

## EXAMINING IRELAND'S POST-FAMINE ECONOMIC GROWTH PERFORMANCE\*

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This paper sets out a short-cut method for allocating country level GDP estimates across regions. Comparing UK regional GDP estimates generated using the short-cut method against existing regional GDP figures suggests that it produces acceptable results. We make estimates of GDP for the four countries of the UK for each of the census years between 1861 and 1911. Irish GDP per worker and per caput grew faster than British. These indicators demonstrate weak convergence of the two regions. The bulk of the Irish performance may be explained by traditional forces such as TFP growth and capital accumulation.

What happened to Ireland's GDP after economic union with Britain? Did the poor region grow faster than the rich one? Economic theory provides no unambiguous answer: depending on the shape of the production function, poorer countries may or may not converge on their richer neighbours. The standard neo-classical growth model predicts, and growth regression exercises suggest, that countries and regions with similar economic characteristics tend to experience conditional convergence (Barro and Sala-i-Martin, 1992; Mankiw *et al.*, 1992). Economic historians, whatever the debate about the shape of the production function, tend to argue that the more backward the economy, the more scope for catching up by adopting the technology of the richer countries subject to social and institutional capacity (Abramovitz, 1986; Maddison 1991; Abramovitz and David, 1996).

The Act of Union set in process the economic union of two countries at very different levels of development and possessing separate currencies.<sup>1</sup> While there was certainly plenty of scope for 'catch-up', given their factor endowments and institutional differences then *a priori* there may be no expectation of convergence: add to this the absence of GDP data and it is perhaps not surprising that there is no consensus on the growth performance of the Irish economy in the nineteenth century nor on the related convergence trends within the UK.

Thirty years ago, Butlin (1968) argued that GDP and GDP per head rose faster in Great Britain than in the UK. This proposition is broadly in line with the growth rates suggested by Feinstein's (1972) indices of real output and real

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<sup>1</sup> The process required a number of steps: abolition of intra-Union barriers, the establishment of a common external tariff, consolidation of the exchequers and, finally, the merger of the two currencies. It began with article six of the Act of Union; from 1 January 1801, items produced in either country were to be free of duty with certain exceptions. The British and Irish exchequers were merged in 1817 and, from April 1824, the so-called Union duties were abolished. The two currencies were merged in 1826 revaluing the Irish pound upwards by about 8%.

output per head for Great Britain and Ireland and is at least implicit in the discussion of British growth rates of GDP by Matthews *et al.* (1982). Most recently, Maddison's (1995) series for the area of the Republic of Ireland, assumes no convergence on the remainder of the UK between 1820 and 1913.

Kennedy *et al.* (1988) tell a more optimistic story, suggesting that average income in Ireland in the post-Famine period grew not only more rapidly than in Britain but also more rapidly than in the rest of Europe. Ó Gráda (1994) argues that Irish income per caput grew more rapidly than British. Williamson (1994), approaching the issue from a different perspective – relative real wage growth – finds a similar process of catching up, suggesting that the British–Irish real wage gap had narrowed more than the output per caput gap by the end of the century. Rather in the vein of Kennedy *et al.*, he concludes that 'Ireland was catching up with the leaders in both the Old World and the New'.

Nor is there agreement on the forces underlying growth: did access to a common pool of technology and to UK-wide markets for goods, capital and labour lead to relative gains in labour productivity and output per caput for the Irish economy, or were other forces at work? Recent accounts attribute at least the convergence element of Ireland's performance to the effects of emigration. Kennedy *et al.* (1988) liken the improvement in living standards in the second half of the nineteenth century to what happened in medieval Europe after the Black Death. Williamson (1994) explicitly emphasises the importance of emigration over more traditional forces such as capital accumulation and total factor productivity (TFP) growth. O'Rourke and Williamson (1997), pointing to Ireland's unimpressive industrialisation, find that Ireland relied exclusively on emigration to achieve convergence on the leader countries. Similarly, Boyer *et al.* (1994) suggest that emigration could have accounted for a significant amount of Ireland's real wage gain relative to Britain. In contrast, an older tradition (revisionist in its day), exemplified by Cullen's (1972) classic textbook, emphasises the real gains from structural change, capital accumulation, technological change and growing trade that the Irish economy made in the second half of the nineteenth century.

Clearly, an additional perspective would be afforded this debate by the construction of a set of real output figures for Ireland. While it might be possible to construct such estimates on the income side using data on occupations, wages and earnings and the income tax returns contained in the annual *Reports of the Commissioners of H. M. Inland Revenue* (if the rent, interest and profit returns contained therein can be successfully imputed to each of the separate countries), they will involve a good deal of labour. Until such time as detailed earnings and tax-based estimates appear, there seems some justification in seeking out an alternative strategy for estimating regional output. We outline below a method for allocating aggregate estimates of real output across regions. The method allows us to generate estimates of the likely level of real output for England, Wales, Scotland and Ireland for each of the census years from 1861 to 1911. The resulting estimates of regional GDP suggest that, in the second half of the nineteenth century, in terms of GDP per caput and per worker, Ireland did indeed catch up on Britain.

