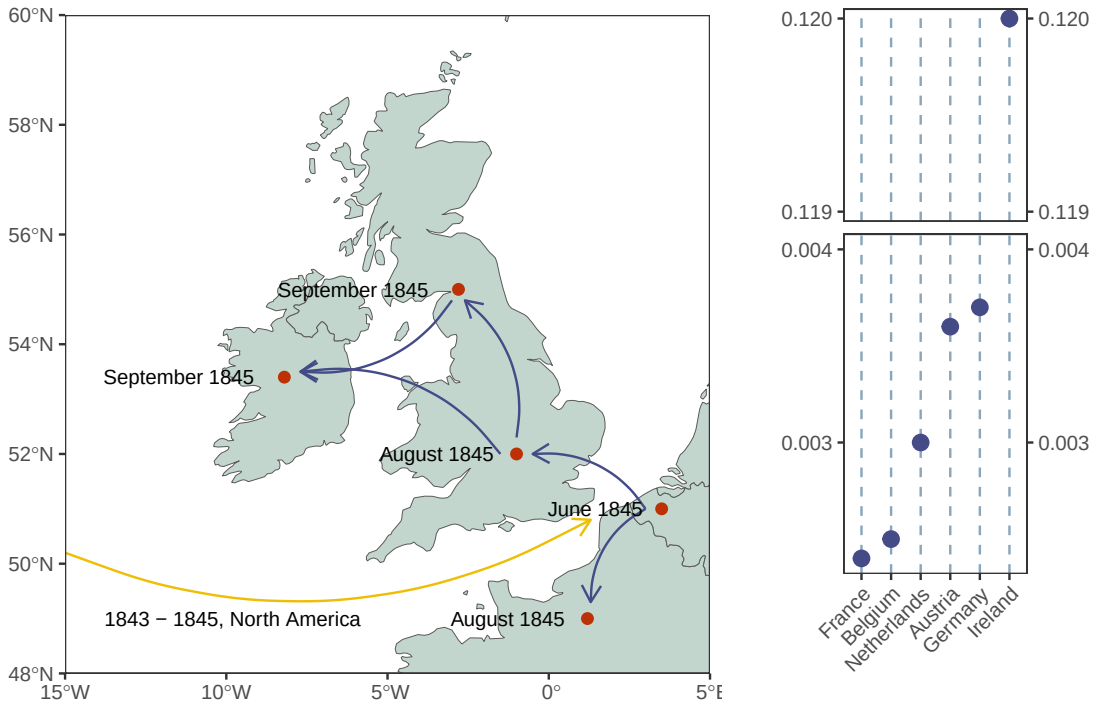
> *"In 1845, about the month of July or the beginning of August, the potatoes withered and decayed all over the country like what you have seen on the watersides with early frost, [. . .] poor families were badly off and striving to live on bran".* (McClure, 1848)

> *"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.

