Economic Geography and the Long-run Effects of the Great Irish Famine

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Abstract: One of the most important debates in Irish economic history has concerned the long-run effects of the Great Irish Famine, with some arguing that it had only temporary effects on the economy and others seeing it as a major demographic and economic watershed. This paper adapts the theoretical framework of Krugman (1991) to illustrate how the combination of the Famine and developments in transportation and the demand for industrial products may have worked together to cause persistent depopulation and relative industrial decline.

I INTRODUCTION

The long-run effects of the Great Irish Famine is an issue that has received much prominence from economic historians. Beyond the discussions in detailed historical studies such as Ó Gráda (1994), the subject has been brought to the attention of a wider audience within the economics profession with the publication of articles on the topic by Guinnane (1994) and O'Rourke (1994) in the *American Economic Review*. That the Famine directly caused a large decline in the Irish population is indisputable. However, what is more controversial is the role it played in the two key elements of post-Famine Irish economic history: the pattern of continuing depopulation that lasted until 1951 and the failure to develop substantial industrial employment despite

economic integration with what was then the world's leading economic power. While some have seen the Famine as a major watershed in Irish economic and demographic history, others have represented it as having only temporary importance and focused on other factors to explain post-Famine developments.

A number of themes have emerged in the debate over the role the Famine may have played in shaping subsequent economic development. The first is whether the Famine had an important influence on the post-Famine pattern of rural depopulation. Peter Solar (1989) and, more formally, Kevin O'Rourke (1991a, 1991b) have argued that, contrary to "revisionist" claims that post-Famine rural depopulation was simply due to exogenous price changes that led to a move away from labour-intensive tillage and potatoes towards pasture, the decline in rural population was due to the effect of potato blight in reducing yields and the pull of higher wages in industry abroad. However, explaining rural depopulation cannot be the full story concerning the decline in Irish population. To quote O'Rourke:

> Given that labour left Irish agriculture to work in industry, why did it end up in industry located abroad rather than in Ireland? Until this question is satisfactorily resolved, explanations for long-run Irish rural depopulation cannot be regarded as explanations for Irish depopulation *per se*.

Thus, whether the Famine and its associated emigration had an important retarding effect on industrial development has been a second important theme.

There are at least two identifiable theories of how the depopulation associated with the Famine may have affected Irish industry in a negative fashion. The first focuses on the potential effects of a "brain drain" in which the best and brightest workers emigrated. O'Rourke (1992) has provided a formal model along these lines. An alternative approach sees the decline in the size of the "home market" for industrial goods as an important causal factor. This concern can be found, for instance, in Cullen (1972). More recently, Cormac Ó Gráda (1994) has suggested that Paul Krugman's (1991) illustration of how "home market" effects resulting from firm-level economies of scale can lead to economies dividing up into manufacturing "cores" and agricultural peripheries may be relevant for understanding nineteenth-century Irish economic history.[1] This paper further explores the implications of Krugman's approach by extending it along two simple lines. First, while Krugman's model examines the forces likely to generate regional economic convergence or divergence, it is static in nature; here, we extend the model to allow for simple dynamics. Second, and more importantly, while Krugman's model contains an agricultural sector with a fixed number of agricultural workers, we allow for rural depopulation.

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1. See pp. 344-345 of Ó Gráda (1994).

These extensions to the basic Krugman model provide some useful insights into how the depopulation resulting from the Famine may have affected industrial development. First, the Krugman model does not unambiguously forecast regional economic divergence but rather shows that whether the economy ends up at a convergent or divergent equilibrium depends on exogenous variables such as the level of transportation costs. The simulations in this paper show that, even if the model's parameters are inconsistent with long-run economic divergence, the population decline that resulted from the Famine would have implied a substantial reduction in Irish industrial employment during the second half of the nineteenth century. Second, available evidence suggests that other economic developments of this period, such as improved transportation networks and a growing demand for industrial products, tended to strengthen the forces encouraging a divergent outcome and thus may have reinforced the effects of the Famine to create a pattern of persistent depopulation and relative industrial decline.

The contents of this paper are as follows: Section II discusses some of the basic facts of the post-Famine Irish economy and outlines some of the important debates in more detail. Section III describes Krugman's model of economic geography and summarises its principal results. Section IV extends this basic model to allow for rural depopulation and some simple dynamics. We show how these extensions deliver a model consistent with many aspects of nineteenth century Irish economic history. Section V concludes.

II THE POST-FAMINE ECONOMY: FACTS AND DEBATES

The Great Irish Famine of 1845-50 was the most momentous event of nineteenth century Irish history. The Famine, triggered by repeated failures of the potato crop due to the mysterious fungus *phythophthora infestans*, led to the death of an estimated one million of the 8.5 million Irish population of 1845. With emigration during this period reinforcing the depopulation, by 1851 the Irish population had declined 20 per cent from its 1845 level, standing at 6.5 million.[2] Measured in proportionate terms, the Famine was probably one of the world's deadliest of the last two centuries.

Significant as the population decline brought about by the Famine was, it would not have had much effect on Irish population in the long run if normal rates of population growth had set in during the post-Famine period. Watkins and Menken (1985) have shown that the resumption of "normal" patterns of population growth would have implied that 50 years later, the Famine's effects

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2. *Sources:* Guinnane (1994), O'Rourke (1991b), and Ó Gráda (1989).

would have been barely noticeable. Ireland's post-Famine demographic experience, however, was anything but normal. The period saw a pattern of persistent population decline unlike that seen in any other European country. Population declined a further 21 per cent between 1851 and 1881, reaching 5.175 million; by 1901 it stood at 4.6 million.[3] Despite the heavy concentration of historians and demographers upon post-Famine patterns of marriage and fertility, emigration was by far the principal cause of this decline. Surveying evidence on post-Famine demographics, Guinnane (1997) indicates that the Irish birth rate during this period was unremarkable by European standards. While this unremarkable birthrate was achieved with the unusual combination of large families but low marriage rates, this still cannot take away from the primacy of emigration as the cause of depopulation. The total number of emigrants from Ireland between 1850 and 1910 was 4.2 million. The US and Britain were by far the most common destinations, with US emigration outnumbering British by a factor of roughly 2 to 1.