## 1. Method

Our approach follows the now well-trodden path of seeking to identify a set of variables that are functionally related to output, which can then be used as predictors of its level (Bairoch, 1976, 1989; Beckerman and Bacon, 1966; Crafts, 1983, 1984). The variables we employ are labour force and productivity, grouped by sector and by country. The sectors are agriculture, industry and services. We assume that each country's sectoral labour productivity is reflected in its sectoral wage, relative to the UK sectoral wage. Sector output is sector labour force times sector labour productivity. GDP in each country is the sum of its sector outputs. The method is set out formally in the Appendix.

A test of the method is to compare estimates that it generates with official regional GDP estimates. The first census year for which there exist both industry wage data and official GDP estimates by country is 1971. Table 1 compares official GDP figures against estimates generated using our method (Columns 2 and 3). We add comparisons against two other approaches: country sector employment multiplied by UK sector GDP per employee (Column 4); country total employment times UK GDP per employee (Column 5).

The wage adjusted estimates are clearly superior and, of these, the hourly wage based estimates are marginally the better. The errors are within those tolerated in national income accounting.

## 2. Data

The method requires three sets of data: an employment series by sector for each of the four countries of the UK; an estimate of output in each of these sectors at the

Table 1  
*Estimates of Country GDP at Factor Cost in 1971*  
(current prices, £m, as a proportion of Column 1 in parentheses)

	Official estimates (1)	Estimates using gross hourly earnings per employee (2)	Estimates using weekly earnings per employee* (3)	Estimates using sector output per employee (4)	Estimates using average output per employee (5)
England	41,418	41,590 (1.004)	41,772 (1.008)	41,082 (0.998)	41,103 (0.993)
Wales	2,102	1,984 (0.943)	1,974 (0.939)	2,151 (1.023)	2,165 (1.030)
Scotland	4,225	4,095 (0.969)	3,977 (0.941)	4,345 (1.028)	4,341 (1.027)
Northern Ireland	1,018	1,094 (1.075)	1,067 (1.048)	1,196 (1.175)	1,153 (1.133)
Sum of relative differences		0.167	0.176	0.234	0.254

Note: \* Gross weekly earnings are restricted to wages not affected by absence and include bonuses and overtime.

Source: See text.

UK level; and a series of wage relatives comparing nominal sector wages in each country with the UK sector average.

The censuses of England and Wales and of Scotland have been used by Lee (1979) to derive an employment series for these three countries that is consistent over time and space. The Irish census returns of occupations have been reclassified to conform with Lee's series for Britain.<sup>2</sup> The resulting series of employment in agriculture, industry and services in each of the four countries of the UK are set out in Table 2.

The second data set required (Table 3) is sectoral output at the UK level in each census year. This is derived from Feinstein's (1972) index numbers of sector output at constant factor cost and the weights that he used in estimating GDP from output data.

The third data set is a series of sector wage relatives by country. Data availability confines our series to male wages. Each of the sector wage relatives is defined as the ratio of the nominal sector wage in a country to the average nominal sector wage in the UK. The wage relatives are calculated as five year averages centred on each of the census years.

The wage relative for agriculture for the period 1855 to the mid-1890s (Figure 1) is derived from Bowley's (1898, 1899) series on the regular earnings of agricultural labourers. For the years to 1913, Bowley's series has been projected forward on the basis of the Board of Trade (1914–16) indices of the wages and earnings of agricultural labourers in England and Wales, in Scotland and in Ireland between 1880 and 1913.

The wage relative for industry (Figure 2) is made up of two series: building; and shipbuilding and engineering. The building series for the years between 1861 and 1900 is based on Bowley's (1900*a*, *b*, 1901) indices of wages in towns in England and Wales, Scotland and Ireland. For the years to 1913, Bowley's series has been projected forward on the basis of Board of Trade (1908; 1910; 1912–13) returns of wages in the building trades in various towns. As with the agricultural wage relatives, it is important to note the implicit assumption that Welsh and English wages were on a par. Data on regional earnings suggests convergence of Welsh on English wages (Hunt, 1973). The impact on the estimate of Welsh GDP of assuming equal wages across England and Wales when wages in Wales may have been up to 10% less than English wages at the start of the period, could lead to an overestimate of Welsh GDP of around 3% at the start of the period. The impact on the estimate of GDP for England is less than 0.25 percentage points; for Great Britain it is imperceptible.

The wage relative for shipbuilding and engineering is calculated from Pollard and Robertson's (1979) indices of wages in Bowley's maritime districts between 1913 and 1864, projected back to 1855 using Bowley and Wood's (1906) indices for

<sup>2</sup> For the purposes of this exercise, there are three problems with the Irish census returns to which attention must be drawn. The first relates to the return as a separate order for 'Wives (of specified occupation)' made in the 1871 census; the second relates to the number of males in the occupations 'Agricultural Labourer' and 'General Labourer'; the third relates to the number of females in the sub-order 'Domestic Service'. Full details of the resolution of these problems may be found in Geary and Stark (1996).