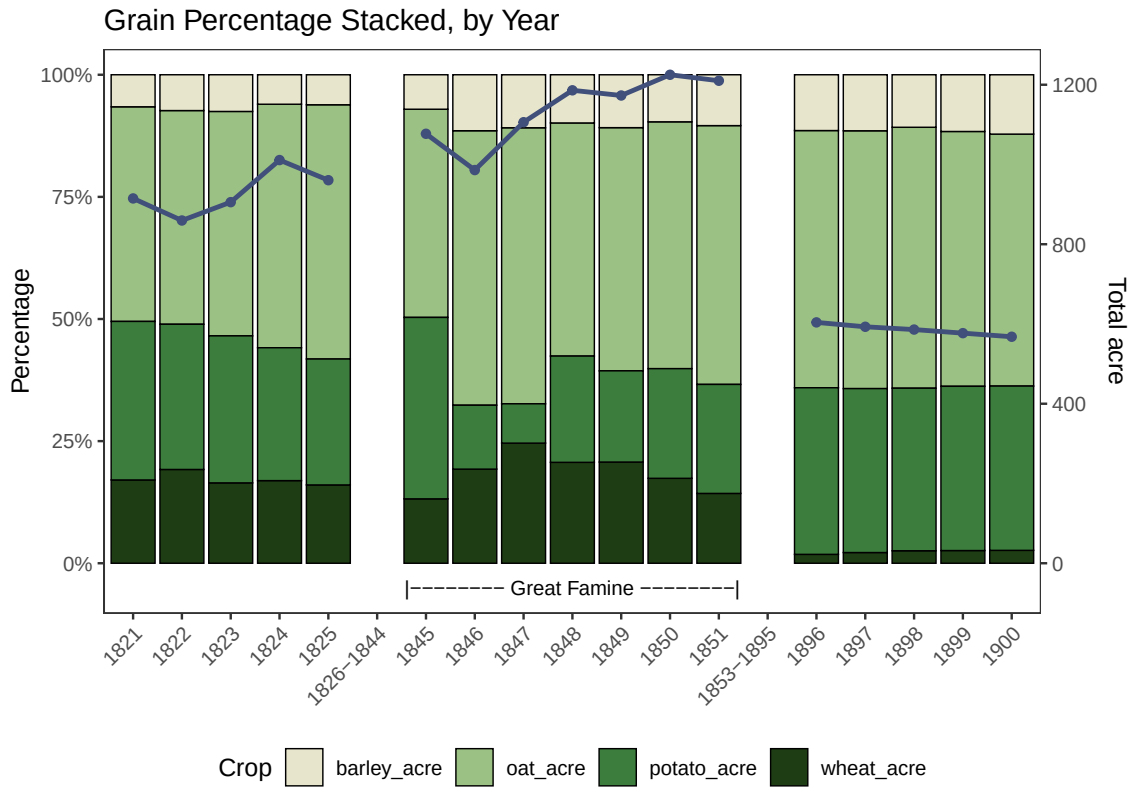
Secondly, the monocultural structure of the Irish diet. A strict distinction must be made between the concepts of dietary structure and cropping structure, since the former relates to daily nutritional intake, while the latter relates to the country's agricultural economy at the macro level. When we 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. Since we cannot directly obtain data such as inheritance and gifts, this paper choose to use national import and export data to describe transfers in this section. 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)

Also, the Poor Law is noticed in studies of the famine. The Poor Law and its reform have been mentioned in Chapter 2.1, so I will not repeat it here.

Most of the research on famine that without the FAD theory generally only takes into account one aspect of the rights method, and regarding to those research with entitlement approach, they propose various indicators and methods to measure the failure of rights during the 19th century famine in Ireland. Fraser (Fraser, 2003), following Amartya Sen's framework, analyzed the failure of entitlement before the 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 the 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 an increase in the number of people who die or migrate during the 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 increase in the number of people who die or migrate during the 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 increase in the number of people who die or migrate during the year.**

This paper use the balance of imports and exports and the Poor Law to estimate people's entitlement in inheritance and transfer — although the balances maybe not necessarily transferred to the people due to situations like policies, corruption or depletion, etc, it is a hypothesis which is deserve to explore.

H_4**: A damage in inheritance and transfer entitlement, more specifically, an increase in the import and export, lead to an increase in the number of people who die or migrate during the year.**

