Did the Great Irish Famine Matter?

KEVIN O’ROURKE

This article tests the hypothesis that price shocks in international commodity markets would by themselves have led to a fall in agricultural labor demand in rural Ireland in the absence of the Famine. This hypothesis has been used by revisionist historians to argue that the Famine was not a structural break between two distinct eras in Irish economic history. In refuting the hypothesis, this article joins a more recent cliometric tradition that has sought to restore the Famine to its rightful place as a major watershed in nineteenth-century Ireland.

I. INTRODUCTION

Did the Great Irish Famine matter? On the face of it, the question seems absurd. As Table 1 shows, the crisis brought to an abrupt halt the upward trend in Irish population growth of the previous 50 years and was followed by a period of population decline lasting into the next century. It is not surprising, therefore, that the Great Famine of the 1840s has long been viewed as a cataclysmic turning point in Irish demographic and economic history. Writing in the *locus classicus* of traditional, nationalistic Irish economic history, George O’Brien claimed that the Famine “initiated that great flood of emigration which was to be the dominant feature of Irish economic life in the second half of the century.”

Notwithstanding the evidence of Table 1, there is a distinguished tradition, most frequently associated with Raymond Crotty, that holds that the Famine did *not* represent a demographic watershed in Irish history. In particular, it is held that (1) exogenous price shocks in commodity markets would have reduced agricultural labor demand

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I am grateful to the following for their encouragement and advice: Iain Cockburn, Susan Collins, Louis Cullen, Mary Daly, Brad De Long, Larry Goulder, Ruth Ann Harris, Glenn Harrison, Tim Hatton, Elhanan Helpman, John James, Kala Krishna, David Landes, Joel Mokyr, Cormac O’Grada, Kevin O’Neill, Dan Raff, Thomas Rutherford, Peter Solar, Barbara Solow, Elizabeth Tighe, David Weir, Jeffrey Williamson, Ian Wooton, two anonymous referees, and this journal’s editor. The work was financed by a Sloan Doctoral Dissertation Fellowship, a Jens Aubrey Westengaard Scholarship, and a grant from the Harvard University Economic History Workshop. The usual disclaimer applies.

1 O’Brien, *The Economic History of Ireland*, p. 3.
O’Rourke

TABLE 1
POPULATION OF IRELAND, 1791–1901

<table>
<thead>
<tr>
<th>Year</th>
<th>Population</th>
<th>Year</th>
<th>Population</th>
</tr>
</thead>
<tbody>
<tr>
<td>1791</td>
<td>4,753,000</td>
<td>1861</td>
<td>5,799,000</td>
</tr>
<tr>
<td>1821</td>
<td>6,802,000</td>
<td>1871</td>
<td>5,412,000</td>
</tr>
<tr>
<td>1831</td>
<td>7,767,000</td>
<td>1881</td>
<td>5,175,000</td>
</tr>
<tr>
<td>1841</td>
<td>8,175,000</td>
<td>1891</td>
<td>4,705,000</td>
</tr>
<tr>
<td>1851</td>
<td>6,552,000</td>
<td>1901</td>
<td>4,459,000</td>
</tr>
</tbody>
</table>

Note: Figures prior to 1841 are controversial; see Mokyr and O’Grada ("New Developments") for a discussion. The basic pattern is undisputed, however.

even if the Famine had not occurred, and (2) this reduction in labor demand would have been sufficient on its own to produce the fall in population documented in Table 1. My purpose here is to refute that claim. I accordingly ask what the effects of those exogenous price shocks would have been on agricultural labor demand if the Famine had not occurred.

The traditional view that the Famine represented a “watershed” or “catastrophe” in Irish economic history was succinctly summarized by Crotty:

It has been traditional to regard the Great Famine as a line which clearly demarcates two eras in Irish agriculture. The earlier era is depicted as one in which, despite acute misery, the Irish rural population had faith in themselves and in the land; they remained on the land; they tilled rather than grazed the land; they married young and few remained unmarried. The latter era is depicted as one in which the people, shocked by the appalling tragedy of the Great Famine, lost confidence in themselves and in the land; they abandoned the land and emigrated; they put away the plough and stocked the land with cattle and sheep; they married at an increasingly later age, when they married at all.²

In the 1960s revisionist historians such as Louis Cullen and Crotty started challenging this view, with considerable success. Crotty claimed that the population would have declined in the absence of the Famine, and that the Famine was “not, as has been frequently claimed, a watershed—at least in any meaningful sense.”³ Cullen, in a famous passage, wrote that “the Famine was less a national disaster than a regional and social one . . . even if a famine had not interfered, a decline in population was inevitable.”⁴ By 1981, in an article surveying the debate, J. M. Goldstrom felt able to write that “From the early 1960’s

² Crotty, Irish Agricultural Production, pp. 50–51.
³ Ibid., p. 46.
⁴ Cullen, An Economic History of Ireland, p. 132.
we have travelled to a point where no historian would argue that all changes stemmed from the Famine."

With the extension of the Cliometric Revolution to Ireland, however, the revisionist view was itself subjected to revision and the Famine brought back as the central event in Irish economic history. Joel Mokyr’s *Why Ireland Starved* took pains to refute the Malthusian argument that the Famine was inevitable due to the overpopulation of pre-Famine Ireland. Indeed, Mokyr found that "there is no evidence that pre-famine Ireland was overpopulated in any useful sense of the word." This is important, as Cullen’s argument regarding the irrelevance of the Famine was essentially Malthusian:

A rise in emigration and a falling population would have been inevitable even if the Great Famine had not occurred. The rapid rise in population in pre-Famine decades had been accompanied by a disproportionate increase in the numbers with no secure stake in the land; the decline in domestic industry deprived them of the prospect of an industrial income as well.

