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Why Ireland Starved after Three Decades: The Great Famine in Cross-Section Reconsidered[1]

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[1] Revised version of presentation to '*Why Ireland Starved* After Three Decades: A Workshop', Queen's University Belfast, 2 May 2014.

ABSTRACT: This short paper revisits two questions that were central to Joel Mokyr's *Why Ireland Starved* (2nd edition, 1985). These are, first, what determined the variation in population change across Ireland during the Great Famine decade of 1841-1851 and, second, whether and in what sense can pre-famine Ireland be characterized as 'malthusian'.

Keywords: Famine, Malthus, population, Ireland

JEL codes: N3, B3

Although *Why Ireland Starved* (*WIS*) may not be Joel Mokyr's best-known work—it is ranked third, a long way behind *The Lever of Riches* and *The Gift of Athena*, on *Google Scholar*—it has achieved an enduring status that would be the envy of many. It is still in print and the trend in citations implies an interest that is by no means flagging. Quite apart from its place in the historiography of the Great Famine, *WIS* continues to be invoked by scholars from removed from Irish economic history. The range of the works citing *WIS* reflects its range and ambition.

Mokyr's initial fascination with Ireland stemmed from an interest in the Netherlands, another economy that 'failed' in the first half of the nineteenth century (Mokyr 1976). This led to several years of research in the late 1970s and early 1980s on the pre-famine economy and on the Great Famine itself. In addressing those issues, Mokyr chose the 'analytical and quantitative' hypothesis-testing approach of the social scientist rather than the more traditional narrative approach of the historian. Moreover, in his analysis he used cross-section rather than time-series data. *WIS* and a series of associated papers (notably Mokyr 1980a, 1980b, 1981, 1985) invoked the considerable variation in economic conditions across the thirty-two counties of pre-famine Ireland in an attempt at accounting for both the vulnerability of the economy on the eve of Great Famine and the demographic impact of the famine itself. The raw material consisted of data on variables ranging from vital statistics to dependence on the potato, and from county net emigration rates to housing quality. Mokyr subjected these data, some already available in contemporary

printed sources, but many newly minted, to econometric analysis. Irish historians of Ireland had never witnessed anything like this before.

1. Malthus and the Famine

This paper revisits two of the best-known themes in *Why Ireland Starved*, the determinants of population loss during the Great Famine itself and the determinants of population growth in the pre-famine era. The former models the demographic impact of the Great Famine, while the latter asks whether the pre-famine Irish economy was 'Malthusian', i.e. whether living standards on the eve of the famine were reduced or constrained by population pressure.

Our approach, like Mokyr's, is cross-section. Here, however, instead of working at county level (n=32), our unit of analysis is the barony (n>300). Given the marked heterogeneity within counties, disaggregation is bound to add to the precision of estimates (Kennedy 1984: 202; Brown and Guinnane 2007). Disaggregation is not entirely costless: some data available at county level are lacking at more disaggregated level. In particular, Mokyr's per capita county income variable is unavailable at barony and parish level, as are wage data on the eve of the famine. Still, thanks to the scope of the 1841 and 1851 censuses, data on several of the variables used in WIS are also available at baronial level—including those on housing quality, literacy rates, and sectoral employment share. We accordingly model proxies for income—the literacy rate and housing quality—as a function of land valuation per capita. The latter might be seen as a measure of the land-labour ratio, adjusted for land quality.

We have median teacher's pay by barony, as given in the 1826 schooling inquiry (Ó Gráda 2013). We also add variables describing physical characteristics: soil, elevation, ruggedness, land valuation, distance from coast.

2. *Population Loss during the Famine Decade:*

On of the costs of disaggregating the data is that whereas in *Why Ireland Starved* and related work Mokyr used his own county estimates of excess mortality as the dependent variable, here we must fall back on proportional population change during the famine decade (1841-51). Our dependent variable, the proportionate change in population between 1841 and 1851, captures the joint effect of the famine on increased mortality, reduced fertility, and emigration.

In Mokyr's analysis of excess mortality, the variables that packed most statistical punch, with coefficients of the right sign, included estimates of income and labour income per head on the eve of the famine, the literacy rate, an index of housing quality, the percentage of the population that was urban, and a proxy for the prevalence of rural industry. Variables that did not 'work', perhaps surprisingly, included average farm size and the percentage of the arable acreage under potatoes (Mokyr 1985: 272-73). Later attempts (Ó Gráda 1999; 2012; Fotheringham *et al*. 2012; Goodspeed 2013) using more disaggregated data also found that 'economic' variables accounted for a significant share of the demographic variation across baronies and parishes.