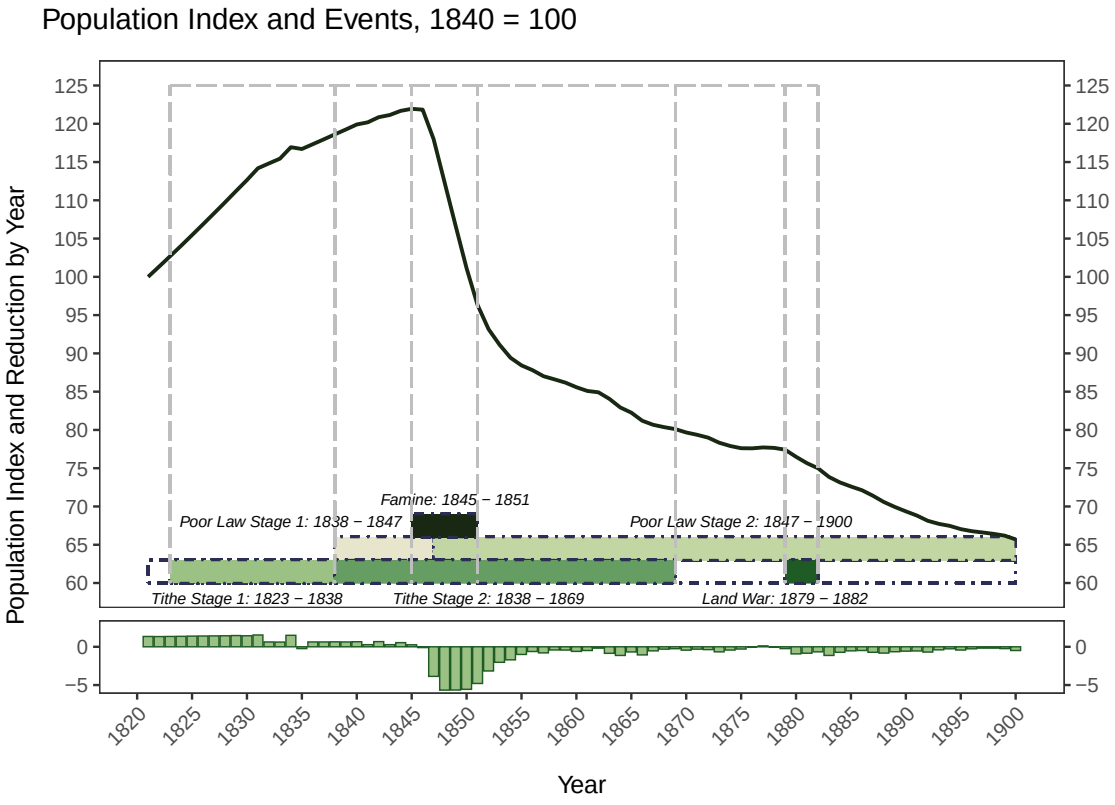
And a final hypothesis test to refute the FAD theory that population decline should not be blamed on acreage or acreage-related yield issues.

$H_{5a/5b}$**: There is no relationship between planting acreage and the number of people who die or migrate during the year / There is not enough evidence to suggest that larger planting acreage leads to fewer number of people who die or migrate during the year.**

3.3 Statistical Description

The first step is to perform descriptive statistics on two key variables which are population and the amount of population change in the current year which is calculated by subtracting last year's population from the current year's population. The amount of population change is also the latter is the dependent variable for the regression analysis carried out in this paper. 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.

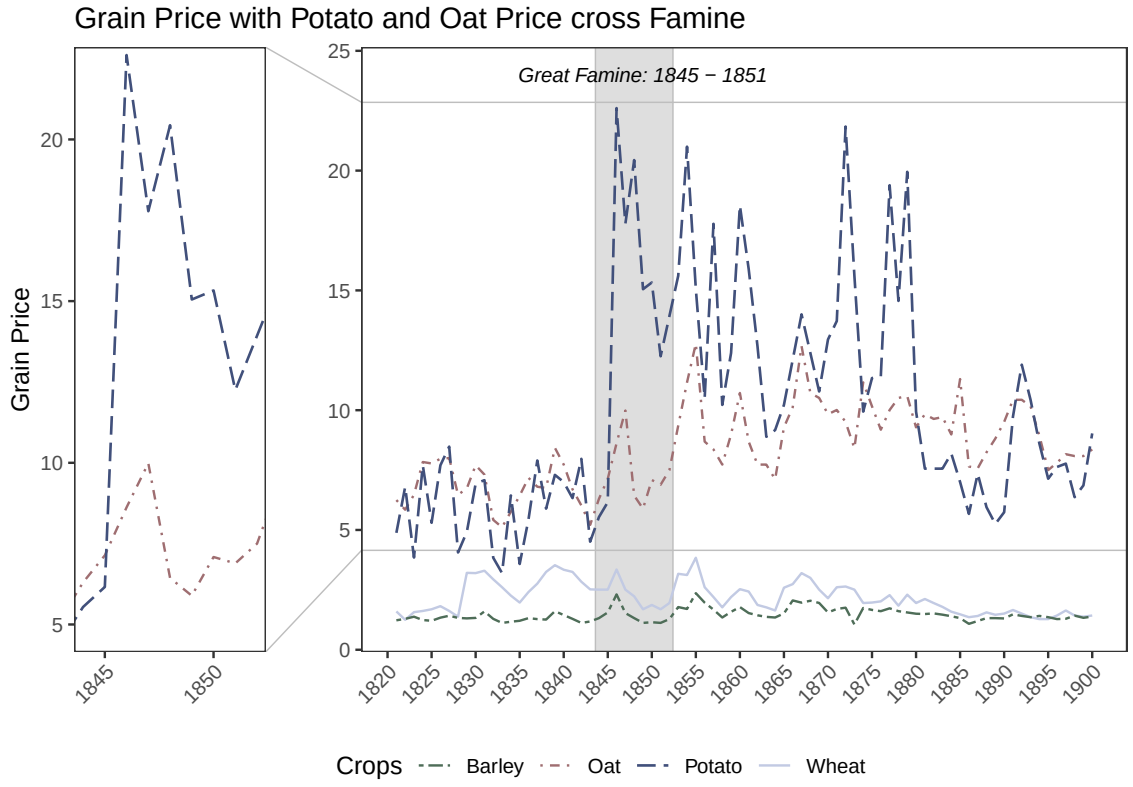
Figure 3.1: Population Index, Decrease and Evens, 1821 – 1900