Moreover, work by both Cormac O’Grada and Peter Solar measuring the structure of agricultural output before and after the Famine revealed a clear break in the data. O’Grada concluded that "in so far as economic and social history can be divided into stages or epochs at all, the Famine is a dividing line."

This paper further revises the revisionists by providing a specific test of Crotty’s claim that the Famine was not a watershed in Irish demographic history. It does so for the period from 1845 to 1876, the eve of a major agricultural depression and fundamental land reform. Any test of Crotty’s claim will inevitably be counterfactual in nature. To say that the Famine did not matter implies that in the absence of the Famine the economy would have behaved in much the same way as it actually did. I have therefore constructed a no–Famine counterfactual and compared it with what actually happened.

To grasp the nature of this counterfactual scenario, it is of course first necessary to clearly understand Crotty’s argument. His argument leans heavily on the changing mix over time of agricultural output, and it may best be understood by examining Tables 2, 3, and 4. Table 2 makes it clear that the decline in Irish population between 1841 and 1876 can be almost entirely explained by a decline in the agricultural population. Indeed, agricultural employment itself fell by 45 percent. Table 3 gives the structure of agricultural output for a typical year during the period between 1840 and 1845 and for 1876. As can be seen, there was a major

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5 Goldstrom, "Irish Agriculture and the Great Famine," p. 158.
6 Mokyr, *Why Ireland Starved*, p. 64.
7 Cullen, *An Economic History of Ireland*, p. 134.
8 O’Grada, *The Great Irish Famine*, p. 65. For a balanced survey of the literature, see Daly, *The Famine in Ireland*. 
TABLE 2
IRISH AGRICULTURAL EMPLOYMENT AND POPULATION DEPENDENT ON AGRICULTURE, 1840–1845 TO 1876

<table>
<thead>
<tr>
<th>Year</th>
<th>Agricultural Employment</th>
<th>Agricultural Population</th>
</tr>
</thead>
<tbody>
<tr>
<td>1841</td>
<td>1,844,000</td>
<td>5,077,000</td>
</tr>
<tr>
<td>1856</td>
<td>1,317,000</td>
<td>3,306,000</td>
</tr>
<tr>
<td>1876</td>
<td>1,016,000</td>
<td>2,599,000</td>
</tr>
</tbody>
</table>

Sources: Numbers for 1856 and 1876 were calculated by interpolating figures for 1851 and 1861, and 1871 and 1881, respectively. Agricultural employment is given in Mitchell, *European Historical Statistics*, p. 165. Numbers dependent on agriculture were derived by applying the ratios in Booth, "Economic Distribution of Population," p. 65, to the population figures in Table 1.

TABLE 3
IRISH AGRICULTURAL OUTPUT, 1840–1845 AND 1876
(in millions of pounds at constant prices)

<table>
<thead>
<tr>
<th>Year</th>
<th>Tillage</th>
<th>Potatoes</th>
<th>Pasture</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>1840–1845</td>
<td>12.9 (32.6%)</td>
<td>8.8 (22.2%)</td>
<td>17.9 (45.2%)</td>
<td>39.6</td>
</tr>
<tr>
<td>1876</td>
<td>6.4</td>
<td>1.8</td>
<td>22.5</td>
<td>30.7</td>
</tr>
</tbody>
</table>

Sources: For the derivation of the pre-Famine figures, see the data appendix. O’Grada’s figures are used for the 1876 output and are then deflated by suitable price indices. Figures are not given in percentage terms for 1876, as they would be meaningless.

TABLE 4
AGRICULTURAL LAND USE, 1840–1845 AND 1876
(in thousands of acres)

<table>
<thead>
<tr>
<th>Year</th>
<th>Tillage</th>
<th>Potatoes</th>
<th>Pasture</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>1840–1845</td>
<td>3,302 (22.3%)</td>
<td>2,100 (14.2%)</td>
<td>9,398 (63.5%)</td>
<td>14,800</td>
</tr>
<tr>
<td>1876</td>
<td>2,346 (15.1%)</td>
<td>903 (5.8%)</td>
<td>12,252 (79.1%)</td>
<td>15,501</td>
</tr>
</tbody>
</table>


shift away from tillage and potatoes and toward pasture, a shift that is also evidenced by the acreage figures in Table 4. The significance of this shift is that tillage and potato cultivation are significantly more labor-intensive activities than is livestock rearing;⁹ thus, such a shift would have led to a reduction in the demand for labor within Irish agriculture.

Moreover, the shift from tillage to pasture seems to be readily explained by changing world market conditions. Between the early 1840s and 1876, the price of animal products increased by 60 percent while the price of grains and flax rose by only 23 percent. Crotty’s hypothesis thus can be simply stated: changing world relative prices would have led to a switch from tillage to pasture, and to a consequent

⁹ See, for example, the figures given in Solow, *The Land Question and the Irish Economy*, p. 107.
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decline in agricultural labor demand, even in the absence of the Famine. This fall in agricultural labor demand would in turn have led to a fall in population as drastic as that which occurred. "The Famine did, of course in many ways hasten developments, but only along paths which were already being followed. It did not change the direction of development."¹⁰

The counterfactual exercise suggested by Crotty’s argument is thus apparent. I constructed a model of the pre-Famine Irish economy and subjected it to the price shocks that occurred over the period from 1845 to 1876. The Crotty claim would be supported if such counterfactual simulations reproduced substantial declines in agricultural labor demand. If they did not, Crotty’s claim that price shocks alone would have led to the observed depopulation would be weakened.

The model I employed was a computational general equilibrium (CGE) model of the Irish agricultural economy, to my knowledge the first to be applied to the study of Irish history. The model is described in the next section. To implement the model, I constructed an input-output table for Irish agriculture as it stood on the eve of the Famine, building on the work of O’Grada and Solar but also incorporating new estimates of certain variables. The subsequent section outlines how the table was constructed; full details are contained in a data appendix available on request. In the fourth section I use the model to test the Crotty hypothesis directly. It will be seen that the hypothesis does not do well when confronted with the model: in fact, the results are rather counterintuitive.