Here we readdress the issue, using new estimation techniques and taking account of factors ignored in previous work. First are the likely collinearity of data, and the possibility of the non-linearity of, and interaction between, variables. Second, since our regressions are based on spatial data, the expectation is that they will be subject to spatial autocorrelation.

In exploring the data, and in particular in looking at potential interactions in the data, we employ a classification tree approach, using the unbiased recursive partitioning framework of Hothorn *et al.* (2006). This is a two-step procedure where the covariate with the highest association with the dependent variable (based on a Strasser-Weber permutation test) is chosen, and this covariate is then split to maximize the difference between the dependent variable in the two subsets. The procedure continues until the p-value of the test for independence between the dependent variable and the covariates, reported at each node, falls below 5 per cent.

A notably successful evolution of classification trees is the random forest methodology of Breiman (2001), which offers a way of ranking the importance of potential explanatory variables in a natural way. Here, in a data set of size *N*, a large number of trees (in our case 1,000) is grown. Each has *N* observations where the observations are chosen with replacement. At each node, rather than searching over all explanatory variables for the best split, the algorithm picks *m* variables at random and choses the split among them. Each split is then chosen as an average over all the trees grown. In this paper we use the

Quantile Regression Forest variant of Meinhuasen (2006), implemented in the R package 'quantregForest'.[2]

Applying a random forest to the population fall data, we find that the best performing explanatory variables are measures of female illiteracy in 1841, industrial employment in 1841, distance from the coast and, considerably less importantly, value per acre. Figure 2 shows the predicted impact of each variable on population fall, holding other variables at their mean values.

We include these variables in an additive Cliff-Ord spatial lag regression

$$Y = \lambda Wy + X\beta + \varepsilon \qquad [1]$$

assuming that the residuals follow

$$\varepsilon = \rho Wy + \eta \qquad [2]$$

where η is heteroskedastic $\eta_i \sim N(0, \sigma_i^2)$

For this model we find that the sums of the direct and indirect effects of each variable, which are interpretable as elasticities, are:

Female illiteracy	-0.27
Industry	0.22
Coast	0.14

[2] For details see: http://cran.r-project.org/web/packages/quantregForest/quantregForest.pdf (last accessed 15 April 2015).

3. Was Malthus Right?

Chapter 2 of *Why Ireland Starved* famously asked 'was Malthus right?' But this raises another question: what would Malthus have expected? Malthus rarely paid much attention to Ireland, but the following prognosis in a contribution to the *Edinburgh Review* in 1808, offers one unambiguous answer (Malthus 1808: 345):

> Although it is quite certain that the population of Ireland cannot continue permanently to increase at its present rate, yet it as certain that it will not *suddenly* [our emphasis] come to a stop… Both theory and experience uniformly instruct us that a less abundant supply of food operates with a gradually increasing pressure for a very long time before its progress is stopt. It is difficult indeed to conceive of a more tremendous shock to society, than the event of it coming to at once the limits of its means of subsistence, with all the habits of abundance and early marriages that accompany a rapidly increasing population. But, happily for mankind, this never is, nor can be the case. The vent is provided for by the concurrent feelings and interests of individuals long before it arrives; and the gradual diminution of the wages of the labouring classes of society, slowly, and almost insensibly, generates the habits necessary for an order of things in which the funds for the maintenance of labour are stationary.

The extract contains both a hypothesis—the principle of population at work—and a prediction. This is very much the Malthus of the 'Second Essay', in which the preventive check to the birth rate plays an important role. 'Happily for mankind', prudential restraint meant that the shock of reaching the margin of subsistence 'all at once… never arrives'. This Malthus—let us call

him 'Malthus A'—would have expected faster growth in those parts of Ireland with the highest living standards, and an eventual erosion of the wage gap between counties.