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.

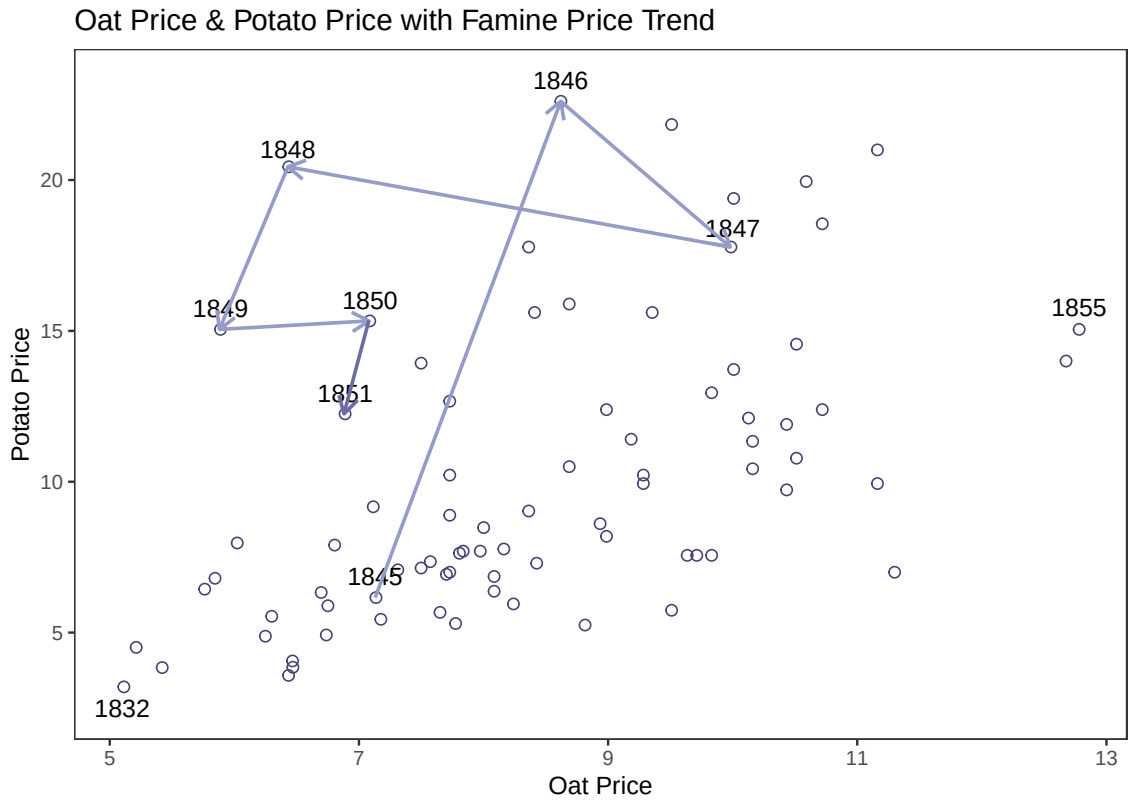
Figure 3.2 depicts the movement of cereal prices throughout the 19th century, especially during the famine, which helps us to visualize the subsequent regression model. When we correspond to the price curves and the population change curves in Figure 3.1, it appears we can see a link between peaks in 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.