Table 2  
*Sector Employment in the UK by Country, 1861–1911 (000s)*

	Wales			Scotland		
	Agric	Indust	Servs	Agric	Indust	Servs
1861	146.5	244.8	166.7	297.4	660.5	379.7
1871	123.2	267.4	222.5	325.0	734.4	405.0
1881	110.0	293.5	239.6	262.8	801.0	510.7
1891	108.4	367.0	292.4	244.3	900.3	603.1
1901	100.8	443.8	286.4	226.5	1,077.5	666.4
1911	105.1	569.0	337.2	217.9	1,133.7	704.7
	England			Ireland		
	Agric	Indust	Servs	Agric	Indust	Servs
1861	1,534.8	4,260.6	2,823.8	1,289.4	659.5	604.8
1871	1,359.4	4,665.9	3,773.4	1,152.0	578.7	635.5
1881	1,217.8	5,097.4	4,197.4	1,077.6	481.9	604.6
1891	1,193.0	5,826.2	4,964.9	993.5	475.8	579.5
1901	1,043.5	6,963.4	5,472.2	923.8	450.1	578.2
1911	1,110.0	7,899.2	6,207.1	846.0	401.0	559.7

*Note.* Services includes unclassified general labourers.

Table 3  
*Index Numbers of Output and Numbers in the Labour Force in the UK by sector, 1861–1911 (000s)*

	Output				Employment		
	Agric	Indust	Servs	Output	Agric	Indust	Servs
1861	7.3	12.1	18.7	38.1	3,268.1	5,825.4	4,048.8
1871	7.5	16.6	23.3	47.4	2,959.6	6,244.1	5,144.2
1881	7.2	20.4	28.6	56.2	2,668.2	6,673.8	5,691.4
1891	7.6	24.5	35.2	67.3	2,539.4	7,569.3	6,440.0
1901	7.0	30.7	43.2	80.8	2,294.6	8,934.8	7,003.2
1911	7.3	34.9	51.6	93.8	2,279.0	10,002.8	7,808.7
1913	7.2	38.2	54.7	100.0			

the same districts. The wage relative for industry in each year was calculated as a weighted average of the two series, where the weights are the shares of the two industries in the sum of their labour force.

There are no readily available regional series for service sector wages. The 'productivity-gap' model of international price level determination (Kravis *et al.* 1978) suggests that higher wages in high-productivity tradeable goods sectors will have a positive influence on wages in the non-tradeable sector (largely services) and *vice versa*. On this basis, wage relatives in the service sector are calculated as a weighted average of the agriculture and industry series for each country, where the weights are each sector's share in the labour force.

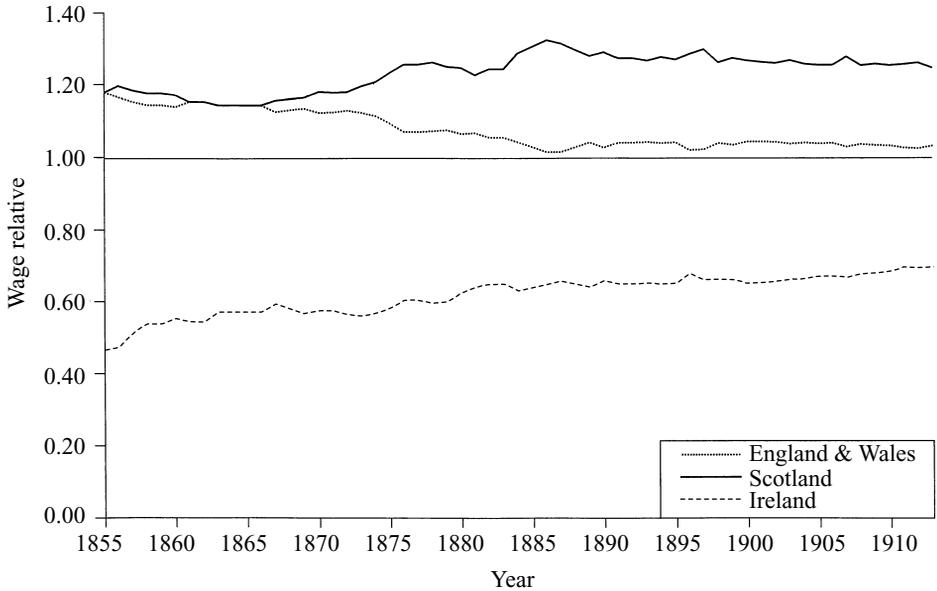


Fig. 1. *Wage Relatives in Agriculture* (UK = 1.00)