What was the driving force behind post-Famine emigration? Most historians have focused directly upon the decline in rural population. The Famine obliterated 200,000 smallholdings and the number of agricultural workers declined from 1.84 million in 1841 to 0.78 million in 1911.[4] Recent years have seen some important research on the role the Famine played in this decline. Certain "revisionist" historians such as Crotty (1966) had suggested that the post-Famine decline in agricultural development had nothing to do with the Famine but was rather the result of essentially exogenous price shocks in commodity markets that moved Irish agriculture away from labour-intensive tillage and potatoes and towards pasture. O'Rourke (1991a), however, has constructed a computable general equilibrium (CGE) model of Irish agriculture of this period and concluded that such price shocks cannot have reduced agricultural employment. He proposes a simpler theory, linked directly to the Famine, of how labour demand factors could have reduced post-Famine agri-cultural employment. The blight that led to the Famine permanently reduced potato yields. The CGE simulations confirm that, through this mechanism, the Famine led to substantially reduced demand for agricultural labour.

Of course, to focus on the "push" factor of rural depopulation is to look at only one-half of the equation driving Irish emigration. Indeed, concentration on the decline in agricultural employment may tend to paint a picture of an economy in crisis with declining living standards. In fact, this is not the case. Living standards of both agricultural and industrial workers in Ireland rose during this period. However, they did so at a slower rate than was occurring in the

3. *Source:* Ó Gráda (1989).
4. *Sources:* Ó Gráda (1989) and O'Rourke (1991b).

United States or Britain. Guinnane (1994) thus argues that it was the "pull" factor of external (and, by implication, exogenous) economic change which drove emigration:

> Growing demand for labour in Britain and North America meant that Irish workers would have to be paid more at home or seek their fortunes elsewhere … Ireland's population did fall after the famine. In the absence of industrialization — the paucity of which is another great question in Irish economic history — one could hardly have expected anything else.

Here Guinnane echoes the point made by O'Rourke, quoted in the introduction, but views the failure of industrialisation as a separate issue, unconnected with the Famine or rural depopulation.

Ultimately, then, a full explanation of Irish depopulation must incorporate an explanation of why Irish industry did not expand to absorb the rural exodus and why Irish industrial wages were insufficient to keep millions of non-agricultural workers in Ireland. While there is evidence that Ireland's industrial decline pre-dated the Famine, as the expansion of transportation networks and the onset of the factory system caused cottage industries to become uncompetitive, the relative decline during the post-Famine period is stark. Bielenberg (1991) shows that during the period 1840-1910 the growth in Irish industrial output was very slight and compared very poorly with the four-fold increase in UK output. Despite the large number of potential suspects (limited resource endowments, perceived riskiness of investing in Irish capital, poor industrial financing) there have been few convincing explanations of the relative failure of Irish industry to develop despite its economic integration with the world's industrial leader, Britain. Generally, explanations have centred around the elusive concept of technological externalities: those regions that industrialise first obtain a productivity advantage over other regions, which thereby reinforces their advantage and leads to economic divergence.[5]

More recently, O'Rourke (1992) has provided a formal analysis of one of the more common "structural" explanations of Irish industrial decline: that this decline was a result of the loss of skilled workers due to emigration.[6] He presents a simple two country model with mobile capital and labour. It is assumed that there are two types of labour, shirkers and non-shirkers, with shirkers having the lower productivity and only non-shirkers being able to move between regions. This productivity difference, however, cannot be detected by firm managers and so each individual receives the average productivity of workers in their firm. O'Rourke shows that, within this framework, there is potential for convergence

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5. See, for instance, O'Malley (1981).
6. See pp. 229-230 of Ó Gráda (1994) for a discussion of this issue.

towards an equilibrium in which all skilled labour ends up in one of the regions. The convergence process consists of a period during which there is emigration of skilled labour from one region (Ireland) to the other (Britain) because the already higher ratio of skilled to unskilled implies higher wages.

While this model does fit some of the important facts of the period, it seems unlikely that it can provide a particularly complete explanation of post-Famine Irish economic developments. Its crucial assumptions, that only the higher-skilled workers emigrated and that managers could not distinguish between high and low skill workers, do not have much empirical evidence to back them up. The second assumption seems particularly untenable since, given the assumption that only non-shirkers move between regions, workers had some characteristics that would have allowed firms to diagnose their skill level. According to the model, all Irish workers in Britain and all British workers in Ireland were high skill. If one adds the ability of firms to distinguish whether an individual is Irish or British (usually not a very difficult task), the model would generate the strange result that all skilled workers in both countries could obtain a wage consistent with their level of productivity by emigrating to the other country while those who remained in their own country could be diagnosed as shirkers and get paid a lower wage. The model also contains only one sector and so is unable to describe the interactions between rural depopulation and industrial development. We now describe a model that we will adapt for this purpose.

III KRUGMAN'S MODEL OF ECONOMIC GEOGRAPHY

Krugman's (1991) model describes how firm-level increasing returns, transportation costs, and free mobility of labour can combine to produce an outcome in which two initially similar regions can become divided up into a manufacturing "core" and an agricultural "periphery". Since, at a very basic level, this story fits the pattern of economic development in Ireland and Britain during the nineteenth century, we may be interested in seeing whether or not the rural depopulation triggered by the Famine can play a role in accounting for post-Famine economic developments. Thus, in the next section, we outline a couple of extensions to Krugman's model which allow us to examine this issue. In this section, we present a brief summary of the model.

3.1 *Krugman's Model: Setup*
The model contains many of the analytical tools that Krugman has employed in a series of seminal articles on international trade. It makes many very specific assumptions concerning the structure of preferences, factor distributions, and technology. However, as Dixit (1993) has stressed, most of the qualitative

implications derived with these functional form assumptions have proved robust to changes in functional forms.