II. THE MODEL

Model Assumptions

Some key features of the model I used must initially be described verbally, because the assumptions made will influence the type of results the model is capable of generating. Six sets of assumptions underlie the model: the small open economy assumption, the exogenous wage assumption, the relative numbers of sectors and factors, the existence of joint outputs, the CES production function assumption, and modeling agriculture separately from the rest of the economy.

THE SMALL OPEN ECONOMY ASSUMPTION

There are three traded goods in the model: animal products, referred to as "beef"; cereal products, referred to as "wheat"; and a consumption good not produced within the model, which serves as a numer-

¹⁰ Crotty, Irish Agricultural Production, p. 46.
It is assumed that Ireland was so small among world markets during the nineteenth century (as it assuredly is today) that it had no influence over the world prices of these goods. That is to say, world prices were determined purely by conditions of supply and demand in the rest of the world. Of course, domestic prices also depended on Irish tariff levels, which since the 1820s had been determined in London. The crucial point is, however, that prices of goods are exogenous to the model.

The small-country assumption is standard for the period, but this is not the reason for making it. The only model capable of testing fairly Crotty’s claim that exogenous price shocks would have caused rural depopulation in the absence of the Famine will, by definition, be a small open economy model.

**FIXED WAGES ASSUMPTIONS**

The second assumption of the model, which differs significantly from standard CGE assumptions, is that of exogenous wages in agriculture. Wages are exogenous because they were set at a subsistence level. The utility of workers, who consume a fixed amount of potatoes and the numeraire, is kept constant, which implies a linear relationship between the nominal wage and the price of potatoes. The reason for making this assumption should be clear by now. Assuming an elastic supply of labor allows a focus on the effects of price shocks on the demand for labor; it is the assumption most favorable to Crotty.

**NUMBERS OF SECTORS AND FACTORS OF PRODUCTION**

The model has three sectors: tillage, pasture, and potatoes. Tillage and pasture both produce traded goods. Consider what would be the implications of having three factors of production: land, labor, and capital. Given that the price of labor is exogenous, the two conditions equating price and unit cost of production (the latter being, under constant returns, merely a function of factor prices) in the tillage and pasture sectors would then be sufficient to determine the returns to land and capital. With all three factor prices determined, the price of potatoes, the nontradeable, would then also be determined as a function of world tradeables prices. For this reason, if for no other, it makes

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11 Both “beef” and “wheat” are thus composite goods. “Beef” includes mutton, pork, butter, milk, wool, and eggs as well as beef; “wheat” includes wheat, oats, barley, and flax.


13 The assumption also has some claim to realism. O’Grada (“For Irishmen to Forget?” p. 18) has written that “the typical farm worker in prefamine Ireland was paid a potato wage not much above subsistence.” If this assumption is taken as a literal statement of how the economy worked, the model is one not only of agricultural labor demand but also of agricultural employment. To take this assumption literally is, however, not necessary for the purposes of this article.
sense to introduce a fourth factor of production—expertise—into the model. Given four factors of production, domestic demand and supply will play a role in determining potato prices.\textsuperscript{14}

\textbf{JOINT PRODUCTS}

It would be impossible to derive unambiguous analytical results within the sort of model framework I am outlining. The existence of joint products makes analytical results elusive even within simpler frameworks. It is, however, necessary to include certain joint products within the model if the links between different agricultural sectors are to be treated effectively. The following discussion itemizes those joint products.

\textit{Hay}

Hay was an important crop in Ireland in the period in question: 8.3 percent of agricultural land was devoted to its production in 1854. It did not contribute much to agricultural output, simply because most of it was fed to on-farm animals. Hay is strictly speaking a tillage crop, generally included with tillage in official agricultural statistics despite the fact that it is clearly linked far more closely with livestock rearing. In terms of factor intensity, it is probably closer to livestock rearing than grain production. It is also nontraded. I have modeled hay and pasture jointly as an activity producing two outputs, hay and livestock. Most of the hay was consumed within the sector itself, but some was sold to feed off-farm horses, and some entered indirectly as an input into other sectors as feed for draught horses. The elasticity of transformation between hay and pasture is assumed to be positive; that is, the farmer could vary the output mix to some extent.\textsuperscript{15}

\textit{Straw and Manure}

As is frequently pointed out, the three agricultural sectors identified earlier were interlinked in many ways. In an attempt to capture this fact, I included straw and manure in the model. Straw is a by-product of grain production; one important reason for including it in the model is that straw is largely nontraded. This might provide a rationale for the maintenance of some tillage even when international price trends seem

\textsuperscript{14} In fact, the introduction of a fourth factor of production such as expertise into the model is also needed for empirical reasons, as otherwise the value of output would not be exhausted by factor payments. (See the next section for details.)

\textsuperscript{15} Note that the model also takes into account the fact that milk, like hay, is produced in the pasture sector and is also used as an input in that sector, being fed to pigs.
to dictate that grain production is uneconomical. Straw is produced in a fixed proportion with grain.\footnote{This assumption abstracts from the possibility of long-run endogenous technical change.}

Manure was an important by-product of livestock rearing that served as an input into potato production. (Moreover, because potatoes and tillage crops, and indeed hay and clover, followed each other in rotation, perhaps it should also be considered as an input into tillage and pasture.) The importance of this link is evident from a report that in England prior to the 1850s livestock were kept on arable farms ""not from a view to profit in the sale of meat, but for the production of dung, and the consequent increase in the corn crop.""\footnote{Quoted in Hueckel, ""Agriculture during Industrialisation,"" p. 196. For the importance of farmyard manure in Ireland in the pre-Famine economy, see Walsh, Ryan, and Kilroy, ""A Half Century of Fertiliser and Lime Use,"" pp. 105-6; and Barrington, ""A Review of Irish Agricultural Prices,"" p. 264.} It is included in the model, therefore, by having manure produced in a fixed proportion with livestock within the pasture sector.

