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EXAMINING IRELAND'S POST-FAMINE ECONOMIC PERFORMANCE:

THE DISTRIBUTION OF GROSS DOMESTIC PRODUCT BETWEEN THE COUNTRIES OF THE UNITED KINGDOM, 1861-1911

Frank Geary
and
Tom Stark

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M. Dowling	Report on the Database of Irish Historical Statistics 1911-1971.
R. O'Connor and E. Henry	Estimates of Gross and Net Output and Income Arising in Agriculture in All Ireland and in the Free State Area in Selected Years between 1900/01 and 1926/27.
A. Bielenberg	An Estimate of Irish Industrial Output in 1907
E. Birnie	A Review of Industrial Output Measures in Ireland in the Inter-War Period: Sectoral Comparisons of Real Product per Head 1935-38

Correspondence on this paper to

Dr Frank Geary
School of Public Policy, Law and Economics
University of Ulster at Jordanstown
Newtownabbey
Co. Antrim BT37 0QB

Tel.: Belfast (0232) 365131
Fax.: Belfast (0232) 366847

Examining Ireland's Post-Famine Economic Performance: The Distribution of Gross Domestic Product between the Countries of the United Kingdom, 1861-1911

1. Introduction

There are no separate output estimates for England, Wales and Scotland in the nineteenth century. For Ireland there is an estimate of 'personal income' of £80m for the early 1840s and there is Cullen's estimate of £150m for GNP on the eve of the Great War (which O'Grada argues should be revised downwards to the range £130-£140m). As 'a by- product' of his estimate for Great Britain, Feinstein derived an index of GDP at constant factor cost for Ireland between 1857/66 and 1908/13 (which he warns should be used 'with extreme caution'); it suggests that aggregate real output in Ireland did not change much between the 1860s and the outbreak of the Great War.[1]

Clearly separate estimates of real output for each of the four countries of the Union are desirable as measures of both aggregate performance and welfare. 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 a simpler less time consuming strategy for estimating regional output.

The purpose of this paper is to outline a method for allocating the existing estimates of UK GDP across the four countries of the Union; to present the resulting estimates of Gross Domestic Product for England, Wales, Scotland and Ireland for each of the census years from 1861 to 1911; and to examine Ireland's post-famine economic performance.

2. Method

The approach adopted here follows the now well-trodden path of seeking to identify a variable or set of variables which are functionally related to output which can then be used as predictors of the likely level of output for any value of the variable or variables in question.[2] The variable or variables in question must, in this case, be available on a consistent basis for each of the four countries; a variable which meets these conditions is occupation. The relationship between employment in each country and aggregate and regional GDP is set out below.

Consider the following matrix:

Table 1. GDP for country by industrial group for any year

	Agriculture	Services	Industry	Total
England	Y_{11}	Y_{12}	Y_{13}	Y_1
Wales	Y_{21}	Y_{22}	Y_{23}	Y_2
Scotland	Y_{31}	Y_{32}	Y_{33}	Y_3
Ireland	Y_{41}	Y_{42}	Y_{43}	Y_4
UK	Y_1	Y_2	Y_3	Y_{UK}

Notes: y_{ij} is GDP per country (i) by industrial group j.

$Y_i = \sum^{j} y_{ij}$ and $\sum^{i}\sum^{j} y_{ij} = Y_{UK} = \sum^{i} y_i$ *and* $Y_j = \sum^{i} y_{ij}$

Employment in country (i) by industrial group j is L_{ij} and

total employment in each industrial grouping across countries is $L_j = \sum^i L_{ij}$. Let $\overline{y}_j = \frac{Y_j}{L_j}$ where $\overline{y}_j$ is UK labour productivity in each of the three sectors. If L_{ij} is known then UK sectoral output can be allocated to each of the four countries according to $L_{ij} \cdot \overline{y}_j$ and $y_i = \sum^i L_{ij} \cdot \overline{y}_j$ calculated.

In this way UK GDP may be allocated across the four countries on the basis of the size and sectoral allocation of the labour force in each country. However this procedure does not allow for variation in output per employed worker in each country and in each industrial grouping. To allow for this it is assumed that such variations will be reflected in country/industry wage rate differentials (W_{ij}), such that:

$$L_{ij} \cdot \overline{y}_i \cdot \beta_j \frac{W_{ij}}{\overline{W}_j} = y_{ij}$$

where $\overline{w}_j$ is average wage per sector j, W_{ij} is the sectoral wage in country i and β_j is a scaler for sector j, from:

$\beta_j = \frac{\sum^i L_{ij} \cdot \overline{y}_j \cdot W_{ij}/\overline{W}_j}{Y_j}$, such that β preserves relative differences, but scales absolute differences so that the individual country totals for each sector sum to be the known sector total. Finally, GDP for each country is obtained from $y_i = \sum^i y_{ij}$.