Factor Allocations: There are two regions, each containing peasants, who work in a homogenous agricultural sector, and workers, who work in differentiated manufacturing industries. There are a total of N such industries in the combined two-region economy. Trade between regions is subject to transportation costs of the "iceberg" form: when x goods are sent for consumption outside the region in which they were produced, only τx arrive. The total number of peasants plus workers in both regions is normalised to 1 with $\frac{1-\mu}{2}$ peasants in each region. There are a total of μ workers distributed between the two regions: $L_1 + L_2 = \mu$.

Preferences: Consumers have utility function

$$U = C_M^\mu C_A^{1-\mu} \tag{1}$$

where C_A is consumption of agricultural goods and C_M is consumption of a manufactures aggregate defined by

$$C_M = \left(\sum_{i=1}^{N} c_i^{\frac{\sigma-1}{\sigma}} \right)^{\frac{\sigma}{\sigma-1}} \tag{2}$$

These preferences dictate that consumers will spend a proportion μ of their incomes on the manufactured goods and the rest on agricultural goods.[7] Given prices p_A, which we will normalise to one, and p_i for each manufacturing good, the consumer's first-order conditions imply a set of demand functions of the form:

$$C_i = \left(\frac{\theta}{p_i} \right)^\sigma \tag{3}$$

where

$$\theta = \lambda^{-1} \mu \left(\sum_{i=1}^{N} c_i^{\frac{\sigma-1}{\sigma}} \right)^{\frac{\mu\sigma-\sigma+1}{\sigma-1}} C_A^{1-\mu} \tag{4}$$

and λ is the Lagrange multiplier on the budget constraint.

7. Krugman chose μ as both the proportion of income spent on manufactures and the proportion of manufacturing workers in the joint two-region economy to give the same wage in industry and agriculture. This assumption could be altered without changing the results.

Technology, Pricing and Output: Producers of each of the manufacturing goods use a labour-only production function with a simple form of increasing returns to scale, defined using a labour-requirement function:

$$L_{M_i} = \alpha + \beta x_i \tag{5}$$

where x_i is production of manufactured good i. The number of manufactured goods, N, is assumed to be large and so each individual firm takes θ as given. Thus, for instance, the output of firms in region 1 is

$$x_1 = L_1 \left(\frac{\theta}{p_i^1} \right)^\sigma + \frac{L_2}{\tau} \left(\frac{\theta}{p_i^2} \right)^\sigma \tag{6}$$

The optimal pricing strategy is

$$p_i^1 = \left(\frac{\sigma}{\sigma - 1} \right) \beta w_1 \quad p_i^2 = \frac{p_i^1}{\tau} \tag{7}$$

A zero-profit condition then defines the output level as

$$x_i = \frac{\alpha(\sigma - 1)}{\beta} \tag{8}$$

Since firms are symmetric this defines the level of output for all firms in both regions. Letting n_i be the total number of manufacturing products in region i we define this using the equation

$$n_i \left(\alpha + \beta \frac{\alpha(\sigma - 1)}{\beta} \right) = L_i \Rightarrow n_i = \frac{L_i}{\alpha \sigma} \tag{9}$$

Thus the number of manufactured goods produced in each region is proportional to the number of industrial workers.

Nominal and Real Wages: The zero profit condition and the fact that wages are the only input means that total wage expenditures in region i, $w_i L_i$, equals total expenditures on goods from region i. Defining z_{11} as the ratio of region 1 expenditure on local manufactures to that on manufactures from other regions:

$$z_{11} = \left(\frac{n_1}{n_2} \right) \left(\frac{p_1 \tau}{p_2} \right) \left(\frac{c_{11}}{c_{12}} \right) = \left(\frac{L_1}{L_2} \right) \left(\frac{w_1 \tau}{w_2} \right)^{-(\sigma - 1)} \tag{10}$$

Similarly, the ratio of region 2 spending on region 1 products to spending on local products is

$$z_{12} = \left(\frac{L_1}{L_2}\right)\left(\frac{w_1}{w_2 \tau}\right)^{-(\sigma-1)} \tag{11}$$

We can use these formulae to derive the wage rates for both regions

$$w_1 = \frac{\mu}{L_1}\left[\left(\frac{z_{11}}{1+z_{11}}\right)Y_1 + \left(\frac{z_{12}}{1+z_{12}}\right)Y_2\right] \tag{12}$$

$$w_2 = \frac{\mu}{L_2}\left[\left(\frac{1}{1-z_{11}}\right)Y_1 + \left(\frac{1}{1+z_{12}}\right)Y_2\right] \tag{13}$$

where

$$Y_i = \frac{1-\mu}{2} + w_i L_i \quad i = 1,2 \tag{14}$$

Finally, real wages are defined using the price indices for manufacturing goods:

$$P_1 = \left[fw_1^{-(\sigma-1)} + (1-f)\left(\frac{w_2}{\tau}\right)^{-(\sigma-1)}\right]^{\frac{-1}{\sigma-1}} \tag{15}$$

$$P_2 = \left[f\left(\frac{w_1}{\tau}\right)^{-(\sigma-1)} + (1-f)w_2^{-(\sigma-1)}\right]^{\frac{-1}{\sigma-1}} \tag{16}$$

where $f = \frac{L_1}{\mu}$ is the proportion of manufacturing firms in region 1. Given these price indices the real wages are

$$\omega_1 = w_1 P_1^{-\mu} \quad \omega_2 = w_2 P_2^{-\mu} \tag{17}$$

3.2 *Convergence or Divergence?*

While Krugman's paper has no explicit dynamics, it does pose the question: Will the movement of manufacturing workers from one region to another tend to increase the relative wage in the region that receives the workers? If so, this will tend to reinforce the original pattern of labour mobility. Ultimately, this

process will lead a divergent outcome in which all industry is located in one region with the other region being solely agricultural. In terms of the model's variables, this question can be re-formulated as: Will an increase in f lead to an increase in $\frac{\omega_1}{\omega_2}$? The answer turns out to be "it depends". The model contains forces that work in both possible directions.