But an earlier Malthus (1798: chapter 7)—'Malthus B'—envisaged another scenario in the event of the principle of population not working:

> Famine seems to be the last, the most dreadful resource of nature… The vices of mankind are active and able ministers of depopulation. They are the precursors in the great army of destruction; and often finish the dreadful work themselves. But should they fail in this war of extermination, sickly seasons, epidemics, pestilence, and plague, advance in terrific array, and sweep off their thousands and ten thousands. Should success be still incomplete, gigantic inevitable famine stalks in the rear, and with one mighty blow levels the population with the food of the world.

This is the Malthus usually associated with Ireland being 'a case study in Malthusian and Ricardian economics' (Solow 1971: 196), but the statement is really about a scenario where the equilibrating mechanism posited by Malthus A does not work.

Malthus's focus had been on the link between population growth and the food supply, but the paucity of time-series data on the key variables prompted Mokyr to treat the thirty-two counties as a pseudo-time series. This presumes that each county pursued its own individual path, a debatable assumption in an economy in which markets were rather well integrated. Although internal migration within Ireland was limited—in 1841 only 0.4

million out of over eight million lived in counties other than that in which they were born, and over two-thirds of those lived in an adjoining county—the variation in agricultural wages across counties was not much higher than in England.[3] The assumption that the counties are independent observations amounts to asserting that variables such as county incomes and demographic change in the different units were spatially autocorrelated. Using the rural land-labour ratio as proxy for population pressure, Mokyr found that land hunger constrained Irish economic development less "than the 'overpopulation' view would have us believe". In cross-section, he could identify no statistically significant relation between poverty and population pressure (1983: 48). This against-the-grain finding did not convince everyone (e.g. Kennedy 1984; Solar 1984). Employing the same cross-sectional approach as Mokyr but relying on a newly constructed measure of land quality (incorporating data on temperature, soil, and elevation) McGregor (1989: 236) could not reject the hypothesis that population pressure reduced income per capita.

In Ireland as a whole the rate of population growth declined quite significantly in the pre-famine era. Using a figure of 5 million for 1800 and Lee's revisions for 1821, 1831, and 1841 (Daultrey, Dickson and Ó Gráda 1981; Lee 1981: 54) implies that the annual growth population growth rate dropped from 1.7 per cent in 1800-1821 to 0.9 per cent in 1821-31 and 0.6 per cent in 1831-41. This drop was achieved through increased emigration and reduced nuptiality

[3] Using the county estimates in Bowley (1898, 1899), the coefficients of variation for agricultural wages 0.15 in 1829 and 0.18 in 1834, while those for England were 0.11 in 1833 and 0.15 in 1837.

rather than through rising mortality. Malthus A would have approved. However, when the focus is shifted to variations in population change across baronies, we find that in the pre-famine era population grew fastest where wages—here proxied by teachers' wages in the 1820s— were low and where land quality was poor (Figure 3).

4. Conclusions:

This short paper has addressed two of the most important questions addressed in *Why Ireland Starved* three decades ago, using more disaggregated data and modern estimation techniques. In accounting for population loss during the famine decade, the best predictors were female literacy, industrial employment, and the distance from the coast. Our analysis of the 'Malthusian' model found that, contrary to Malthusian presumptions, wages were increasing in land quality and that pre-famine population growth was diminishing in wages. These findings are broadly consistent with those proposed in *Why Ireland Starved*.