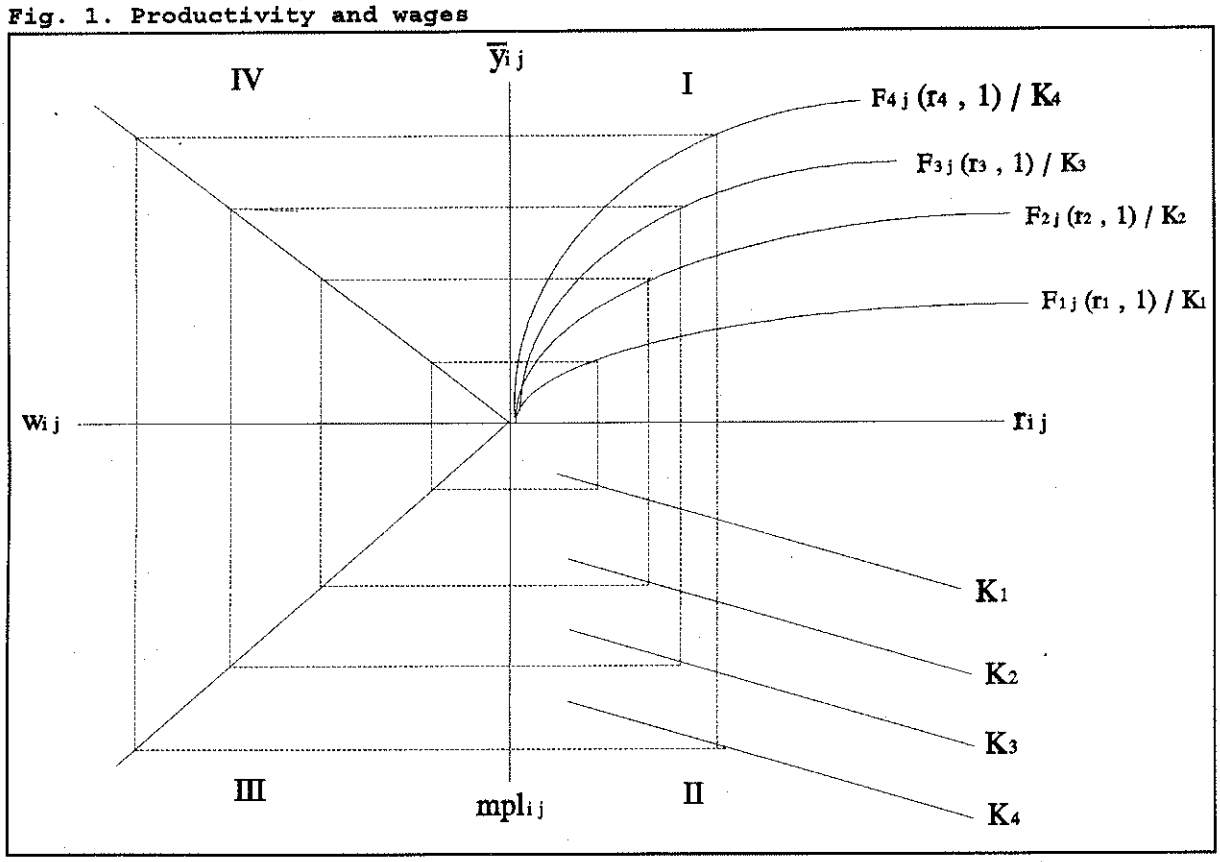
What is the justification for using average nominal wage rates to adjust for productivity differences across countries?

Assume that the relationship between output and inputs is governed by a production function with all the standard neo-classical properties, $y_{ij} = F_{ij}(K_{ij}, L_{ij})$ and define:

$$\bar{y}_{ij} = \frac{y_{ij}}{L_{ij}} = F_{ij}\left(\frac{K_{ij}}{L_{ij}}, 1\right) = F_{ij}\ (r_{ij}, 1) \ .$$

The relationship between wages and labour productivity in any given year in each of the four countries is set out in Fig. 1.