There are two forces tending to encourage divergence:

- The "home market" effect: If production costs were identical in both regions, then economies of scale would dictate that it would always be more profitable to produce in the large market, thereby minimising transportation costs. The zero-profit assumption must then imply higher wages in the bigger economy. The larger the difference between big and small economies, the stronger this effect will be.
- Price effects: Workers choosing to live in the larger economy will obtain more goods at pre-transportation-cost prices and so will have higher real wages.

Acting to encourage convergence is the fact that when firms re-locate to the other market, those firms that remain have a higher demand for their products because the re-located firms are now selling their products at the higher post-transportation-cost price. The zero profit condition then implies a higher wage.

Dictating whether the convergent or divergent forces are the stronger are the share of expenditure on manufactures, μ, the transportation cost measure, τ, and the elasticity of substitution, σ. We will not be interested in σ but the effects of changes in μ and τ are as follows:

- τ: The higher are transportation costs the stronger is the force for convergence: When workers move to another region, higher transportation costs imply a more significant shift in expenditure patterns towards products still produced locally. To illustrate this effect, Figure 1 reproduces a figure from Krugman (1991) illustrating the effects of an increase in $f = \frac{L_1}{\mu}$ on $\frac{\omega_1}{\omega_2}$ for τ = 0.5 and τ = 0.75. The other parameters are μ = 0.3, σ = 4. For τ = 0.5 transportation costs are high and increasing concentration of labour leads to a higher relative wage in the smaller economy. This pattern is reversed for τ = 0.75.
- μ: An increase in the budget share of manufactured goods strengthens the forces for divergence since it implies a higher proportion of income is spent on goods obtained cheaper in the large market. Figure 2 graphs $\frac{\omega_1}{\omega_2}$ against f and shows how, for τ = 0.5, σ = 4, increasing μ from 0.3 to 0.5 moves the model away from convergence and towards divergence.

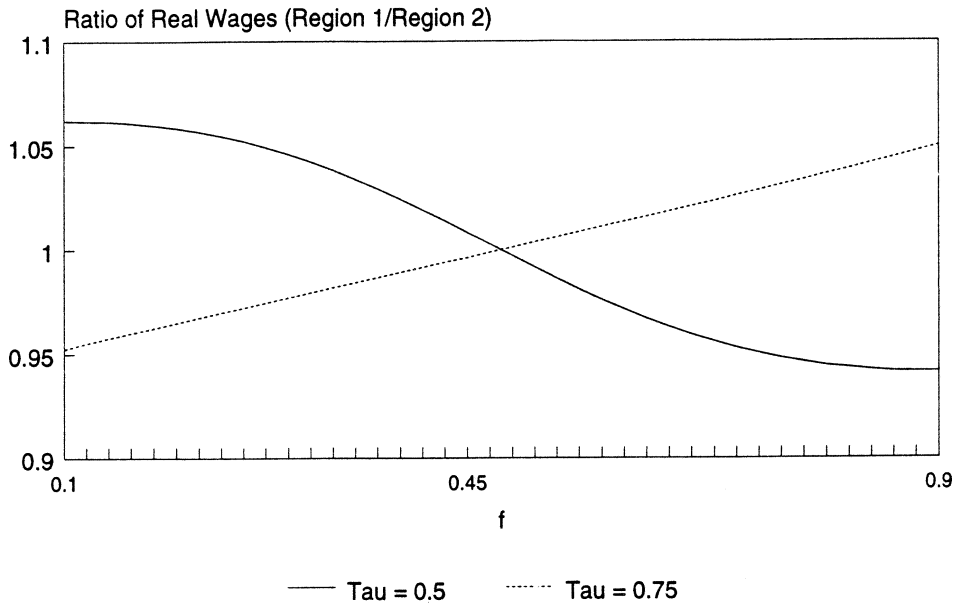Ratio of Real Wages (Region 1/Region 2)

Figure 1: *Effect of f on Relative Wages*
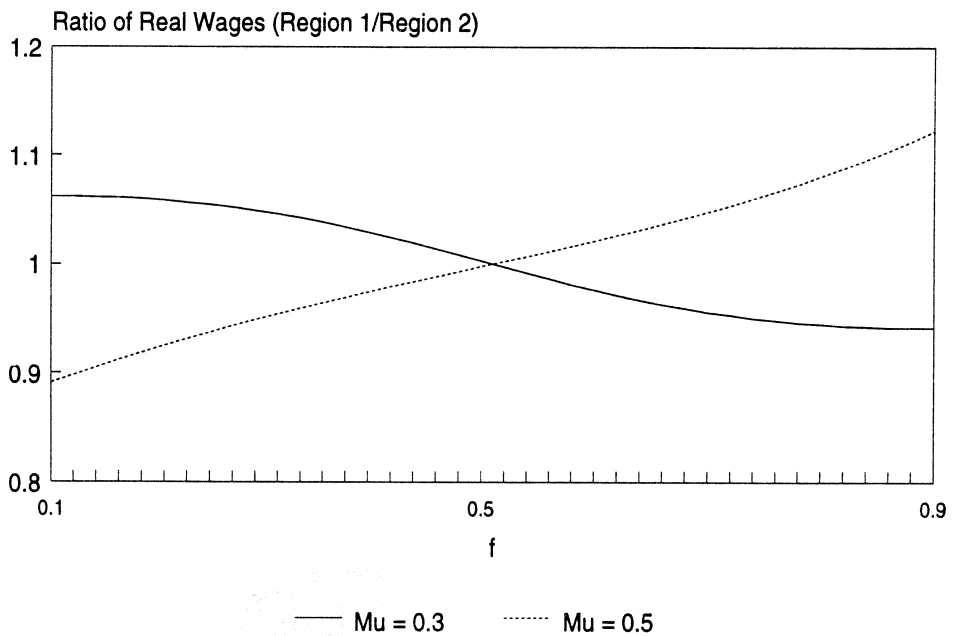
Ratio of Real Wages (Region 1/Region 2)

Figure 2: *Effect of f on Relative Wages*

IV SIMULATING POST-FAMINE IRELAND

We now show how Krugman's model can be adapted to shed light on the dynamics of post-Famine Ireland. The starting point for our simulation is a very rough picture of 1845 Ireland and England (we will use the subscripts I and E): We model them as symmetric economies with equal populations and an identical allocation of individuals between industry and agriculture. One simple justification for the assumption of symmetry is the fact that at our 1845 starting point the population of Ireland was very close to the combined population of England and Wales.[8] Thus, our starting values are $L_I = L_E = 0.15$ and $A_I = A_E = 0.35$. In other words, the sum of all individuals is equal to 1 and 70 per cent of the population is employed in rural areas.