CONSTANT ELASTICITY OF SUBSTITUTION (CES) PRODUCTION FUNCTIONS

All production functions are assumed to be of the familiar CES variety. The key parameter in such functions is the elasticity of substitution (denoted as $s$ in what follows). The basic form of CES production functions is

$$y = (\Sigma b_i x_i^{(s-1)/s})^{s/(s-1)}$$

where $y$ is the output, the $x_i$'s are inputs, and the $b_i$'s are constants. Where several outputs are produced, constant elasticity of transformation production functions are used; in this case, the output of an individual good $q_i$ is given by

$$q_i = \frac{y[p/a_i F(p)]^t}{p_i}$$

where $y$ is as above, $p_i$ is the price of good $i$, $p$ is the vector of prices, $a_i$ is a constant, and $F(p)$ equals $[\Sigma a_i p_i^{(1-t)}]^{1/(1-t)}$, where $t$ is the elasticity of transformation.\footnote{Rutherford, General Equilibrium Modeling, pp. 13-14.}

CAN AGRICULTURE BE MODELED SEPARATELY?

The question now arises whether one can justify modeling agriculture separately from the rest of the economy. Imagine a fourth sector, manufacturing, whose output is denoted by $M$. Let it employ capital, skilled and unskilled labor, and imported intermediate inputs (such as coal). Let the price of $M$ be determined abroad, along with the price of coal, and let both wage rates that the sector faces be exogenous.

Irish capital markets in the first half of the nineteenth century were
severely underdeveloped. This had crucial implications for the working of the economy.

In the absence of capital markets most accumulation took the form of self-finance. In other words, investment was seldom "financed" in the literal sense of the word. In agriculture land was improved by "investing" in soil fertility through drainage, weeding, crop rotation, the judicious application of manure, and the raising of more farm animals. Since farmers were forgoing present consumption and/or leisure for the sake of greater output in the future, such actions were an investment, although capital markets had little or nothing to do with them. In the Industrial Revolution... self-finance in the form of plowed-back profits was doubtless the main source of fixed and circulating capital.19

If self-finance were the main source of investment funds, it would seem reasonable to treat agricultural and industrial capital as distinct entities. Different groups of people were making the investment without any financial intermediation linking the two activities. There would be no reason to expect the rate of return on investment in agriculture and industry to be equal. It would thus seem sensible to distinguish between industrial capital and agricultural capital. Moreover, it would also seem reasonable to distinguish between the expertise possessed by farmers and that possessed by skilled workers in the manufacturing sector.

It is clear that if these (quite plausible) circumstances held and further if all potatoes were consumed within the agricultural sector, the model would separate into two components—agricultural and industrial—having essentially nothing to do with each other. It is easy to see why this would be the case. The two factors that agriculture and manufacturing both use are capital and unskilled labor; capital is sector-specific and labor is in perfectly elastic supply at an exogenous wage rate. Thus there are no negative supply-side links between the two sectors. On the other hand, because all goods other than potatoes are perfectly traded, domestic incomes do not affect the demand for these goods, which is determined abroad. The demand for potatoes is by assumption internal to the agricultural sector. Thus there are no positive, demand-side links between agriculture and industry, either. (Off-farm sales of hay and straw, which are also nontraded, are negligibly small.)

If there were nontraded, nonagricultural goods in the model, nonagricultural output and employment would depend on agricultural incomes and tastes; however, agricultural output would still essentially be determined by foreign prices. If some potatoes were consumed in the nonagricultural sector, obviously farm output would depend on what went on in the rest of the economy. If the shock that we are considering originated in the agricultural sphere, however, we would only need to consider feedback from industry if agricultural change affected industry—that is, if there were also nontradeables outside of agriculture.

19 Mokyr, Why Ireland Starved, pp. 159–60.
How important were industry-agriculture linkages on the eve of the Famine? If one accepts that capital markets were segmented and labor was in elastic supply, the answer will depend on the extent to which nontradeable food was sold to the nonagricultural population. Potatoes constituted the great bulk of nontraded agricultural food; Table 3 shows that they accounted for 22.2 percent of agricultural output. According to figures presented by P. M. A. Bourke, 8.02 percent of the potatoes produced was sold to off-farm consumers in Ireland. Thus, only 1.78 percent of the total agricultural output consisted of nontradeable output sold to the nonagricultural sector. It therefore seems safe to model agriculture without explicitly modeling industry.

Model Structure

In this section the structure of the model is presented in a somewhat heuristic fashion. It is a model of long-run equilibrium, constant returns, and perfect competition, with all factors perfectly mobile between sectors. There are three sectors—tillage $(T)$, pasture $(P)$, and potatoes $(S)$—and four primary factors of production—labor $(L)$, land $(R)$, capital $(K)$, and a factor $E$, for expertise, whose income accrues to occupiers of farms in excess of the return to their labor. Occupiers of farms are those fortunate enough to have tenancy; the remaining workers are landless laborers.

Potatoes are produced by combining labor, capital, land, expertise, and manure $(M)$; manure is produced by combining dung $(D)$ and straw $(ST)$ in fixed proportions:

$$ S = S(L_S, K_S, R_S, E_S, M) $$

$$ M = M(ST_M, D) $$

The tillage sector produces two joint outputs, straw and grain $(G)$, in fixed proportions by combining labor, capital, land, expertise, and horse feed $(F_T)$. Horse feed is produced by combining straw, hay $(H)$, potatoes, and oats $(O)$:

$$ (ST, G) = T(L_T, K_T, R_T, E_T, F_T) $$

$$ F_T = F_T(ST_T, H_T, S_T, O) $$

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20 Bourke, "The Use of the Potato Crop," p. 82.