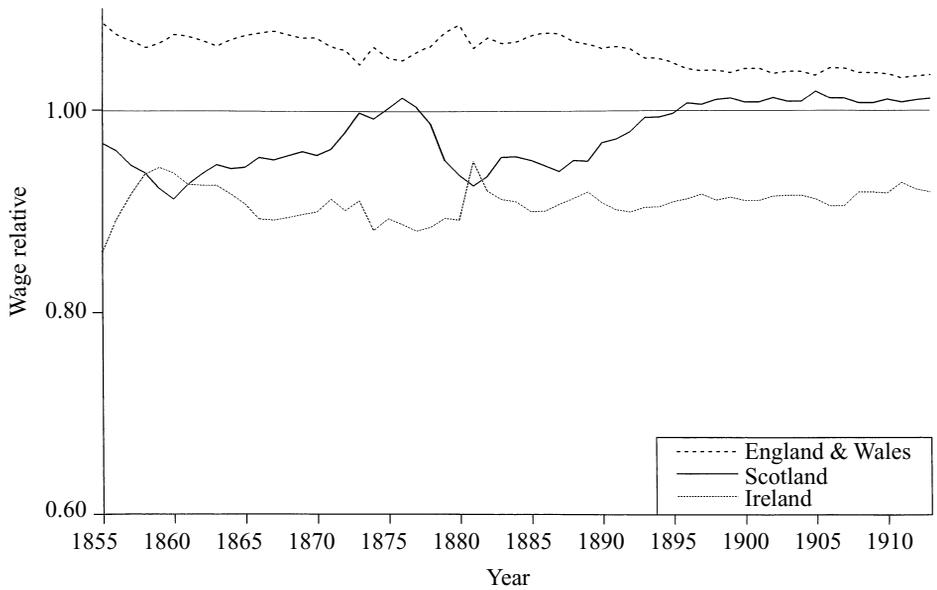


Fig. 2. *Wage Relatives in Industry* (UK = 1.00)

For purposes of the regional output estimates, we make three main assumptions with respect to wages: first, that male wage relatives accurately reflect the relative average productivity across sectors and countries for all employees; second that industry sector wages may be represented by an average of those in shipbuilding

and engineering, and construction; and third, that service sector wages may be represented by a weighted average of the above plus agriculture sector wages. All of these assumptions are imposed on us by data deficiencies.

As a test of their likely influence, Table 4 presents their impact on our 1971 estimates. The results suggest that the method is robust with respect to each of the enforced assumptions. A general conclusion in respect of our wage assumptions is that likely biases are small.<sup>3</sup> We conclude that the likely error in the estimates of GDP generated using the method and wage assumptions outlined above is plus or minus 10% of the correct total.

### 3. Results

The indices of UK sector output were combined with the regional sector labour force figures and the sector wage relatives to generate index numbers of output in

Table 4  
*Estimates of Country GDP at Factor Cost in 1971*  
(current prices, £m, as a proportion of Column 1 in parentheses)

	Official estimates (1)	Estimate using first assumption* (2)	Estimate using first and second assumptions† (3)	Estimate using all assumptions‡ (4)
England	41,418	41,650 (1.006)	41,602 (1.004)	40,977 (0.989)
Wales	2,102	1,986 (0.945)	1,992 (0.948)	2,131 (1.014)
Scotland	4,225	4,065 (0.962)	4,080 (0.966)	4,436 (0.952)
Northern Ireland	1,018	1,062 (1.045)	1,088 (1.076)	943 (0.926)
Sum of relative differences		0.142	0.156	0.147

Notes: \* Male wages only. † Industry sector wages represented by average of engineering, shipbuilding plus construction wage. ‡ Industry sector wages represented by average of engineering and shipbuilding plus construction wage and service sector wage proxied by average of industry proxy plus agriculture sector wage.

<sup>3</sup> Biases will also be introduced if the proportions of female employment within sectors differs across countries. In industry and services, the proportion of female employees in Ireland exceeded that in Great Britain but tended to converge on the British proportion between 1861 and 1911. These biases may be enhanced or diminished according to how the ratio of female to male wages varies across countries. By taking a range for this ratio of 50–80% of male wages, identical throughout the UK, we estimate that the higher but falling and converging proportions of female employment in these sectors in Ireland may lead to an overestimate of Irish GDP by 3–6% in 1861 falling to 1–3% by 1911. However, a modestly higher ratio for female wages in Ireland (by one-third in 1861 and one-fifth in 1911) could reverse this overestimation.

*Female Employment as a Proportion of Total Employment*

	1861		1911	
	Ireland	Great Britain	Ireland	Great Britain
Agriculture	0.09	0.08	0.07	0.09
Industry	0.51	0.28	0.37	0.25
Services	0.60	0.48	0.45	0.37

each of the four countries. In effect, this exercise distributes Feinstein's estimates of UK output across the four countries of the Union on the basis of labour force structure and relative wages. Since labour force is used to distribute UK output, the country levels of output assume similar levels of capacity utilisation across countries. See Table 5.