We set our starting parameter values to be consistent with regional convergence: In the terminology used above, we set τ, σ and μ so that an increase in f has a negative effect on $\frac{\omega_1}{\omega_2}$. To ensure this we choose relatively extreme parameter values, setting $\tau = 0.15$ (very high transportation costs) and $\mu = 0.3$ (only 30 per cent of income is spent on industrial goods). We set $\sigma = 7$ and $\gamma = 0.325$. Thus, given the parameter values chosen, the symmetric outcome is a dynamically stable equilibrium.

Now, we add two new elements to the model. First, instead of fixing the number of peasants as constant, we allow for Irish rural depopulation. As we outlined above, the Famine led directly to a large decline in rural population and the effect of potato blight ensured a continuing decline in agricultural employment during the post-Famine period. Thus, we assume a substantial exogenous decline in the number of Irish agricultural workers. Figure 3 shows the simulated decline (with the number of agricultural workers indexed to its 1845 level). Rather than be precise about the exact pattern of this decline, we simulated a gradual decline from 1845 to 1890, the magnitude of which closely matches that observed during this period. We assume that, of the individuals leaving rural Ireland, a fraction ρ (which we set equal to 0.75) emigrate to the US while the rest move into Irish industry.

Second, we explicitly model the dynamic process driving emigration of industrial workers from Ireland to England using the following simple equation:

$$M = \gamma(\omega_E - \omega_I)L_I \qquad (18)$$

This equation states that the proportion of industrial workers emigrating from Ireland to England is a function of the difference between English and Irish wage rates. Thus, letting A_I be the number of people in rural Ireland, the change in industrial employment in Ireland can be modelled as

$$\Delta L_{It} = -(1-\rho)\Delta A_{It} - \gamma(\omega_E - \omega_I)L_{It} \qquad (19)$$

8. *Source:* Mitchell (1980). Note, however, that exact symmetry is not crucial to our simulations.
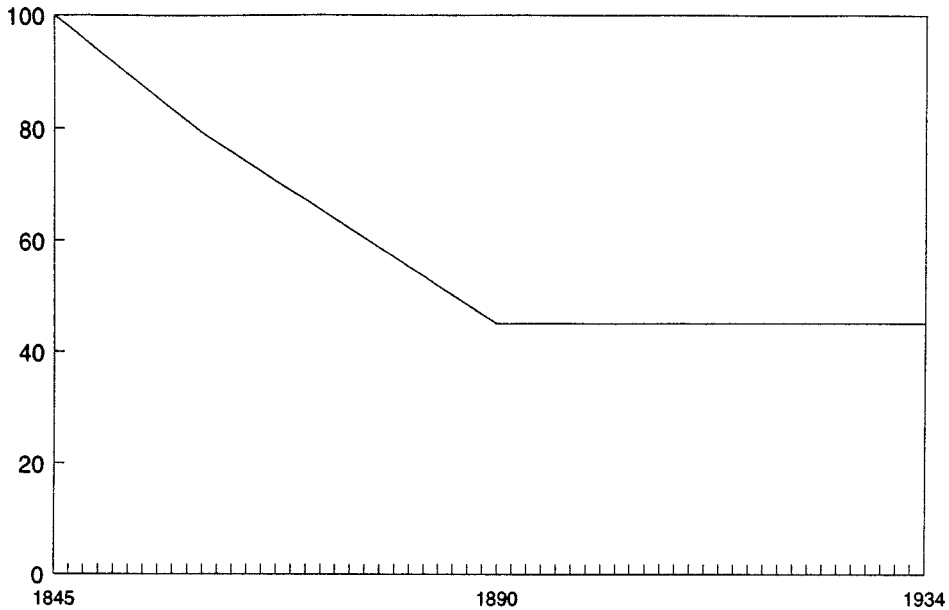
Figure 3: *Agricultural Employment (Base Simulation)*

The results of this "base" simulation can be seen in Figures 4, 5 and 6. These show industrial employment, population, and real wages, respectively, for both Ireland and England. Since we assume that a quarter of those leaving Irish agriculture go into Irish industry, the direct impact of rural depopulation is to increase industrial employment. However, the wage effects work in the opposite direction. A decrease in the number of agricultural workers leads to a lower wage through the home market effect. Thus, we observe a decline in real wages in both Ireland and England with the decline in Ireland being larger because the lost customers were relatively more important for Irish firms. The effects on emigration of higher wages in England quickly overrides the positive impact of rural depopulation on Irish industrial employment. The period of falling industrial employment in Ireland eventually comes to an end, however, because we have set parameter values so that, given stable values of agricultural employment, the convergence force eventually takes over again.