Fig. 1. Productivity and wages



Notes: mpl is marginal product of labour; w is the nominal wage for a given price level such that p is set equal to unity in the UK and each country's price level is equal to that of the UK.

Assume different production functions in each country for each sector, each incorporating a different level of technology and capital stock such that we may have:

$\frac{\overline{K}_{1j}}{L_{1j}} < \frac{\overline{K}_{2j}}{L_{2j}} < \frac{\overline{K}_{3j}}{L_{3j}} < \frac{\overline{K}_{4j}}{L_{4j}}$. Postulate for each country that the marginal productivity of labour rises as the K/L ratio rises and that marginal productivity is also higher for the more advanced technologies at each given K/L ratio. Assume that in each country wages are determined such that W = MPL; on this basis quadrant IV sets out the relationship between $\overline{y}_{ij}$ and W_{ij}: $\overline{y}_{ij} = \beta_j W_{ij}$. In turn relative productivity and relative wages are related as follows:

$\frac{\overline{y}_{ij}}{\overline{y}_j} = \beta_j \frac{W_{ij}}{\overline{W}_j}$ or $\frac{y_{1j}}{y_{2j}} = \beta_j \frac{W_{1j}}{W_{2j}}$. The relationship between relative wages and relative output per man - β - will depend upon the height of the production function i.e. on technology factors and on the capital to labour ratio in each country.

Given that the estimated W_{ij}s and Y_{ij} s are correct, the major difficulties with this procedure stem from the assumptions that workers received the value of their marginal product and that there is no difference in the aggregate price level between regions. As regards the first, we may observe that since it is unlikely that workers received more than the value of their marginal product the direction of bias introduced by this assumption seems clear; to the extent that the workers in any region received less than the value of their marginal product or, perhaps more accurately, to the extent that the difference between the wages of labour and the value of marginal product of labour was greater in any region than in

others, then the assumption of equality between wages and marginal product leads us to underestimate the GDP of that region. As regards the impact of differing regional price levels, we may observe that to the extent that the average price level in any region is less than the UK average, then relative real wage and hence productivity is underestimated for that region with the implication that GDP is also underestimated. The most likely source of difference in regional price levels lies in the size of the non-traded goods sector; *a priori* the country most likely to be affected by this is Ireland. Again the direction of bias is clear; for a country such as Ireland the (implicit) use of a common price deflator probably leads to an underestimate of mpl and thus of GDP with the implication, in turn, that the estimate of GDP for a country such as England is probably slightly overestimated.

3. Data

The procedure outlined above 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 UK level; a series of wage relatives comparing nominal sectoral wages in each country with the UK sectoral average.

3.1. Sectoral employment series

It is important that the series be consistent over time and space; since the system of classifying occupations in the census changed both across countries and over time, the

country returns of occupations have to be reclassified to a common system of classification. Fortunately one such system is to hand; the censuses of England and Wales and of Scotland have been used by Lee to derive an employment series for these three countries based on the twenty-seven industrial orders of the standard industrial classification as revised in 1968.[3] Sectoral employment for England, Wales and Scotland is derived from this series simply by reducing the 27 industrial orders in Lee's series to three global sectors: agriculture; industry (mining, manufacturing, construction and utilities); services (transport, distribution, financial, professional and scientific, miscellaneous, public administration and defence, and not classified).[4]

To enable Ireland to be incorporated into this data set, the occupational statistics of the Irish Census must be reclassified to conform with the British series. For the most part this is a fairly straightforward task; Lee has provided a list of the component occupations which make up the main orders of his series and this may be supplemented by the appendix to volume ten of the 1911 census of England and Wales which provides a classified list of occupations showing the order and sub-order in which each is to be located. There are, though, 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'.

3.1.1. The return of females in 1871

The system of classification of occupations adopted in the Irish census of 1841 was made up of nine orders and the returns for 1851 were tabulated under these same orders. In 1861 the number of orders was increased from nine to thirteen. At the direction of the Irish government (and most reluctantly) the Irish Census Commissioners in 1871 adopted the British system of Classes, Orders and Sub-Orders.[5] In the process a problem, specific to 1871, arose over the occupational classification of females, which is perhaps best set out in the words of the Irish Commissioners, themselves:

> Deferring simply to the will of the Government, and conforming strictly to the English methods as set out in the Book of Instructions compiled for the tabulators in the English Census Office, we referred...all wives of specified occupations to Order IV. of the Domestic class, although nothing, as it occurred to our judgement, could be more erroneous in principle than such a classification. A wife of specified occupation may be a milliner or dressmaker, a draper, a governess or schoolmistress, a mill hand in a linen or cotton factory, a folder in a printing establishment, a bookbinder, or a seamstress. In all these capacities - and we have enumerated but a few at random - she belongs, unless as a governess or schoolmistress, to what would be called the Industrial class, while the governess and schoolmistress, or music or drawing mistress, would belong to the Professional class. The Domestic class, however, under the scheme in hand, abstracts, at a clean sweep, every wife of a professional or industrial calling from the class to which she is naturally referable, and transfers her to a class which represents in great part not so much a calling as a relation...' [6]

The reasoning behind this procedure was that, 'in the English classification wives of husbands following certain callings

are presumed to be assistants in the husband's business'.[7] In 1881 and in subsequent years females returned as wives of butchers, innkeepers etc were placed in Class VI (Persons Not Producing) along with those females returned as wives of no specified occupation; in the 1861 census of Ireland females returned as wives were returned outside the total of occupations.

The 1871 census of Ireland returned some 362.6 thousand females in Sub-Order 1, Order 4, Class II (Domestic service) 'wives (of specified occupation)'. Clearly the Irish commissioners were not happy with this procedure which they felt had been forced on them; they recognized that it tended to both misallocate and to inflate the female work force. Their preferred solution was to treat wives described as following their husband's calling equally with wives of no specified occupation and return them in Class VI while locating females returned as wives, but also following a specific occupation, in the order and sub-order of their occupation.[8] In order to rectify this omission in the published tables, it is a simple enough matter to remove those females returned as wives following their husbands calling to the not occupied category, however this leaves the 86 thousand females returned as 'wife following other specified occupation' who, although active, do not necessarily belong in Class II.

Fortunately the commissioners returned an additional table of occupations of wives in which those wives following specific occupations are referred to the class, order, and sub-order under which the occupation which they followed was classified;[9] it would be possible to remove all of the 362.6 thousand females in Class II, Order 4, sub-order 'wives (of specified occupation)' from the main summary table and then to add back the 86 thousand active females who were wrongly included in that sub-order referring them (using the summary table of occupations of wives mentioned above) to the particular order and sub-order to which the occupation which they followed properly belongs.

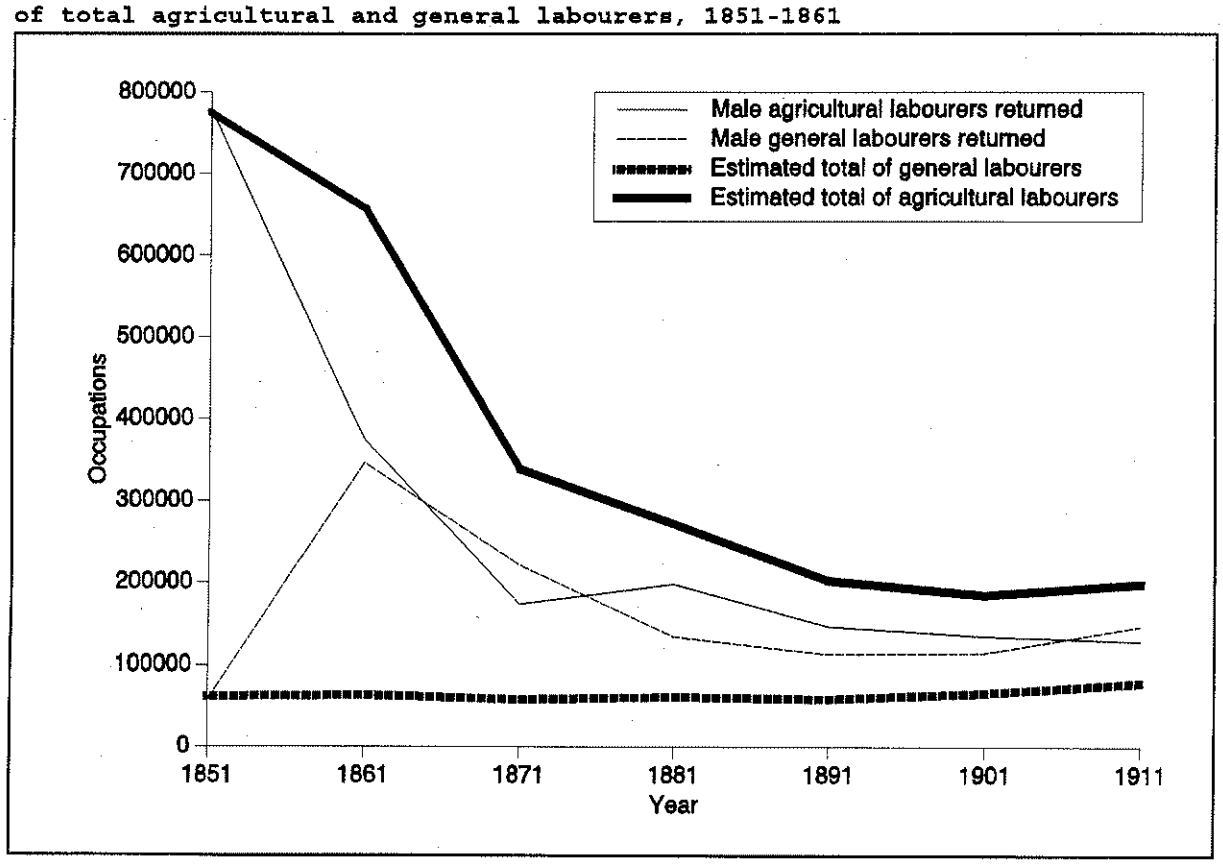
In the event, there is an easier approach; the commissioners provided a further summary table showing, by province and in the aggregate, occupations in Ireland according to the Irish classification of 1841 in which wives following their husbands occupation were either returned as not occupied or returned as such, and wives following specified occupations were located in the appropriate order and sub-order to which their occupation properly belonged.[10] It is this table which has been used here to generate the revised classification of Irish occupations in 1871.