It does not necessarily follow that satisfactory tests against 1971 data mean that the method will generate satisfactory results using nineteenth century data. A further test, then, is to compare our estimates of Irish GDP with current estimates of Irish output on the eve of the Great War. Feinstein puts Irish output at around 6–6.5% of the UK total, Cullen (1995) estimates Irish gross national product (GNP) at factor cost in 1911 at £139 million in current prices: adjusting to GDP and 1900 prices produces a figure of around £130 million which is about 6.4% of the UK GDP figure used in this study. Ó Gráda's (1994) suggestion that Irish GNP was around £130–140 million in 1911 seems to be broadly in line with Cullen's most recent estimate. All of these figures provide support for the results produced by this exercise at 6.3% of UK GDP in 1911.<sup>4</sup>

#### 4. Ireland's Post-famine Economic Growth

We turn now to the post-Famine performance of the Irish economy. With only six observations covering 50 years, it is important for purposes of comparison to select years at similar points on the trade cycle. With this in mind, Table 6 seeks to place the Irish performance in terms of level and growth of GDP in a European context for the years 1871 and 1911. The basis for comparison is Maddison's estimates of the incomes of the west European economies and their offshoots. Great Britain and Ireland are located in this table by splitting his estimates for the UK (actual 1870–1911 borders) according to the ratios in Table 5.

As far as comparison with Great Britain is concerned, the proposition of slower growth of income per caput in Ireland, does not hold: if economic growth in the

Table 5  
*Index Numbers of GDP at Constant Factor Cost, 1861–1911*  
(UK 1913 = 100)

	England	Wales	Scotland	Ireland
1861	27.7 (72.6)	1.8 (4.6)	3.8 (10.1)	4.8 (12.7)
1871	35.4 (74.6)	2.2 (4.6)	4.7 (10.0)	5.1 (10.7)
1881	42.5 (75.6)	2.6 (4.6)	5.7 (10.2)	5.4 (9.7)
1891	51.3 (76.3)	3.2 (4.8)	7.1 (10.5)	5.6 (8.4)
1901	62.3 (77.1)	3.7 (4.6)	8.9 (11.0)	5.9 (7.3)
1911	73.6 (78.5)	4.7 (5.0)	9.6 (10.3)	5.9 (6.3)

*Note.* Figures in parentheses set UK = 100 in each year.

<sup>4</sup> It is perhaps important to note that, when considering Irish output as a percentage of the UK figure, the half percentage points are important: if Irish output were 6% of UK output, then a half of a percentage point of the latter represents 8% of Irish output.

Table 6  
*Levels of GDP per caput and per worker, 1871–1911*  
 (1990 Geary–Khamis international dollars)

	GDP per caput			GDP per worker		
	1871	1911	Growth (% p.a.)	1871	1911	Growth (% p.a.)
Australia	3,533	5,467	1.1	8,977	13,093	0.9
Belgium	2,626	4,060	1.1	6,199	9,379	1.0
Canada	1,662	3,991	2.2	4,779	7,973	2.3
Denmark	1,917	3,710	1.7	4,195	8,420	1.8
Finland	1,094	1,683	1.4	2,454	4,373	1.4
France*	1,881	3,219	1.4	3,817	6,617	1.4
Great Britain	3,571	4,844	0.8	7,950	10,819	0.8
Germany*	1,800	3,428	1.6	7,134	13,729	1.6
Ireland	2,100	3,018	0.9	4,802	7,333	1.1
Italy	1,476	2,434	1.3	2,903	5,049	1.4
Japan†	741	1,304	1.4	1,361	2,638	1.6
Netherlands	2,655	3,739	0.9	6,879	10,100	1.0
Norway	1,314	2,100	1.2	3,231	5,308	1.2
Sweden	1,684	3,002	1.5	3,646	6,583	1.5
Switzerland†	2,172	4,118	1.6	4,483	8,547	1.6
USA	2,508	5,052	1.8	6,794	13,072	1.6

Notes: \* Data based on actual frontiers in 1871 and 1911 extrapolated from 1870 and 1913 data.

† 1870 data.

Sources: Maddison (1995), appendices A, C and H; Great Britain and Ireland see text.

aggregate in Ireland was less than that of Great Britain, in terms of productivity growth and of growth of GDP per caput, Ireland between 1871 and 1911 outpaced the aggregate performance of the three other countries of the Union. Measuring levels, in a league table of 16 countries Ireland's GDP per caput ranked seventh in 1871 falling to eleventh in 1911. The corresponding placings for GDP per worker were seventh and tenth. Along with Great Britain, though, Ireland is at the bottom of the league in terms of growth of output per head and per worker. Only Great Britain performed worse than Ireland in terms of growth of GDP per caput and only Great Britain, Australia, Belgium and the Netherlands performed worse in terms of growth of productivity.

It would seem that good as Ireland's post-Famine performance was – and it was good enough to locate the Irish economy, in per caput terms, among the richest in the world in the 1870s and on the eve of the Great War – the Irish economy lost ground after the 1870s to most of the advanced economies outside the UK.