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

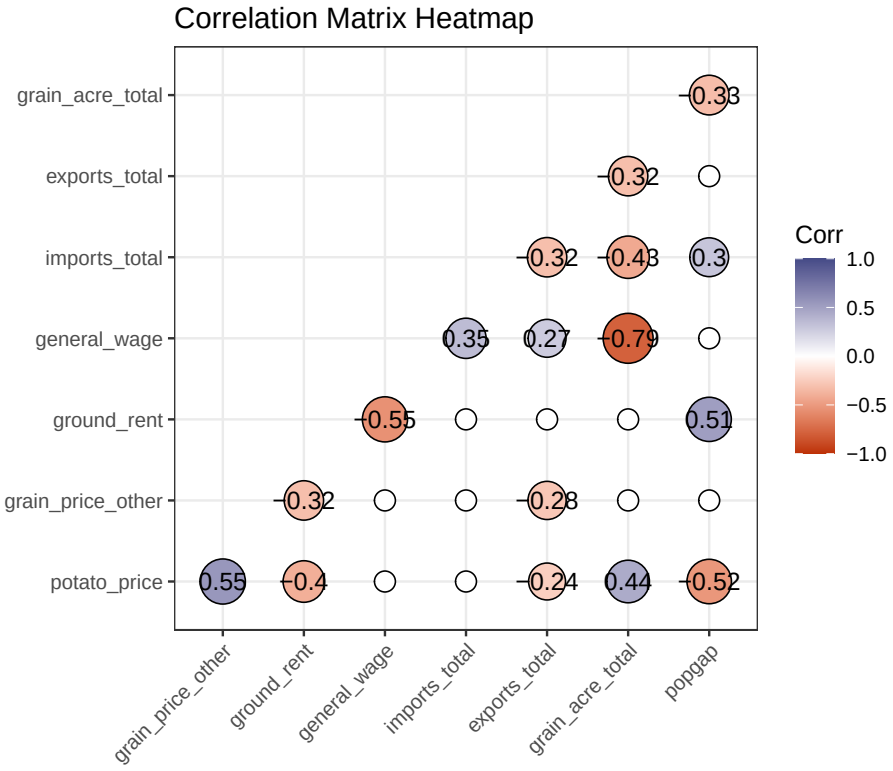


The arrows describe the price trends of the two grains during the famine, and the suddenly rise in the prices of both grains in 1846 may be directly related to the severe disaster of 1847, i.e., as stated earlier, an impairment of trade-based entitlement. While at the same time the sustained increase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