3.1.2. Agricultural labourers and general labourers

The second problem relates to the numbers (almost all males) returned as agricultural labourers. In each census between 1871 and 1911 the commissioners attached to the return for the

occupation 'Agricultural Labourer' a note to the effect that the reader should 'see "General Labourer"...the majority of whom may be assumed to be Agricultural Labourers, although not having returned themselves as such'. The nature of the problem may be illustrated by examining the numbers of males returned in these two occupations between 1851 and 1911.

Fig. 2. Return of male agricultural and male general labourers and estimates of total agricultural and general labourers, 1851-1861



Notes: In 1851 and 1861 the return for agricultural labourers includes farm servants and probably farmer's male relatives who from 1871 were returned separately in the occupation, 'Farmer's, Grazier's - Son, Grandson, Brother, Nephew. In 1851 general labourers were returned in the occupation, 'Labourers (not agricultural) and Porters' which, clearly, is intended specifically to exclude agricultural labourers. In subsequent censuses this occupation was returned under the term 'labourer' or 'general labourer'.

The problem may be clearly seen in the dramatic fall in the number of agricultural labourers returned between 1851 and 1861 and the equally dramatic rise in the number of general labourers in the same decade. It seems reasonable to suggest

that these changes arise, in some part, from a reallocation of some of those who had been allocated to the occupation 'agricultural labourer' in 1851 to the occupation 'labourer' in 1861. Similarly the fall in both between 1861 and 1871 is in some part due to the addition of two new occupational categories in 1871: 'Farm Servant (In-door)' and 'Farmer's, Grazier's - Son, Grandson, Brother, Nephew'. For purposes of the present exercise reallocation of labour within one of our global sectors is not important (we are interested in total employment within agriculture) however allocation between sectors is important so we must seek to resolve the problem of the allocation of male labourers between the two occupations, 'Agricultural Labourer' and 'General Labourer'.

The 1881 Commissioners made the commonsense observation that, 'the majority of persons in rural districts who returned themselves as "labourers" and who are tabulated under the head "General Labourer"....may be assumed to be agricultural labourers'.[11] In seeking to establish how many of those returned as general labourers should be located in the agricultural sector as agricultural labourers we assume that those returned as general labourers living in towns were general labourers and that those returned as general labourers living outside towns should be regarded as agricultural labourers. The proportion of the Irish population living in towns of 2000 or more increased from about 17 per cent in 1851 to about 34 per cent in 1911;[12] we shall regard this group as the urban population. Of this urban population the population