The relatively superior productivity growth performance of Ireland compared to Great Britain, implies a degree of convergence within the UK. Table 7 sets out two measures of convergence. The first is a weak measure – the ratio of GDP per caput or GDP per worker of the two areas – which should move to unity for convergence. The second is a strong measure – the absolute difference in GDP per caput or GDP per worker of the two areas – which should move towards zero. The latter will, of course,

Table 7  
*Measures of Convergence, 1861–1911*

	Relative		Absolute	
	Output per worker (GB/I)	Output per caput (GB/I)	Output per worker (1900 £s) (GB – I)	Output per caput (1900 £s) (GB – I)
1861	1.68	1.73	27.6	13.1
1871	1.65	1.70	30.4	14.2
1881	1.59	1.63	32.0	14.3
1891	1.55	1.63	32.4	14.4
1901	1.53	1.56	34.5	15.3
1911	1.47	1.60	33.3	17.5

imply the former; the former, though eventually leading to the later, does not necessarily imply it between any given points of time.

Weak convergence is clear-cut for labour productivity as it is also for output per caput down to 1901. This conclusion is not reflected, though, in the absolute differences: there is no long-term movement of the difference to zero. Indeed, for the most part, there is divergence of both productivity and output per caput. A conclusion of weak convergence but no absolute catching up by the Irish seems reasonable.

## 5. Accounting for Ireland's Post-Famine Growth

Output and labour input figures by country and sector permit examination of the sources of growth within each region and regional contribution to UK growth. Standard shift-share analysis identifies three effects.<sup>5</sup> The productivity effect is the change in GDP resulting from the change in output per worker in each sector in each country, given that the initial levels of employment remained constant. The employment effect is the change due to the change in the numbers employed in each sector/region cohort while keeping output per worker constant. The third is an interaction effect and is usually estimated as a residual; this term picks up changes within cohorts and diminishes as the level of disaggregation increases.

It is possible to disaggregate the residual into two further elements: a sector distribution effect<sup>6</sup> that is the effect of transposing the 1911 country-sector

<sup>5</sup>

$$\Delta GDP_{UK} = \sum_i \sum_j N_{ij1861} \Delta Y_{ij} + \sum_i \sum_j Y_{ij1861} \Delta N_{ij} + \sum_i \sum_j \Delta N_{ij} \Delta Y_{ij}$$

where  $\Delta$  is the change from 1861 to 1911,  $i$  is for each country and  $j$  for each sector.  $Y$  is output per worker and  $N$  the number of workers.

<sup>6</sup>

$$\sum_i \sum_j N_{i1861} \left( \frac{N_{ij1911}}{N_{j1911}} \right) Y_{ij1861} - \sum_i \sum_j N_{ij1861} Y_{ij1861}$$

employment patterns to 1861; and a national distribution effect<sup>7</sup> which is the equivalent transposition of the 1911 sector-country employment pattern. The outcome of this accounting exercise is set out in Table 8.

Productivity and employment gain does account for almost 80% of the gain in Great Britain's output and there were gains from structural change both within Great Britain and between Great Britain and Ireland. The Irish case was quite different: almost all of the gain in Irish output may be accounted for by productivity gain. The negative 'employment effect' for Ireland results from a 29% decline in the labour force between 1861 and 1911. While there is a positive effect from within country sector structural change, there is also a negative 'national interaction' effect for Ireland. This picks up some of the impact of the decline in employment levels but also picks up the relative shift of industrial and service sector employment away from Ireland.

The results show that for the UK as a whole, growth in employment accounted for just under a half of growth in GDP with productivity growth accounting for slightly over 30%. Taking account of the fact that the productivity measure used here includes relative growth in capital inputs then (not surprisingly) this is broadly in line with the findings of Matthews *et al.* (1982) that over the period 1873–1913 factor inputs accounted for around 70% of the growth of GDP. What is surprising is the respective contributions of Ireland and Great Britain to the UK productivity gain: at around 17% of the total, Ireland's contribution considerably exceeded her share of both UK output and employment.

This leads to some observations about the origins of Ireland's productivity performance in these years. It is clear from Table 8 that Ireland's post-Famine growth and its convergence on Great Britain is largely explained by labour productivity gain. As we have seen, recent explanations for Ireland's post-Famine process of convergence have emphasised the effects of migration over more traditional explanations such as capital accumulation and diffusion of technology. How much of the labour productivity gain in Ireland was due to decline in the labour force and how much was due to capital accumulation and TFP growth?

It seems reasonable, in the context of what has gone before, to examine post-Famine Irish economic growth in terms of a standard growth accounting model based on a Cobb–Douglas production function:

$$Q = AL^\alpha K^{(1-\alpha)}$$

where  $Q$  is GDP,  $L$  is labour input,  $K$  is capital input and  $\alpha$  is the elasticity of output with respect to labour input. The term  $A$  is a measure of TFP or the residual factor in economic growth that cannot be explained by growth of factor inputs combined in a production function with constant returns to scale.

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$$\sum_i \sum_j N_{j1861} \left( \frac{N_{ij1911}}{N_{i1911}} \right) Y_{ij1861} - \sum_i \sum_j N_{ij1861} Y_{ij1861}.$$

Table 8  
*Regional Contribution to the Change in UK Output 1861–1911 (%)*

Type of change	Great Britain	Ireland	UK
Productivity effect	26.7	5.6	32.3
Employment effect	50.0	-2.2	46.8
Interaction	22.4	-1.5	20.9
of which:			
Sector distribution	3.4	0.9	4.3
National distribution	6.2	-3.7	2.5
Remainder	12.8	1.3	14.1
Total	98.1	1.9	100.0

*Note.* We include the sector and national distribution factors as part of the interaction/residual. It could be argued that they are subsumed within the employment effect.