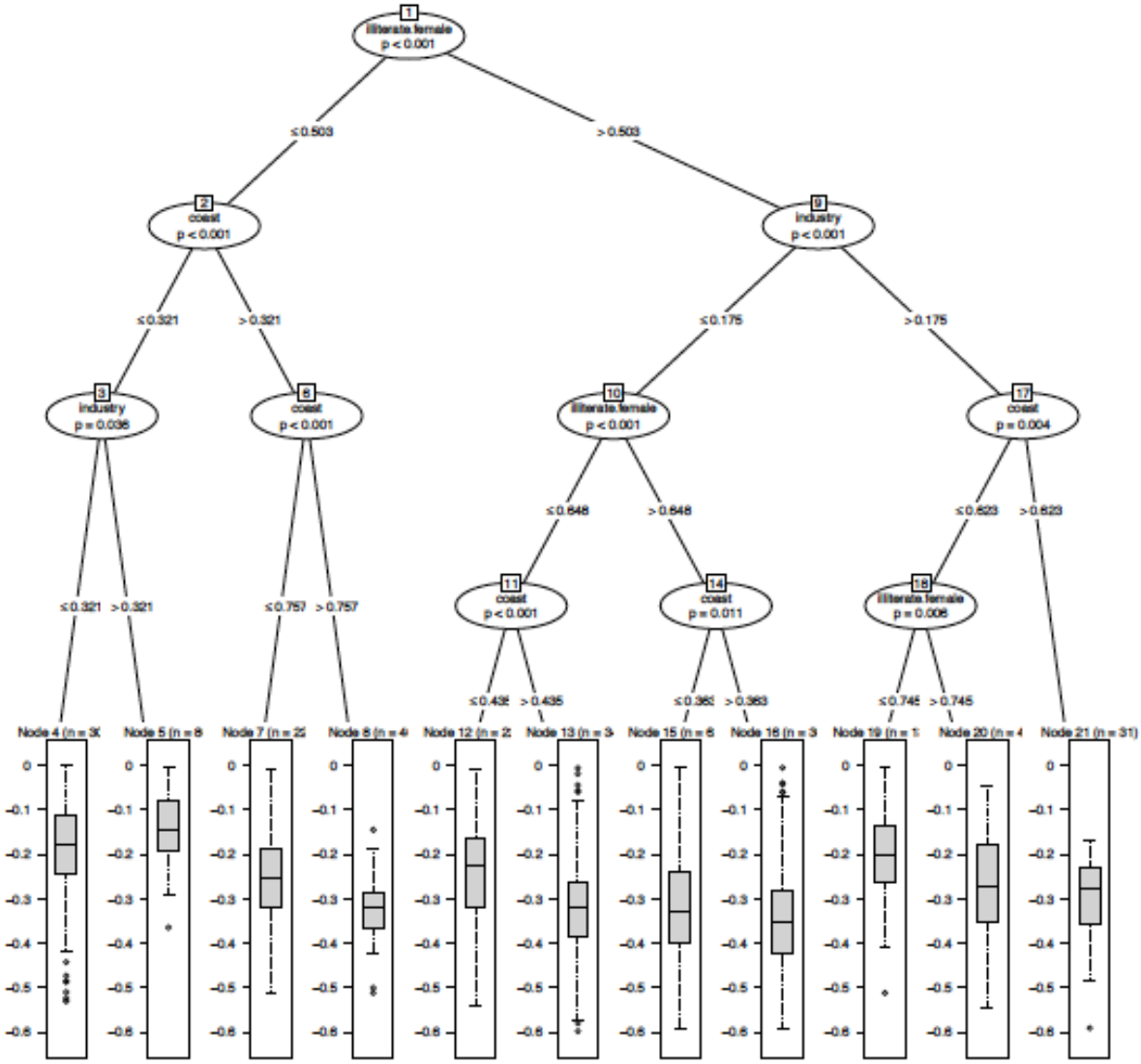

Figure 1. Classification tree giving the predicted population fall in different subsets of baronies where splits are chosen to maximize differences between groups.