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

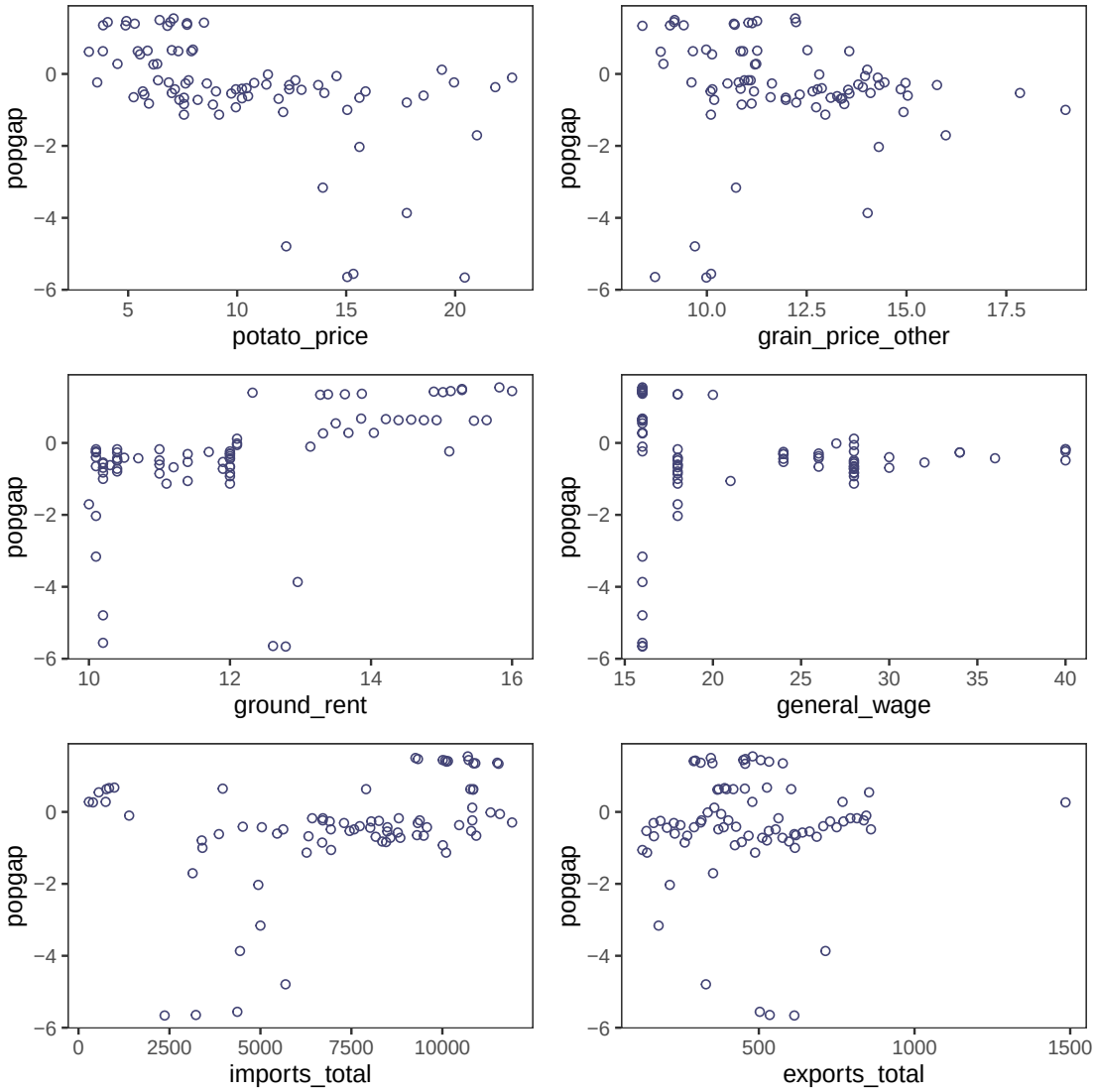
4.1 Generalized Additive Model

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



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`.

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. Based on observation of scatter and correlation matrix, a smoothing function was added to the variables `grain_price_other`, `general_wage`, and `exports_total`.

The formulation of the regression model, including the assumptions, is as follows:

$$
\begin{aligned}
\texttt{E(popgap)} = {} & \beta_0 + \beta_1 \times \texttt{potato\_price} + f_1(\texttt{grain\_price\_other}) \ldots \textit{(H1)} \\
& + \beta_2 \times \texttt{ground\_rent} + \beta_3 \times \texttt{factor(if\_tithe)} \ldots\ldots \textit{(H2)} \\
& + f_2(\texttt{general\_wage}) \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots \textit{(H3)} \\
& + \beta_4 \times \texttt{imports\_total} + \beta_5 \times f_3(\texttt{exports\_total}) \\
& + \beta_6 \times \texttt{factor(poorlaw)} \ldots\ldots\ldots\ldots\ldots\ldots\ldots \textit{(H4)} \\
& + \epsilon
\end{aligned}
$$

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

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 model must be justified before proceeding with the regression analysis. Firstly, the VIF test between the variables shows that there is no multicollinearity between the variables (Table 4.1):