Growth of output arises from increases in factor inputs and TFP. Ireland's labour inputs fell; this leaves growth of output and of labour productivity to be explained by a rise in the capital to labour ratio and/or a rise in TFP. In the Irish case, a rise in the capital to labour ratio may have resulted either from a fall in the labour force with capital stock constant, or from capital accumulation. With capital stock constant, a decline in labour inputs *ceteris paribus* would have moved the economy down the aggregate product curve with two effects: it would have raised the capital-to-labour ratio increasing the marginal and the average product of labour, and it would have lowered total output. The likely proportion by which total output would have fallen in the absence of either capital accumulation or TFP gain is approximated by the percentage fall in labour inputs weighted by the partial elasticity of output with respect to labour. Assuming competitive pricing of factors, this latter is given by labour's share in GDP. We do not know labour's share of GDP in nineteenth-century Ireland; the UK figure for this period is around 0.6 (Matthews *et al.*, 1982). Turner (1996) estimates labour's share in Irish agricultural output at 60% in 1850s rising to 66% in the 1910s. For the exercise in Table 9, we adopt upper and lower bounds of 0.7 and 0.5. Table 9 sets out indices of the likely change in output and productivity resulting from a fall in the labour force of around 29% and the actual change; the difference is attributed to a shift in the aggregate production function.

Column 2 provides an answer to the question, what would have happened to labour productivity by 1911 given a 29% fall in employment and no capital accumulation or TFP gain? The answer returned depends on the elasticity of output with respect to labour input, which is proxied here by the weight attached to labour inputs: with a weight of 0.5, labour productivity would have been about 30% less than it turned out to be; with a weight of 0.7 it would have been about 35% less. The suggestion is that 17–28% of Ireland's labour productivity gain between 1861 and 1911 was due to labour force decline with the rest attributable to the effects of capital accumulation and TFP.

What does this imply for the convergence debate? Irish labour productivity as a proportion of British was about 59.6% in 1861. To maintain this position in 1911, it had to increase by the same as the increase in productivity in Great Britain which

Table 9

*Contribution of Labour Force and TFP to Output and Labour Productivity between 1861 and 1911*

	1861	1911 (expected outcome)	1911 (actual outcome)
	(1)	(2)	(3)
$\alpha = 0.5$			
GDP	100	85.4	122.3
Labour	100	70.7	70.7
GDP/Labour	100	120.7	172.8
$\alpha = 0.7$			
GDP	100	79.5	122.3
Labour	100	70.7	70.7
GDP/Labour	100	112.4	172.8

was about 51.9%; in fact it increased by about 72.8%. The difference we may regard as that portion of growth enabling catch-up or convergence: this represents about 28.7% of the increase in Irish labour productivity. We have said above that with  $\alpha = 0.5$ , about 28.4% of the increase in Irish labour productivity is accounted for by the fall in the labour force. It seems, then, that given  $\alpha = 0.5$  the direct effects of emigration – falling labour force – can account for a share of Irish labour productivity gain similar to the amount of catch-up which Ireland achieved; higher values of  $\alpha$  reduce this contribution. In this sense, i.e., the direct effects on observed change, emigration can account for a minor part of Ireland's overall labour productivity growth and a major part of its related convergence performance. Labour market flows are not, however, the exclusive or even major explanation for Ireland's post-Famine performance; more traditional explanations based on capital accumulation and TFP growth explain the bulk of the Irish performance. Convergence was made possible by these forces. Emigration may account for a proportion of Irish productivity growth similar to that which accounts for Ireland's convergence on Great Britain, but convergence is explained by labour force flows only in partnership with the traditional convergence forces.

This result is not entirely unexpected; the Irish economy of 1911 was not the Irish economy of 1861 with fewer people. A casual and incomplete survey quickly identifies a number of sectors in which industrial change, capital accumulation and TFP gain took place. Ó Gráda (1993) calculates that TFP growth in Irish agriculture after 1850 was higher than in Britain and the US. There were a number of industries in which capital accumulation probably carried with it technical progress and productivity gain: Ireland acquired a rail network and developed a factory based linen textile industry after 1841; its shipbuilding industry from the 1870s was the fastest growing of the four main shipbuilding regions of the UK (Geary and Johnson, 1989); in the industry which displayed the fastest growth of TFP in the UK between 1873 and 1913 – gas, electricity and water – employment increased by over 500% between 1861 and 1911; taking three so-called 'new' industries – chemicals, electrical engineering and vehicles – employment increased by 16%, 106% and 18% respectively between 1901 and 1911; and between 1861

and 1911 employment in the service sector declined in distribution (46%) and in miscellaneous services (50%) while it grew in transport and communications (8%), in insurance and banking (340%) and in professional and scientific services (59%) (Census of Ireland, 1861, 1901, 1911).