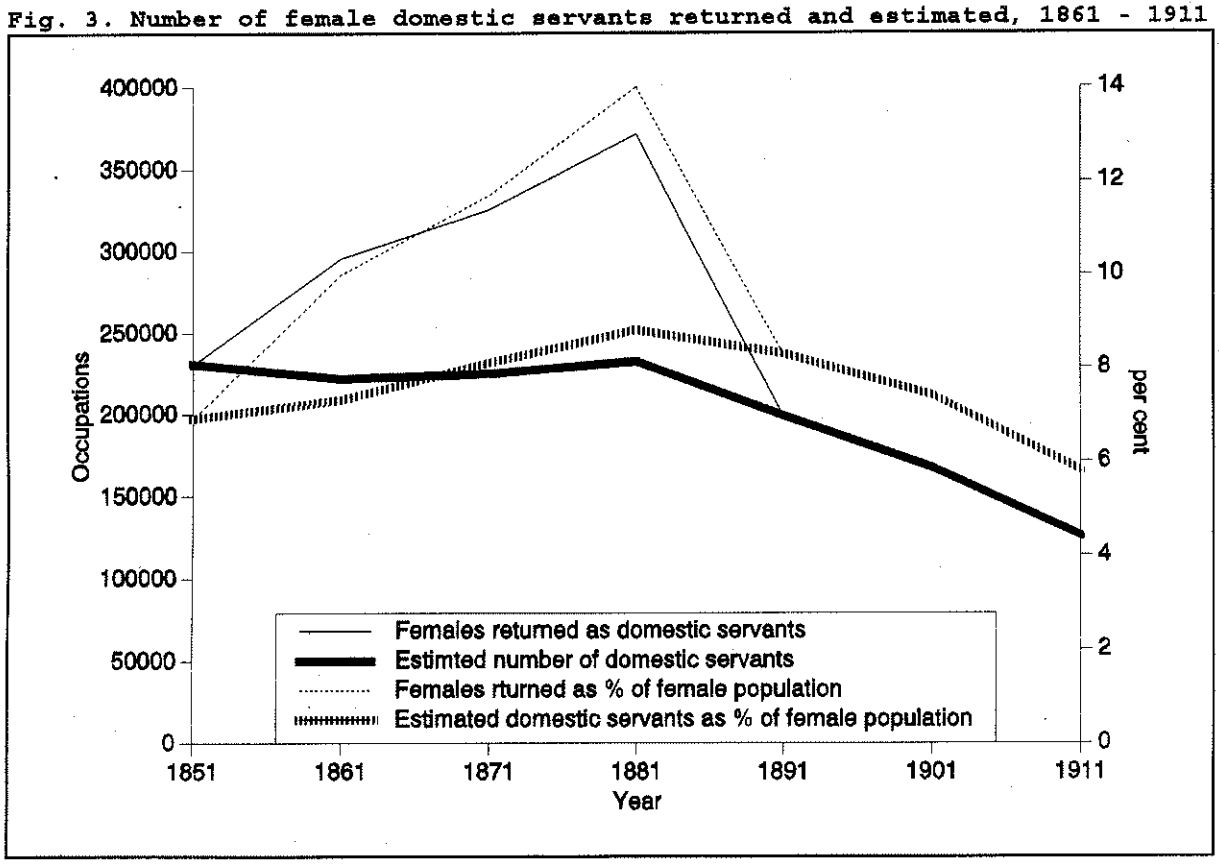
of the towns and cities returned in the census accounts for about 50 per cent in 1851 increasing to about 60 per cent in 1911. Considering the total population of the towns and cities returned in the census, the proportion returned as general labourers ranged from a high of 5.6 per cent in 1851 to a low of 4.7 per cent in 1891 rising to 5.3 per cent in 1911. If the proportion of the total population returned as general labourers in the (large) sample of Ireland's urban population covered by the census is assumed to be the same as that for the total of Ireland's urban population then an estimate of the numbers of general labourers in each census year may be derived with the remainder assumed to be agricultural labourers. The resulting revised figures for the numbers of general and agricultural labourers are graphed in figure 2.[13]

3.1.3. Female domestic servants

The remaining problem lies with the number of females returned as domestic servants. Between 1881 and 1891 the number of female domestic servants returned in the census fell from 372 thousand to 199 thousand; the reason given by the 1891 commissioners was that, 'in 1881 there were tabulated under the heading of "others engaged in service", 139,092 females almost all of whom - being cases of wives and other near relatives of the heads of families returned as "housekeepers" - have on this occasion been placed in Order 24, the Indefinite and Non-productive class'. Clearly inclusion of these females would act to inflate the size of

the female work force and this appears to have affected earlier returns. The problem is illustrated in fig. 3; from around 7 per cent of the female population in 1851, the proportion of female domestic servants apparently jumped to 10 per cent in 1861 peaking at 14 per cent in 1881 before falling in 1891 to around 9 per cent. Fig. 3 suggests that there are three problem years, 1861, 1871 and 1881.