21 Rural cottage industries may have supplemented agricultural incomes. By 1845, however, these industries seem to have been in decline, in Ireland as throughout all of Europe; see Mokyr, Why Ireland Starved, pp. 281–83, for an account. It is not clear that the existence of these industries would substantially change the story being told.
Horses are used in the tillage but not the potato sector because potato cultivation was almost exclusively done by spade in pre-Famine Ireland.\textsuperscript{22}

The pasture sector produces two joint outputs, cows (C) and hay, in variable proportions. They are produced by combining a value-added aggregate (VA\textsubscript{P}) and cow feed (F\textsubscript{P}) in fixed proportions. (The logic behind this is that you need a fixed amount of food to feed an animal.) The value-added aggregate is produced by combining labor, capital, land, and expertise; cow feed by combining straw, hay, milk (MK), and potatoes. Cows produce beef (B) and dung in fixed proportions:

\begin{align*}
(C, H) &= P(VA\textsubscript{P}, F\textsubscript{P}) \\
VA\textsubscript{P} &= VA\textsubscript{P}(L\textsubscript{P}, K\textsubscript{P}, R\textsubscript{P}, E\textsubscript{P}) \\
F\textsubscript{P} &= F\textsubscript{P}(ST\textsubscript{P}, H\textsubscript{P}, S\textsubscript{P}, MK) \\
(B, D) &= SL(C)
\end{align*}

Beef and grain are sold in return for the consumption good (N) at exogenously determined prices. Oats and milk are purchased with the consumption good, also at an exogenously determined price.\textsuperscript{23} All other prices are endogenous, the other commodities being nontraded. Some straw (ST\textsubscript{NF}) and hay (H\textsubscript{NF}) is also sold in return for the consumption good; this represents sales to off-farm users. Otherwise, they are used as intermediate farm inputs. Straw and hay are both used as cattle feed and horse feed, but straw is additionally used to litter cattle (which is how it is combined with dung to form manure). Potatoes are eaten by farmers (S\textsubscript{F}) and workers (S\textsubscript{W}), cattle and horses. They are also sold in exchange for the consumption good, representing sales to the off-farm population (S\textsubscript{NF}).

Balance in the markets for potatoes, straw, and hay requires that

\begin{align*}
S &= S\textsubscript{P} + S\textsubscript{T} + S\textsubscript{F} + S\textsubscript{W} + S\textsubscript{NF} \\
ST &= ST\textsubscript{P} + ST\textsubscript{T} + ST\textsubscript{M} + ST\textsubscript{NF} \\
H &= H\textsubscript{P} + H\textsubscript{T} + H\textsubscript{NF}
\end{align*}

There are three consumers in the model: landlords, farmers, and workers. Landlords are endowed with all the land and capital and spend all their income on the consumption good. Farmers are endowed with expertise and labor (L\textsubscript{F}), workers with labor alone (L\textsubscript{W}). Both groups

\textsuperscript{22} Salaman, \textit{History and Social Influence}, p. 329.

\textsuperscript{23} The reason for modeling oats separately is that because oats (and all grains) are traded commodities, a domestic demand for oats does not require them to be produced domestically. To let grain enter directly into the horse feed function would require that all oats fed to horses be grown in Ireland. The reason for modeling milk in this way is that the price of milk stayed constant over time during the period we are considering, whereas the prices of other animal products rose sharply.
consume a fixed amount of potatoes per capita \( (s_F \text{ and } s_W, \text{ respectively}) \) and spend the rest of their incomes on the consumption good \( (N_F \text{ and } N_W, \text{ respectively}) \). The budget constraints are as follows:

\[
\begin{align*}
rK + dR &= N_L \\
eE + wL_F &= p_Ss_FL_F + N_F \\
wL_W &= p_SS_WL_W + N_W
\end{align*}
\]

where \( w \) is the nominal wage, \( r \) the return to capital, \( d \) the rent on land, \( e \) the return to expertise, and \( p_S \) the price of potatoes.

The consumption good provides a simple way to close the model. It represents an aggregate of all goods not produced in the Irish agricultural economy. All transactions between the Irish agricultural economy and the rest of the world involve use of the consumption good. As was stated already, it is obtained by selling beef \( (N_B) \), grain \( (N_G) \), straw \( (N_{ST}) \), hay \( (N_{H}) \), and potatoes \( (N_S) \); it is consumed by landlords \( (N_L) \), farmers \( (N_F) \), and workers \( (N_W) \) and is also used to buy oats \( (N_O) \) and milk \( (N_{MK}) \). Balance in the market for the consumption good requires that

\[
B/p_B + G/p_G + ST_{NF}/p_{ST} + H_{NF}/p_H + S_{NF}/p_S = N_L + N_F \\
+ N_W + N_O + N_{MK}
\]

where \( p_i \) is the price of good \( i \) in terms of the consumption good.

The only rigidity in the model is a real wage that is fixed in the sense that it holds workers’ utility constant at the benchmark level. As the model is designed to predict labor demand in the long run, the supply of labor is assumed to be perfectly elastic at this constant real wage. We normalize the benchmark wage to be 1. As workers consume a fixed amount of potatoes per capita, keeping utility constant involves a linear relationship between the wage and the price of potatoes:

\[
w = a_Sp_S + (1 - a_S)
\]

where \( a_S \) is the share of workers’ income spent on potatoes in the benchmark equilibrium.\(^{25}\)

---

\(^{24}\) This assumption is not necessary to the results of the article. An appendix, available on request, reports a simulation for the case in which utility functions are of the Cobb-Douglas variety. The assumption is, however, convenient as well as realistic, being an example of the linear expenditure system. This representation of consumer demand is frequently used in the context of developing countries; see for example Taylor, *Macro Models.*