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

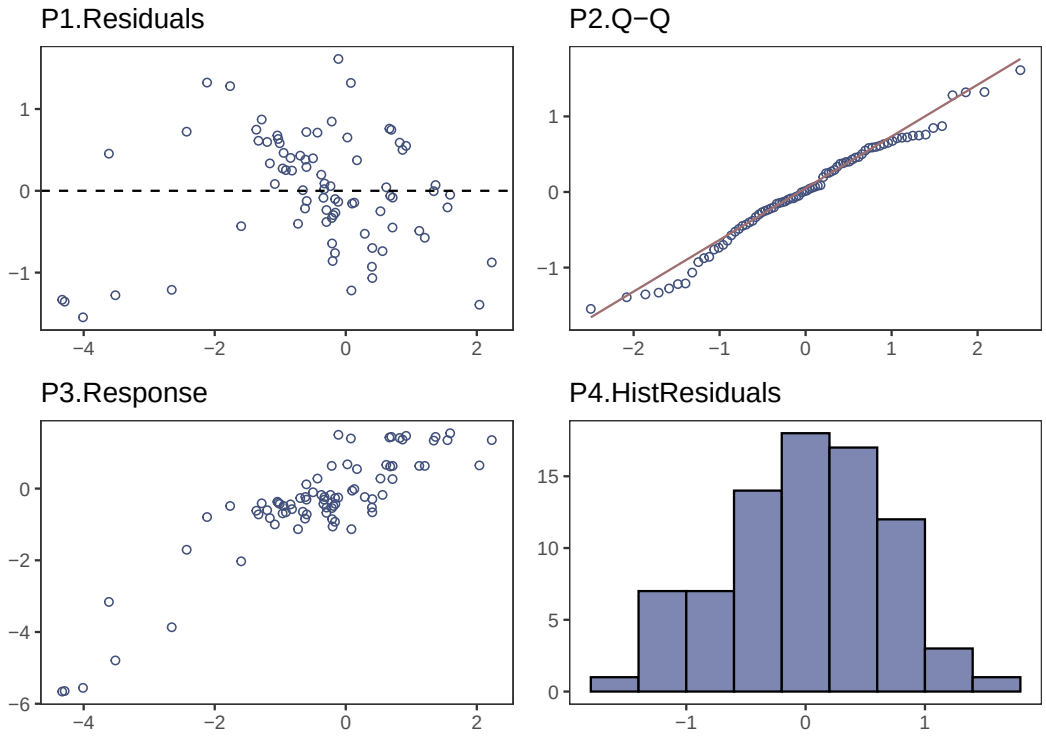
Compared to linear regression, the GAM was found to have a significantly higher R-squared and a lower AIC, so it can be concluded that the GAM possesses a better fitting ability and explanatory performance. Figure 4.2 shows the details:

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

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.

4.2 Brief Summary

An overview of the research logic used throughout the article is given.