The final outcome of this simulation shows falling numbers of agricultural and industrial workers for over 45 years after the Famine with significant emigration to both the US and England. Because real wages fall slower in England than they do in Ireland, the majority of displaced agricultural workers who do not emigrate directly to the US eventually end up, along with large numbers of industrial workers, emigrating to England. The moral of this story
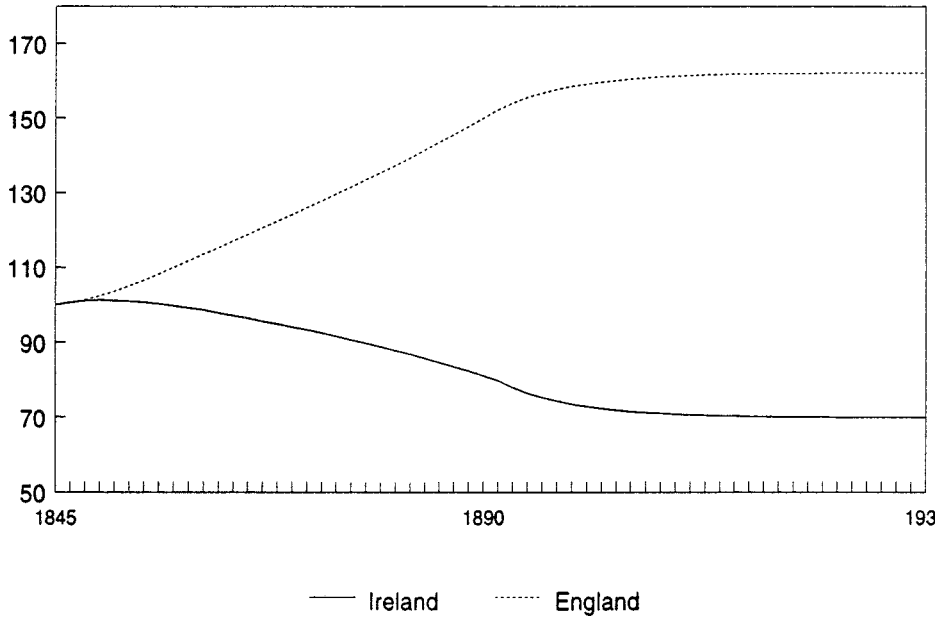
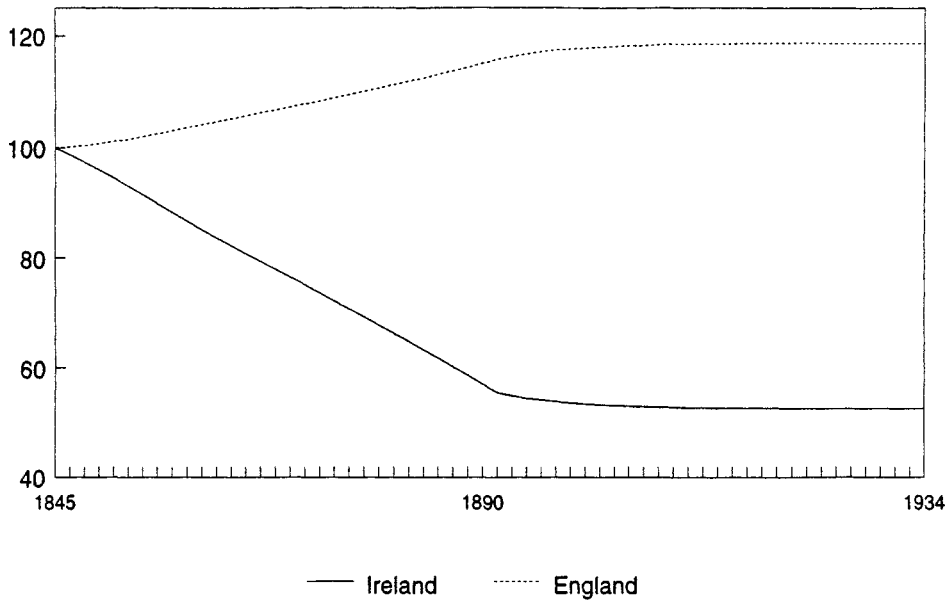Figure 4: *Industrial Employment (Base Simulation)*

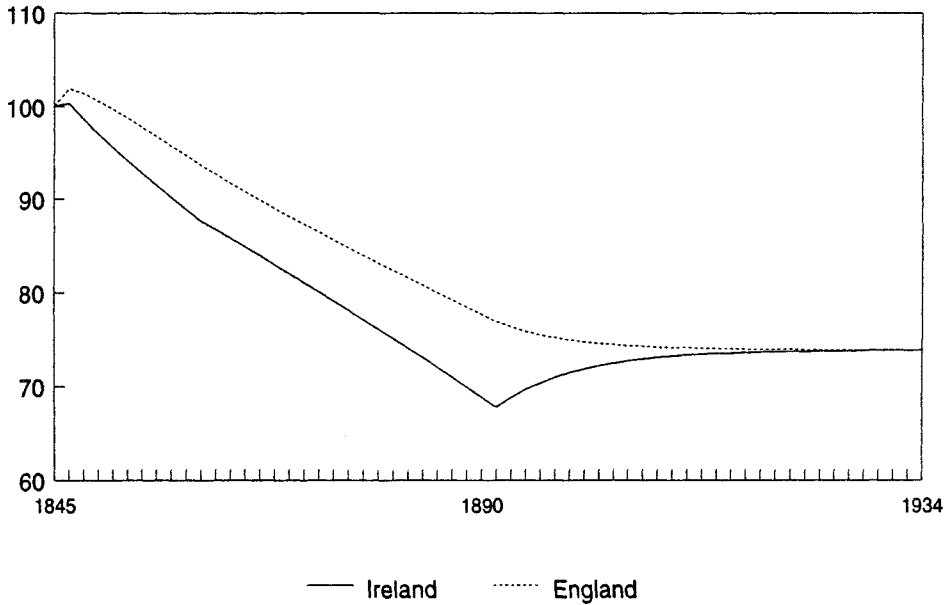

Figure 5: *Population (Base Simulation)*

Figure 6: *Real Wages (Base Simulation)*

is as follows. Even with parameter values set to be consistent with a convergent equilibrium, the logic of firm-level increasing returns implies that the fall in the number of agricultural workers induced by the Famine through its different channels (direct effects during 1845-55, effect of potato blight on the demand for agricultural workers, and facilitation of further emigration to the US) would have implied a very large fall in population. We have modelled a large part of this population decline — emigration to the US — as exogenous, but the results would be similar if we had specified an endogenous rule for US emigration. The initial decline in population triggered by the death of one million people and the emigration of one million more, implied a large fall in the size of the local Irish market for industrial goods. This reduced the profitability of local firms and thus wage rates, triggering a process of declining industrial employment. Thus, Irish wages never rose enough to reduce emigration during the post-Famine period.