\(^{25}\) There is an implicit assumption here that the price of the numeraire good is constant. This is realistic: between 1840–1845 and 1856–1860, wheat prices fell while oat and barley prices rose; milk prices remained constant between 1845 and 1854; and the CPI relevant to agricultural laborers remained broadly unchanged between 1856–1860 and 1874–1876. The one consumer price to jump significantly during the period was the potato price: this was of course due to the blight. To construct a “no-blight counterfactual CPI” would take a lot of work and would be somewhat
The full-employment conditions for capital, land, and expertise are

\[ K = K_P + K_T + K_S \]  
(17)
\[ R = R_P + R_T + R_S \]  
(18)
\[ E = E_P + E_T + E_S \]  
(19)

Labor demand is determined endogenously as the sum of labor demands in the three sectors:

\[ L_W + L_F = L_P + L_T + L_S \]  
(20)

It is assumed that changes in labor demand are reflected by changes in the numbers of workers demanded—that is, by changes in \( L_W \) rather than changes in \( L_F \). This can be justified both theoretically (farmers hired laborers, rather than vice versa) and empirically (the number of farmworkers per 100 farmers collapsed from 271 in 1841 to 149 in 1881).\(^{26}\)

Keep in mind that this section has presented the model heuristically rather than formally. For example, it has described technologies in terms of production functions rather than cost functions. A formal statement of the model would involve cost-price equations for each sector, demand-equals-supply equations for all flex-price goods and factors, equations expressing agents’ incomes in terms of factor prices, and equation 16 relating the wage rate to the price of potatoes.

III. THE DATA

The data used in constructing the pre-Famine benchmark equilibrium were taken from a variety of sources, including contemporary farmers’ journals, textbooks, government reports, the work of O’Grada,\(^{27}\) and most importantly, Solar’s painstaking reconstruction of pre-Famine agricultural output.\(^{28}\) The benchmark equilibrium is intended to represent an average year during the period from 1840 to 1845.

Table 5 gives estimates of production levels and end uses of the main crops grown in Ireland on the eve of the Famine. Clearly, straw, hay, and potatoes were heavily used as intermediate inputs within the agricultural sector. Oats were also fed to horses. The importance of

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speculative: it seems easier and just as satisfactory to assume that consumer prices remained constant. See O’Grada, “Irish Agricultural Output,” p. 163; and O’Rourke, “Agricultural Change,” pp. 103, 154, 179 for the evidence on prices.


\(^{27}\) O’Grada, “Irish Agricultural Output” and Ireland Before and After the Famine.

\(^{28}\) Solar, “Growth and Distribution,” chap. 9. The work of Turner on post-Famine Irish agriculture promises to become an invaluable data source in the future; for an example see his “Agricultural Output and Productivity.” Unfortunately, so far too little of his work has been made public to have had a major impact on this paper. For a skeptical look at the data sources I use, see O’Grada, “Too Much Faith in Numbers?”
<table>
<thead>
<tr>
<th>Crop</th>
<th>Total</th>
<th>Off-farm sales &amp; human food</th>
<th>Pigs, cows</th>
<th>On-farm horses</th>
<th>Manure</th>
<th>Seed &amp; waste</th>
</tr>
</thead>
<tbody>
<tr>
<td>Potato</td>
<td>12,600</td>
<td>6,640</td>
<td>2,910</td>
<td>740</td>
<td>0</td>
<td>2,510</td>
</tr>
<tr>
<td>Wheat</td>
<td>375</td>
<td>345</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>30</td>
</tr>
<tr>
<td>Oats</td>
<td>1,365</td>
<td>898</td>
<td>0</td>
<td>299</td>
<td>0</td>
<td>168</td>
</tr>
<tr>
<td>Barley</td>
<td>170</td>
<td>157</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>13</td>
</tr>
<tr>
<td>Flax</td>
<td>25</td>
<td>25</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Hay</td>
<td>2,090</td>
<td>111</td>
<td>1,522</td>
<td>457</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Straw</td>
<td>3,732</td>
<td>187</td>
<td>1,830</td>
<td>550</td>
<td>788</td>
<td>377</td>
</tr>
</tbody>
</table>

Source: Most numbers are taken from Solar, *Growth and Distribution*, chap. 9; the figures for potatoes fed to horses are based on Bourke, “The Use of the Potato Crop”; the source of the figures for hay and straw is explained in the data appendix.

potatoes is particularly striking. Their role in making available cheap labor is well known; what emerges from these figures is the fact that a local variant of the Norfolk rotation was already in place in Ireland, the criticisms of English observers notwithstanding. “It is true that the Irish were castigated for not using artificial grasses and turnips. But there was really no need for the former, and the potato did the job of the latter.”

Not only were potatoes stall-fed to cattle, horses, and pigs; they also played a role in crop rotations similar to that of the turnip in England.

Using figures contained in Bourke, I further disaggregated the total of potatoes fed to humans or sold off-farm; off-farm sales amounted to 1,263 tons, farmers’ consumption to 3,277 tons, and workers’ consumption to 2,100 tons. Applying the prices from O’Grada and the *Agricultural Statistics of Ireland* for 1907–1908 produces estimates for the following variables, as defined in the previous section (all estimates are in value terms, being denominated in millions of pounds):

\[
\begin{align*}
S &= 13.7 \\
ST &= 5.5 \\
ST_S &= 1.3 \\
H &= 8.0 \\
H_T &= 1.8 \\
H_P &= 5.8 \\
S_W &= 2.8 \\
S_F &= 4.3 \\
S_{NF} &= 1.7 \\
ST_P &= 3.0 \\
ST_{NF} &= 0.3 \\
G &= 14.6 \\
O &= 2.0
\end{align*}
\]

Further, the output of animal products is estimated at £18.3 million (hence B equals 18.3), and the value of dung (D) produced at £2.9 million. The value of milk (MK) fed to pigs is estimated at £0.8 million.