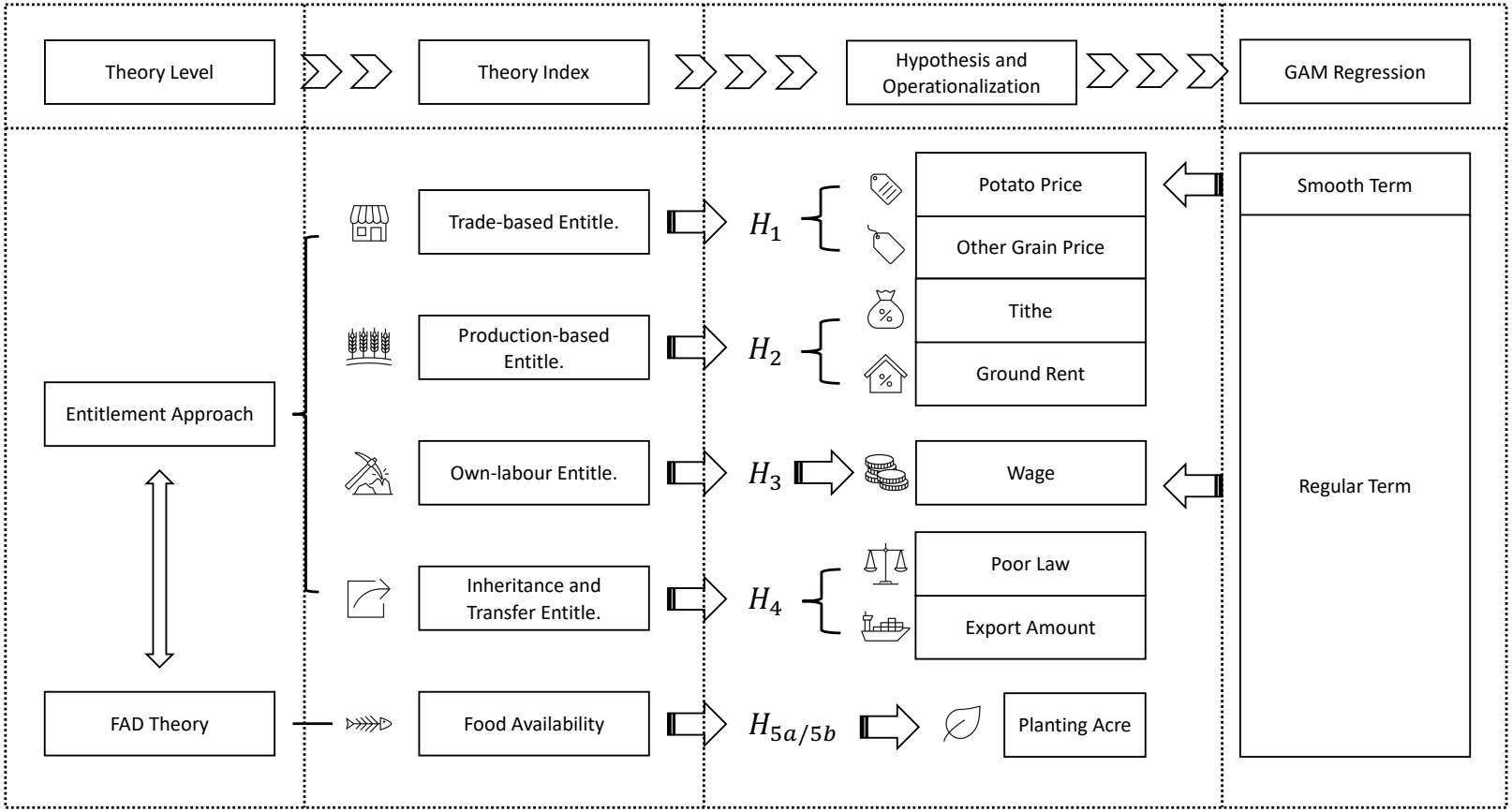
First is the theoretical framework: (1) entitlement approach used by Amartya Sen in his book "Poverty and Famine", and (2) refutation of the FAD theory. According to Sen's construct, the entitlement approach consists of the following four indicators: trade-based entitlement, production-based entitlement, 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 on the basis of these indicators, with each indicator corresponding to a hypothesis and each hypothesis corresponding to a more specific variable in the dataset. $H1$ corresponds to price of potatoes and other cereals, $H2$ corresponds to ground rent and presence or absence of tithing, $H3$ corresponds to general wage, $H4$ corresponds to the imports and exports amount, and the Poor Law, and $H5$ corresponds to the grain planting acreage.

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 tests 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 test, and the residual normality test. All of the results identify the GAM as a reasonable regression model under this data.

Figure 4.3 visualizes the framework of the entire research.

Figure 4.3: Research Framework



Chapter 5 | Discussion

5.1 Regression Results Summary

Table 5.1: 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		-0.003^{***}	
		(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)
imports_total	0.044^{***}		0.042^{***}
	(0.008)		(0.010)
exports_total			0.001
			(0.001)
factor(poorlaw)1	3.616^{***}		3.103^{***}
	(0.617)		(0.752)
Constant	-7.420^{***}	1.987^{**}	-7.751^{***}
	(1.391)	(0.796)	(1.964)
s(grain_price_other)	0.003^{**}		
s(general_wage)	0.000^{***}		
s(exports_total)	0.302		
Observations	80	80	80
Adjusted R^2	0.741	0.097	0.570
AIC	201.470		235.916
Residual Std. Error		1.436 (df = 78)	0.990 (df = 71)
F Statistic		9.457^{***} (df = 1; 78)	14.115^{***} (df = 8; 71)
Note:			*p<0.1; **p<0.05; ***p<0.01

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