Fig. 3. Number of female domestic servants returned and estimated, 1861 - 1911



The solution adopted here is to exclude the 139 thousand females returned in 1881 as 'others in service' and to exclude in 1871 some 100 thousand returned as housekeepers. To obtain an estimate of the true number of female domestic servants in 1861 an average of the ratio of female domestic servants to female population in 1851 and 1871 was used to generate an estimate of 222 thousand female servants in 1861.[14] The

revised estimates of numbers of female domestic servants are graphed in fig. 3.

These adjustments to the Irish census returns of occupations complete, they have been reclassified to conform with Lee's series for Britain. The resulting series of employment in agriculture, industry and services in each of the four countries of the United Kingdom are set out in table 2.

Table 2. Sectoral employment in the UK by country, 1861 - 1911

	Wales			Scotland		
	Agric	Indust	Servs	Agric	Indust	Servs
1861	146.5	244.5	122.7	297.4	658.7	381.5
1871	123.2	266.9	223.0	325.0	731.6	407.7
1881	110.0	292.8	240.3	262.8	797.8	513.9
1891	108.4	364.9	293.6	244.3	895.5	607.9
1901	100.8	441.8	288.4	226.5	1,069.0	674.9
1911	105.1	566.0	340.2	217.9	1,123.4	715.0

	England			Ireland		
	Agric	Indust	Servs	Agric	Indust	Servs
1861	1,534.8	4,248.3	2,836.1	1,289.4	659.2	605.1
1871	1,359.4	4,647.3	3,792.0	1,152.0	575.7	643.3
1881	1,217.8	5,072.6	4,222.1	1,077.6	480.7	605.8
1891	1,193.0	5,787.1	5,005.0	993.5	474.3	581.1
1901	1,043.5	6,896.9	5,538.7	923.8	448.3	579.9
1911	1,110.0	7,814.6	6,291.7	846.0	399.2	561.5

Note: Services includes unclassified general labourers.

Source: see text

3.2. Sectoral output series for the UK

The second data set required is a series for value added in agriculture, in industry and in services at the UK level in

each census year. This is derived from Feinstein's estimate of GDP at constant factor cost (1900 prices); the weights which he used in estimating GDP from output data; and his indices of sectoral output. The starting point is his estimate of GDP(E) at constant factor cost in 1900 prices of £2229 million in 1913.[15] Aggregating the weights attached by Feinstein to different industries in his estimate of GDP from output data to conform to the three sectors, yields the following sectoral shares of output: agriculture, 0.0716; industry, 0.3819; services, 0.5465.[16] These weights were used to apportion GDP across the three sectors in 1913 and Feinstein's indices of sectoral output were used to extrapolate sectoral value added back to 1861.[17] The outcome along with sectoral employment at the UK level is set out in table 3.

Table 3. Output (£m) and employment (000s) in the UK by sector, 1861 - 1911

	Output			Employment		
	Agric	Indust	Servs	Agric	Indust	Servs
1861	162.0	269.9	425.8	3,268.1	5,810.8	3,989.7
1871	166.5	370.3	528.8	2,959.6	6,221.6	5,066.0
1881	159.6	455.4	643.6	2,668.2	6,643.9	5,582.2
1891	169.8	545.7	788.3	2,539.4	7,521.7	6,487.6
1901	155.1	683.6	958.8	2,294.6	8,856.0	7,081.9
1911	162.0	778.9	1,145.8	2,279.0	9,903.3	7,908.3

Source: see text

From Table 3 an estimate of the level of output per employed person in agriculture, industry and services at the UK level can be derived. Table 2 then enables the generation of estimates of output in each country according to its level and

structure of employment but ignoring inter-country productivity differences.

3.3. Sectoral wage relatives by country

To complete the estimates of GDP for each country a series of sectoral wage relatives is required. Each of the sectoral wage relatives is defined as the ratio of the nominal sectoral wage in a country to the average nominal sectoral wage in the UK. The emphasis is on wage rates because it is wage rates which, in principle are determined by productivity.