31 See the data appendix for details.
Land inputs in the three sectors were easily obtained, as I had the acreage estimates of Table 4 and an estimate of total rent (£12 million) from O’Grada. Capital inputs were also easily calculated. According to Feinstein, they mostly consisted of stocks of harvested and standing crops, livestock, and horses. These stocks can be estimated for each sector; assuming with O’Grada that profits accounted for 6 percent of the income accruing in agriculture, or £2.4 million, the capital income arising in each sector can be easily calculated.

For labor inputs in the three sectors, I made use of the 1836 Poor Law Commission Report. In it, accounts are given for a “typical” farm of the period, prepared by local farmers in conjunction with the Poor Law Inspector. From these accounts I calculated the share of labor in production (net of seeds and waste) in each of the three sectors: the share in tillage was 0.464, in potatoes 0.394, and in pasture 0.063. Applying these labor shares to production allowed me to calculate labor inputs in the three sectors. Finally, inputs of expertise in the three sectors were calculated as residuals. Details of all these calculations can be found in the data appendix.

The following are the estimates of inputs of primary factors of production into the three sectors (again, all estimates are in millions of pounds):

\[
R_S = 1.7 \quad R_T = 2.7 \quad R_P = 7.6
\]
\[
K_S = 0.6 \quad K_T = 0.9 \quad K_P = 0.9
\]
\[
L_S = 5.4 \quad L_T = 9.3 \quad L_P = 1.6
\]
\[
E_S = 1.8 \quad E_T = 1.5 \quad E_P = 5.6
\]

Elasticities of substitution in agriculture (denoted as s in Table 6) were set at unity in the basic simulations; however, following O’Grada, simulations were performed for elasticities of substitution ranging from 1 to 0.25. The elasticity of transformation in pasture (t in Table 6) should in the long run have been very high; once having grown grass, one can decide whether to feed it to grazing cattle or make hay with it. The elasticity was therefore set at 10 in the basic simulation but allowed to vary from 10 to 0 for the purpose of a sensitivity analysis.

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32 O’Grada, Ireland Before and After the Famine, p. 69.
34 O’Grada, Ireland Before and After the Famine, p. 69.
35 This is a standard assumption in the development economics literature. See, for example, Yotopoulos and Nugent, Economics of Development, pp. 69–70, in which a CES production function was estimated for Indian agriculture. They found that the elasticity of substitution was not significantly different from 1.
Recall the strategy of this article. The model described thus far was subjected to the price shocks that occurred over the period from 1845 to 1876. The resulting simulations constituted a "no-Famine counterfactual" experiment. The Crotty hypothesis would be supported if these counterfactual simulations showed a decline in labor demand on the order of 45 percent.

Table 6(a) presents the results of experiments simulating the effects of observed relative price movements on my model of the pre-Famine economy. The price shock considered was a 60 percent increase in the price of animal products and a 23 percent increase in the price of cereals and flax. The experiment was performed for a wide range of elasticities of substitution and transformation; the elasticity assumptions are given
in the first column, at the left. The elasticity of transformation in pasture
is denoted by $t$, the elasticities of substitution by $s$.

$P$, $T$, and $S$ are the levels of output in the pasture, tillage, and potato
sectors, respectively; $w$, $d$, $r$, and $e$ are the returns to labor, land,
capital, and expertise, respectively. $L$ is total labor demand. All
variables are given in percentage change terms; thus the entry in the top
left-hand cell states that when $t$ is 10 and $s$ is 1, the observed price
shocks would have increased the output of the pasture sector by 13
percent relative to its benchmark level.

As can be seen, the qualitative results were invariant to the choice of
elasticities, and were at first sight surprising. The Crotty hypothesis
maintained that the price shocks produced a decline in labor demand of
45 percent. This hypothesis is now unambiguously rejected. Far from
predicting a 45 percent decline in agricultural labor demand, Table 6(a)
suggests that agricultural labor demand would have increased as a result
of the price shock—from between 6 and 29 percent. Price shocks on
their own would have shifted the labor demand curve rightward, not
leftward, as Crotty would argue.

The reasons for this result are twofold. First, though there would
indeed have been an increase in land-intensive pasture, there would also
have been a large increase in labor-intensive potato production. The
reason for this can be seen in Table 5: the pre-Famine economy was
very potato intensive. A greater animal output would have required
increased inputs of potatoes as animal feed.

Second, as can be seen from Table 6(a), labor would have become
much cheaper relative to the other primary factors of production. This
reflects the fact that overall agricultural prices were rising during this
period. For a given real wage, increases in agricultural prices would
have led to increases in the returns to factors other than labor. This
would have led farmers to adopt more labor-intensive techniques in all
three sectors; the fact that product prices were so high relative to wages
would in fact have meant that even tillage would not have contracted.36

The relative importance of these effects can be seen from the last
column, labeled $L^*$. This column shows what labor demand would have
been had output levels in the three sectors changed as shown but labor
intensities remained constant in each. (This is not a possible outcome,
of course. The column is merely given as a means of disaggregating the
results into two components.) As can be seen, even at constant factor
intensities, labor demand would have increased by between 1 and 7
percent. In other words, the input-output structure of the economy was
enough by itself to generate an increase in labor demand in response to
the price shocks.

36 Although the relative price effect worked against tillage, the increase in employment made
possible by the reduction in the product wage worked to expand grain production.
Changed factor intensities account for the difference between the figures in the \( L \) and \( L^* \) columns. As can be seen, taking changed factor intensities into account boosts labor demand considerably. From this disaggregation it appears that both the input-output structure of the economy and the rising overall agricultural prices help explain the results of this section, with the labor-intensity effect being dominant (in the sense that it seems to explain the larger proportion of the increase in labor demand).