While the simulation illustrated in Figures 4, 5 and 6 may capture some of the important features of post-Famine Ireland (declining industrial employment, emigration driven by higher wages abroad) there is one feature that does not fit the facts. While the reduction in Irish rural population may indeed have restrained industrial wages in both Ireland and England, we know that real wages in both countries were in fact rising with the rate of increase being slower in Ireland. However, the model can be adapted to allow for two developments

that helped increase real industrial wages during the post-Famine period:

- Transportation Costs: Throughout the post-Famine period the railway and canal systems of Ireland and Britain were substantially developed, making it far easier to transport industrial goods in both directions. In terms of our model, this implied a large increase in τ. To model this, we allowed for a gradual increase in τ from 0.15 to 0.75 over the same period as the decline in agricultural employment, 1845-90.
- Increased Demand for Manufacturing Goods: Our assumption that individuals spend only 30 per cent of their incomes on manufacturing goods is also unlikely to fit the facts of this period. While we do not have any exact data on this variable, it seems likely that this period of rising prosperity saw an increase in the proportion of income spent on manufacturing goods. This can be modelled from microfoundations by altering preferences to take the Stone-Geary form with individuals having utility function $U = C_M^\mu (C_A - S)^{1-\mu}$ where S is a subsistence level of consumption of food. For simplicity, however, we will just model this process through a gradual rise in μ from 0.3 to 0.6 over the period 1845-90.

Figures 7 through 10 illustrate the result of this "full" simulation adding these changes in exogenous parameter values to move towards a more realistic model for the period.[9] These changes have an important effect on the results of the simulations. The shift towards higher τ and μ implies rising real wages in both Ireland and England during the post-Famine period with English wages rising by more. However, it also implies that by the time the decline in agricultural employment triggered by the Famine is over (1890 in our simulations), parameter values are now consistent with a divergent equilibrium. Thus, industrial employment and population keep falling after 1890 and beyond. The final figures for cumulative emigration from Ireland, shown in Figure 10, are very close to the actual figures.[10]

While the outcome of the process described in this simulation — Ireland ends up with almost no industry — is clearly extreme, it actually fits the picture of Free State Ireland circa independence (1921) relatively well. By the early 1920s Irish industry was very heavily concentrated around Belfast, located in eastern Ulster, the area which suffered least during the Famine.[11] Furthermore, the post-independence performance of the Irish economy was one of relative economic decline.

9. There is also one other difference. We reduce the parameter γ which describes the sensitivity of emigration to Irish-English wage differentials because if it is kept at its previous level industrial employment goes to zero too quickly.

10. The balance between US and UK emigration shown in Figure 10 could also have been altered to fit the data if we allowed for emigration of industrial workers to the US.

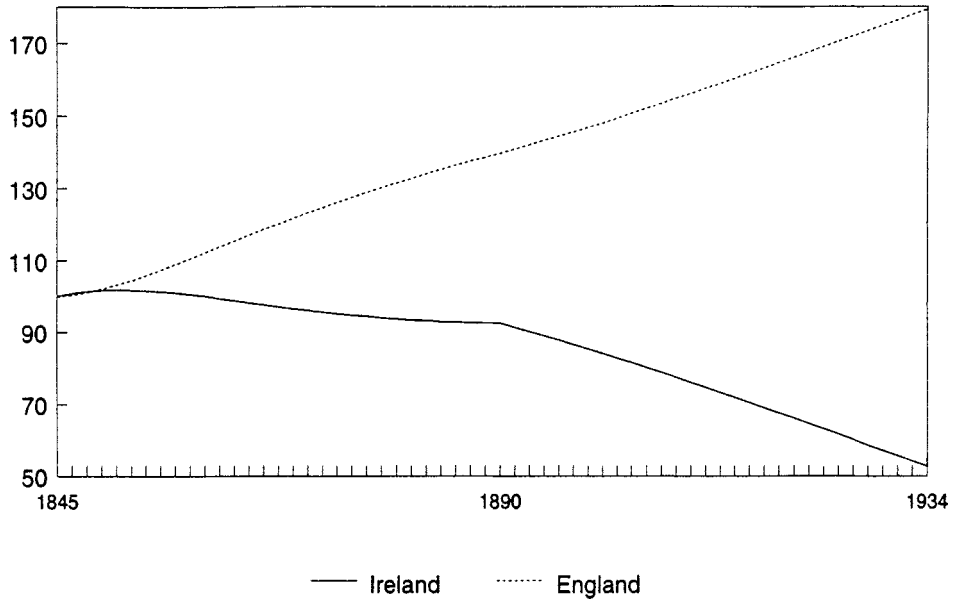11. See Ó Gráda (1989) for a discussion of the regional dimensions of the Famine.