There may though be an indirect role for emigration in this, in that the alteration in factor endowments brought about by emigration may have altered the perceived profitability of adopting the technology of the richer partner. This certainly appears to have happened in the case of power weaving of linen (Geary, 1998).

## 6. Conclusion

Our general purpose here has been twofold: to set out a method for allocating aggregate estimates of GDP across component regions; and to put it into operation by making some estimates of regional GDP in the UK in the second half of the nineteenth century. The method appears capable of generating fairly reliable results and the procedure appears to be robust with respect to the particular assumptions about wages across industry that we have made for purposes of estimating country GDP between 1861 and 1911.

Our objective in generating these GDP estimates was to examine Ireland's post-Famine growth performance. The Irish experience is one of declining employment but of superior growth of output per worker relative to the rest of the UK. It provides a shred of evidence in favour of conditional convergence or, more generally, of catch-up. This performance had implications for the overall UK performance in the period: Ireland is seen to have made a disproportionately positive contribution to UK productivity growth. Irish productivity growth is explained only partly by the effects of emigration, the dominant contribution came from the combined effects of capital accumulation and TFP growth: emigration in the Irish case may have been necessary for convergence but it was not sufficient. In short, the Irish performance in terms of structural change, capital accumulation and TFP growth was probably nearer that of the advanced western economies than is currently credited – 'probably', because more economic history is needed to flesh out the rough numbers presented here, and 'currently credited' because, more than twenty years ago, Louis Cullen (1972) pointed out that, by the end of the nineteenth century, 'its large foreign trade, its export-oriented industries, its highly developed infrastructure of banking, commerce and railways, and its foreign investment yielding a sizable income made Ireland comparable in some respects to a handful of highly developed nations.' Over-emphasis on the role of emigration in raising Irish living standards in the post-Famine period loses sight of this, as it seems to us, important insight.

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## Appendix: Method

We can define UK GDP as

$$Y_{UK} = \sum^i Y_i \quad (\text{A.1})$$

where  $Y_i$  is GDP of country  $i$ .  $Y_i$  can in turn be defined as

$$Y_i = \sum^j y_{ij} L_{ij} \quad (\text{A.2})$$

where  $y_{ij}$  is the average output (value added) per worker in country  $i$  in industry  $j$  and  $L_{ij}$  is the corresponding number of workers. It follows that we can define

$$Y_{UK} = \sum^j Y_j \quad (\text{A.3})$$

where  $Y_j$  is GDP of country  $j$ .

We have data for the above elements apart from  $y_{ij}$ . We postulate that the relationship between  $y_{ij}$  and  $y_j$  (UK output per worker in industry  $j$ ) will be reflected in the relationship with respect to the corresponding wages paid, ie,  $w_{ij}$  and  $w_j$ . Specifically, we postulate that

$$Y_i = \sum^j \left[ y_j \beta_j \left( \frac{w_{ij}}{w_j} \right) \right] L_{ij} \quad (\text{A.4})$$

with

$$\beta_j = \frac{Y_j}{\sum^i \left[ y_j (w_{ij}/w_j) \right] L_{ij}} \quad (\text{A.5})$$

where  $\beta_j$  is a scalar which preserves the relative country differences but scales the absolute levels so that country totals for each industry sum to the known UK total.

Common sense dictates that there is a relationship between wages paid and average product of labour (APL). Economic theory suggests that wages equal marginal product of labour (MPL), in which case the method requires a fixed MPL/APL. Moreover, since we use nominal wages then we must assume no variation in country price levels. A 'market perfect' neo-classical world of Cobb–Douglas production functions with constant returns to scale and neutral technical progress is our ideal support. Such a world produces the required constant ratio of MPL to APL. In this instance,  $\beta$  would reflect the height of the production function (capital accumulation and TFP).

Cobb–Douglas production functions are a limiting case of the class of constant elasticity of substitution (CES) production functions in which the elasticity of substitution ( $\sigma$ ) between capital and labour is one. Other values of  $\sigma$  in a CES framework (given the above conditions) mean that the ratio MPL/APL is an increasing function of the level of output which will lead to underestimation of the level of GDP among the lower wage and lower output countries.<sup>8</sup> The existence of decreasing returns to scale in CES production functions, *ceteris paribus*, will also increase the ratio of MPL to APL, leading to further underestimation. Market imperfections or structures which cause the ratio of MPL to APL to diverge across regions will only bias results to the extent that they are unevenly experienced. As regards the use of nominal wages, to the extent that there are regional variations in price levels then there will also be bias. *A priori*, it is not possible to assess the net effect of

<sup>8</sup> Arrow *et al.* (1961), using industry data for the 1950s, conclude that, for manufacturing,  $\sigma$  is typically 0.8–0.9 but, for primary production, is not significantly different from unity. If this applies to nineteenth-century Ireland then the likely biases are small and, in the case of Ireland, tending to underestimate GDP.

these biases, tests confirm that the method produces acceptable results (see Table 1 and discussion).

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