I tried several different specifications of the model in an attempt to avoid the conclusions of Table 6(a), but the result seems to be remarkably robust.\(^{37}\) It also seems appropriate to ask whether the assumptions of CGE models in general (and this one in particular) bias the results in favor of or against the Crotty hypothesis. The standard constant returns, perfect competition, and perfect factor mobility assumptions seem to work in favor of Crotty, as they heighten the responsiveness of the economy to relative price shocks. Ignoring crop rotations, as my model does, also favors Crotty, because the greater sectoral interdependence that rotations imply would dampen the relative output response to relative price shocks. Finally, the assumption that there is a fixed stock of fully employed land may seem counterintuitive to those schooled in Ricardo. The simulations in Table 6(a) show that the price of land increases substantially in response to the price shocks; thus, introducing rigidity in rents and a variable supply of land would lead to a greater supply of land, and hence (presumably) to even greater labor demand. In conclusion, because the assumptions of the model seem to work in favor of Crotty, they strengthen rather than weaken the argument of this article.

Thus the Famine did matter, in the precise sense that exogenous price shocks would not have reduced labor demand in its absence. Let us go one step further and use the pre-Famine model to speculate about what Irish agriculture would have looked like in the absence of the Famine. Comparing the results of such an exercise with the historical record would then provide an indirect estimate of the long-run effects of the Famine on the Irish agricultural economy.

Table 6(a) gives the effects on the pre-Famine economy of imposing the exogenous price shocks only. Other exogenous variables would also have changed over the period between 1845 and 1876. The table therefore does not give a full picture of what the economy might have looked like in 1876 had the Famine not occurred. Most obviously, there would have been accumulation in the economy over this period. Say that capital had continued to accumulate at the pre-Famine rate: how would this have affected matters?

\(^{37}\) An appendix (available upon request) reports details of these simulations.
The problem is that we do not know at what rate the capital stock grew in the years before the Famine: indeed, there is considerable dispute about the rate of growth of agricultural output. It seems sensible to take an upper-bound estimate of pre-Famine capital formation. O’Grada presented the most optimistic view of pre-Famine agricultural development, estimating that output doubled between 1800 and 1845. This implies an annual growth rate of 1.55 percent per annum. Assuming that capital accumulated at the same rate is surely an upper-bound estimate. If capital had continued to accumulate at this rate for the 33 years between 1843 and 1876, the capital stock would have risen from £2.4 million to £4 million. This shock to the capital stock can easily be imposed on the pre-Famine model.

Table 6(b) imposes both the observed price shocks and the counterfactual accumulation shock on the pre-Famine model. As is evident (and as should be expected), output in all three sectors as well as labor demand would have been even greater than if the price shock alone had occurred. If capital accumulation had been slower than is assumed here, outputs and labor demand would have been somewhere between the levels of Tables 6(a) and 6(b).

Finally, something would have happened to labor supply conditions had the Famine not occurred: it is here that our counterfactual guesses are of necessity weakest. After the Famine real wages increased rapidly; before the Famine they were probably stagnant. It seems reasonable to assume that the Famine had a lot to do with this turnabout, by both cutting the labor force in the short run and helping to integrate Irish with world labor markets in the long run. What would have happened in the Famine’s absence?

One plausible hypothesis is that the Irish agricultural labor market would gradually have become more integrated with world labor markets, at a slower rate than actually occurred. Wages in Ireland might have increased, but at a slower pace than they did in the post-Famine period. Table 6(c) shows what different growth rates in wages would have implied for the economy, given the price and accumulation shocks discussed earlier. The growth rates chosen are 0.5 percent, 1 percent, and 1.5 percent per annum. These compare with the 1.4 percent growth rate achieved between 1855 and 1880. Table 6(c) also gives the results of the model when labor is in elastic supply at the pre-Famine subsistence wage reproduced from Table 6(b) and the historical record—that

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39 Remember that the pre-Famine benchmark data set is for an average year over the period from 1840 to 1845.
40 O’Rourke, “Agricultural Change,” chap. 5.
41 O’Grada, *Ireland Before and After the Famine*, p. 35.
42 O’Rourke, “Agricultural Change,” chap. 5.
is, the output and employment changes that actually occurred (derived from Tables 2 and 3). The table gives output in the three sectors and total agricultural employment, denoted by $E$.\footnote{As I am hypothesizing different growth paths for equilibrium wages, it seems reasonable to speak of agricultural employment rather than agricultural labor demand.}

The results of Table 6(c) are striking. Even if wages had risen at 1.5 percent per annum, or more rapidly than they were rising from 1855 to 1880, employment still would have been a lot higher in a no-Famine world than it actually was. If the Famine had not occurred, pasture output would not have grown so quickly as it did, nor would tillage have contracted so rapidly. Most importantly, potato output would have been much higher than it actually was.

Table 6(c) conforms with my simple intuition about how the Famine changed the long-run structure of the Irish economy. Potato yields were permanently reduced in the wake of the blight; this was bound to lead to the abandonment of the highly potato-intensive farming of the pre-Famine period. In particular, stall feeding (which meant feeding cattle potatoes as well as hay and straw) declined in the wake of the Famine. As stall feeding became rarer, the links between pasture, tillage, and the potato sector became weaker: not only did cattle eat fewer fodder crops, but less manure could be collected and used as fertilizer in tillage and potato growing. Neither could potatoes play as prominent a role in crop rotations as they had previously done. With fewer links between sectors, more exaggerated relative output responses to price shocks became possible. Meanwhile, labor could not be fed so cheaply as before, so farming had to become less labor intensive: an effect exacerbated by a growing scarcity of labor, as the Irish and world labor markets became increasingly integrated.

In short, the table provides strong support for the view that the Famine hastened the switch from tillage to pasture and played a significant long-run role in reducing agricultural employment. The Famine emerges from these exercises as having indeed been a major watershed in Irish agricultural history.

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