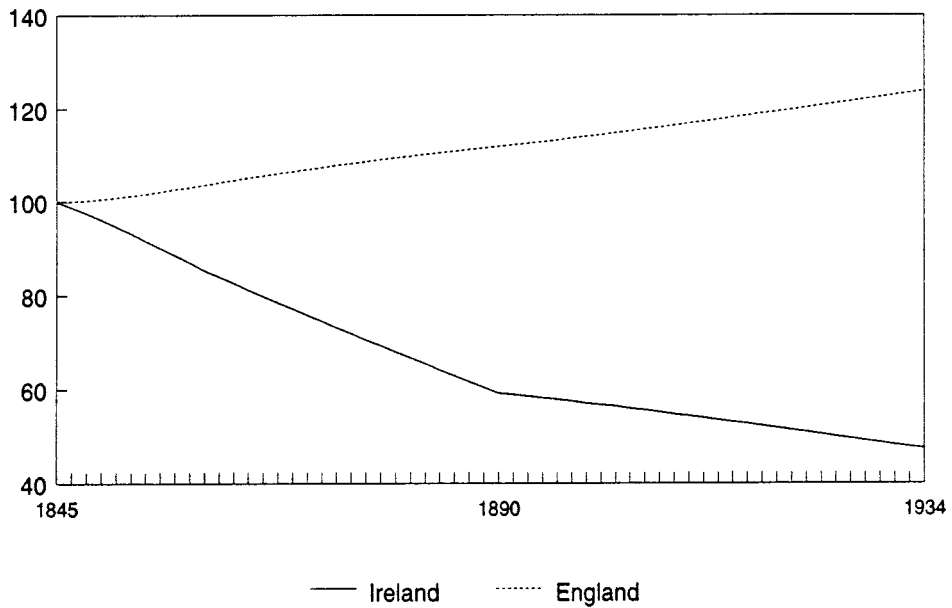Figure 7: *Industrial Employment (Full Simulation)*
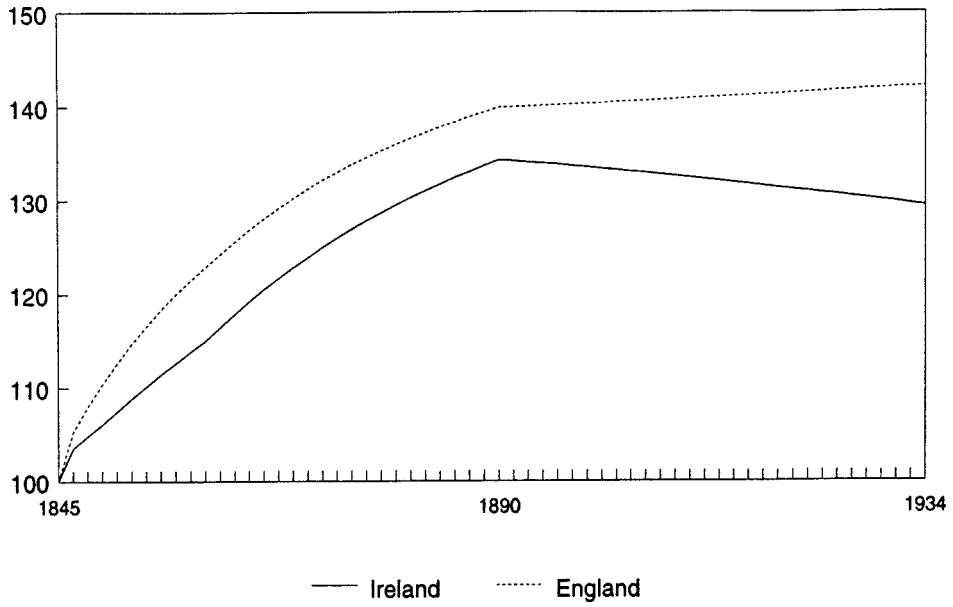
Figure 8: *Population (Full Simulation)*
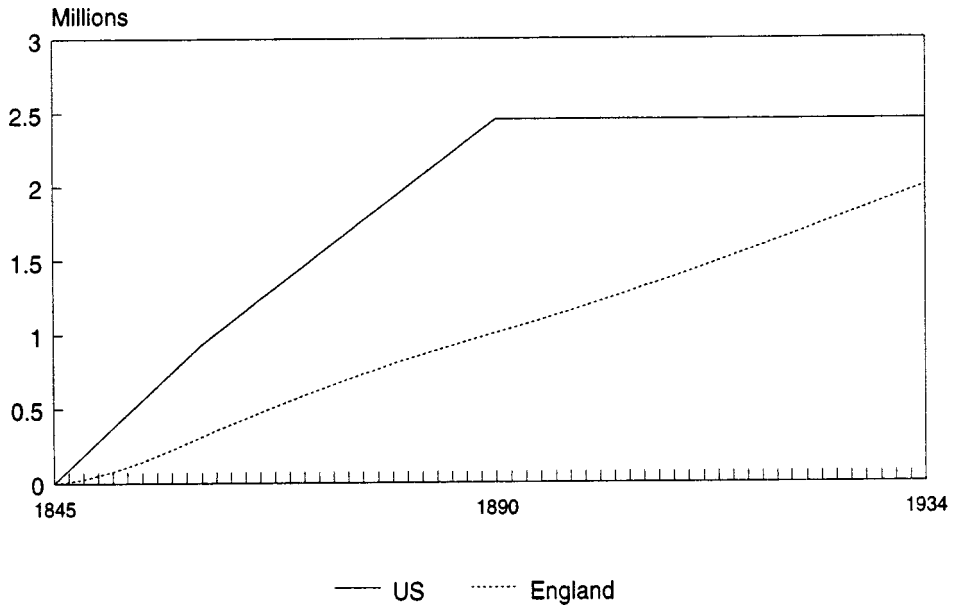
Figure 9: *Real Wages (Full Simulation)*

Figure 10: *Cumulative Emigration (Full Simulation)*

V CONCLUSION

This paper has adapted the model of Krugman (1991) and used it to explain how the Great Irish Famine of 1845-55 may have had more far-reaching effects on subsequent Irish economic development than most economic historians have believed. In particular, it provides a warning against "compartmentalising" Irish economic history and viewing the process of rural depopulation, emigration, and industrial failure as separate issues requiring separate explanations. This is what many Irish economic historians have done: rural depopulation is explained by exogenous price shocks (Crotty), emigration by external economic change (Guinnane), and industrial failure by a range of theories such as those appealing to external economies of scale. If Irish people emigrated because of higher wages elsewhere, to explain Irish emigration as a result of external economic change is to look at only one side of the coin. An explanation for the failure of Irish industry to grow is also required.

The argument in this paper is that the rural depopulation triggered by the Famine decreased the profitability and wage levels of Irish industry. This led to more emigration and, by the time the rural depopulation had ceased, exogenous changes to transportation costs and the demand for industrial goods ensured continued industrial backwardness. While the model is clearly stylised, it fits some of the key important facts of the period and, perhaps, may prove useful in analysing other aspects of post-Famine Irish economic history.

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