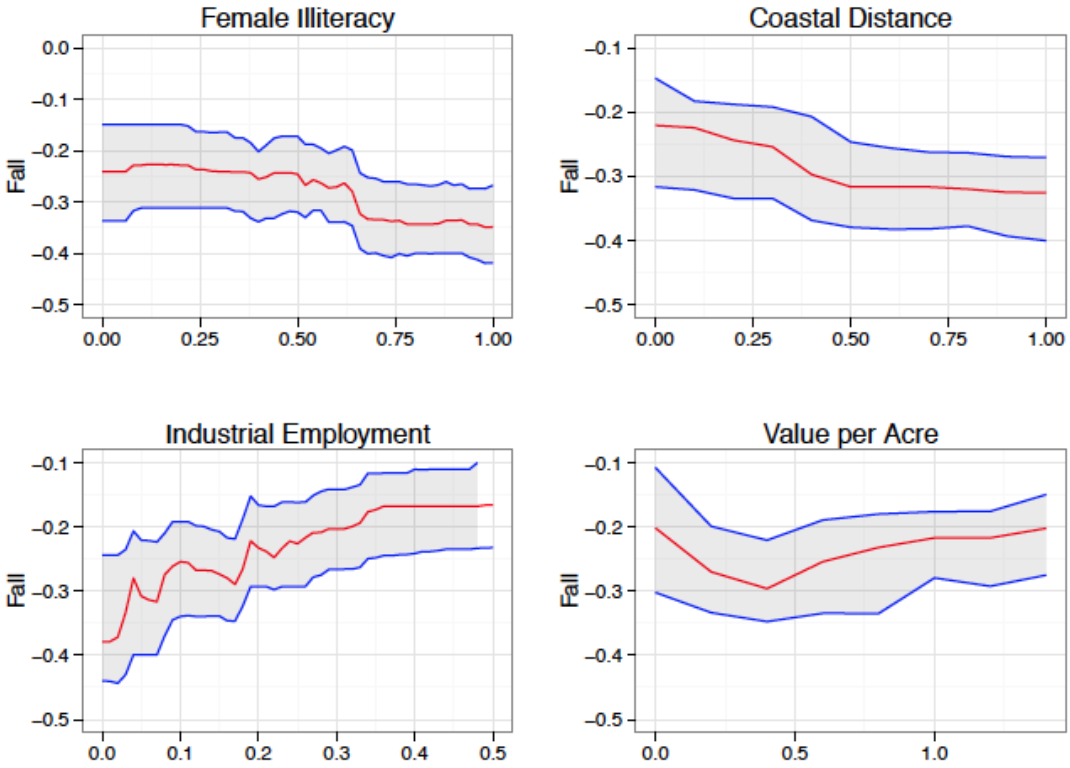

Figure 2. Random forest showing the predicted impact of the most important predictors on population fall.

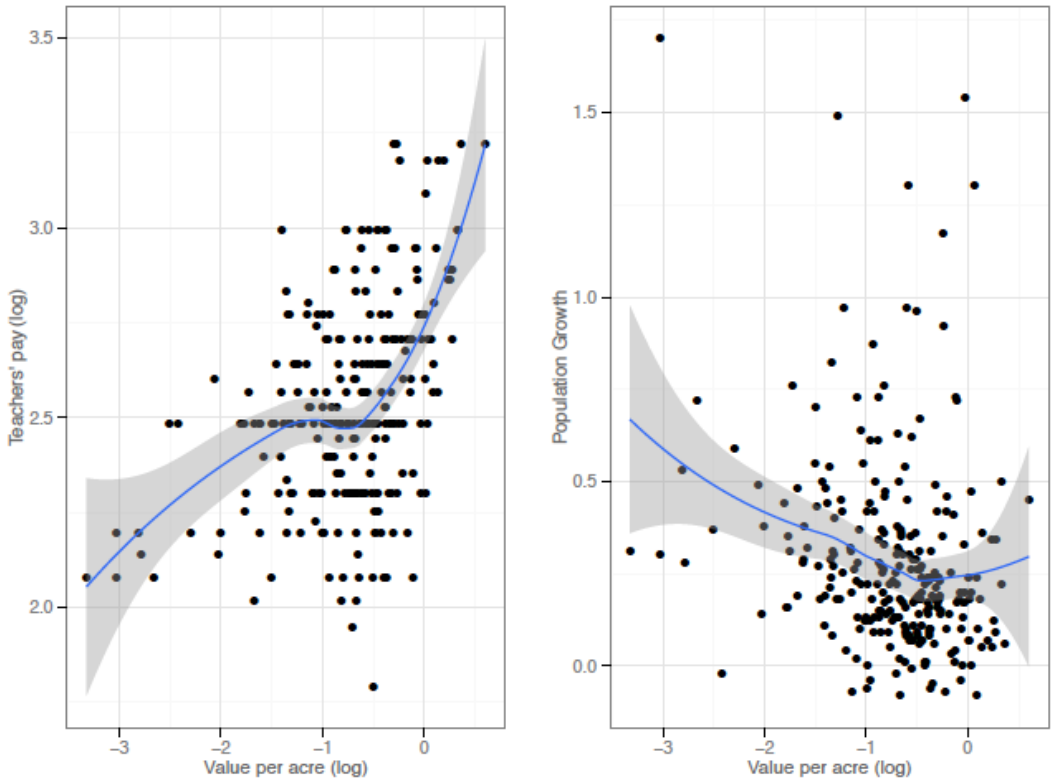

Figure 3: Scatter plots of value per acre and teachers' pay (in logs); and value per acre and population growth 1821-1841. Locally weighted sum of squares lines included.

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