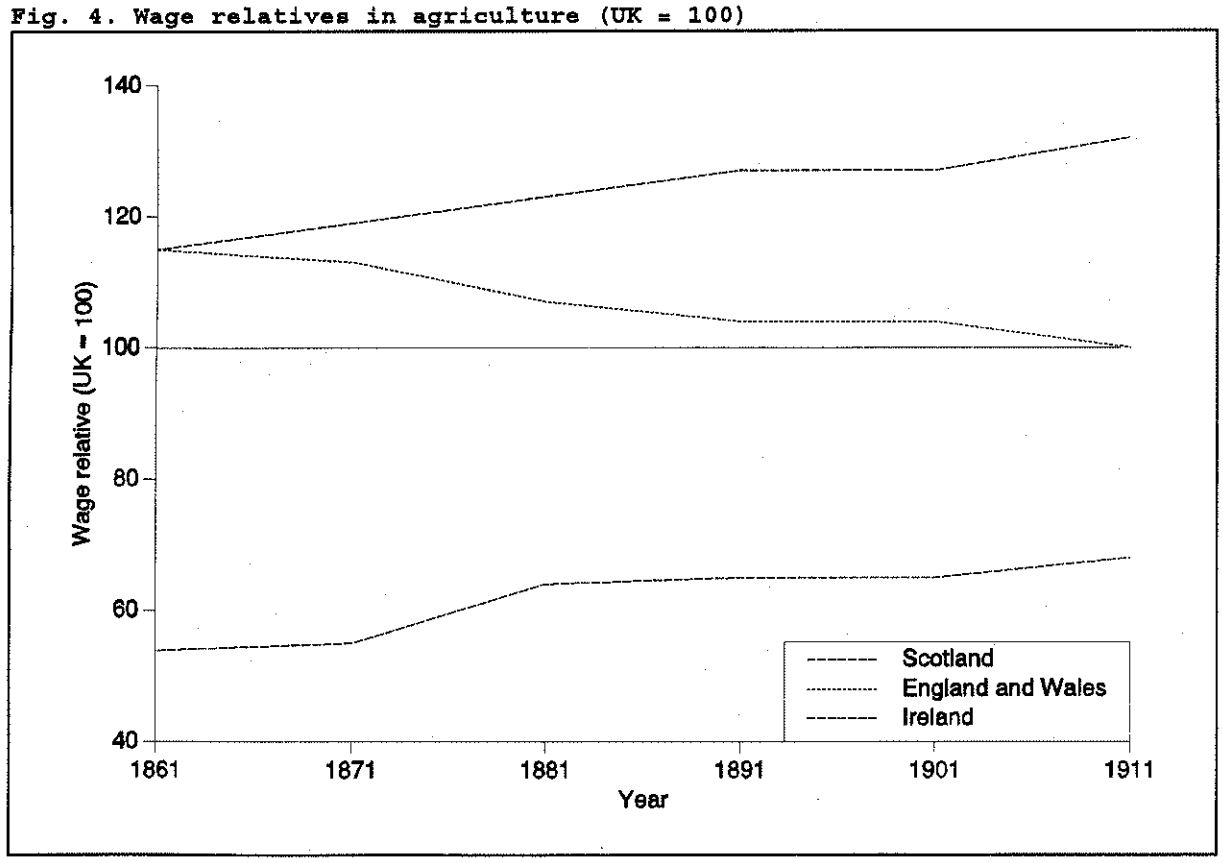
3.3.1. Agricultural wage relatives

The wage relative for agriculture for the period 1861 to 1891 is derived from Bowley's series on the earnings of agricultural labourers.[18] The series for England and Wales and for Scotland assumes that there is 'no change in loss of earnings through want of employment'[19] and the series for Ireland is based on regular earnings. We should be clear that in using a series on earnings from which to derive the wage relatives it is implicitly assumed that the ratio of earnings to wages is the same in each country. For the years 1901 and 1911 Bowley's series has been projected forward on the basis of the Board of Trade indices of the wages and earnings of agricultural labourers in England and Wales, in Scotland and in Ireland between 1880 and 1913.[20]

Using a series which gives returns for England and Wales combined obviously assumes that Welsh wages were on a par with

English wages. Hunt's occasional series on regional earnings of agricultural labourers suggests that this procedure may overestimate the ratio of wages in Wales to wages in the UK by between five and ten per cent at the beginning of the period, though by the end of the century Welsh wages appear to have been on a par with English wages.[21] The implication is that at the beginning of the period the estimates of value added in the agricultural sector in England, Scotland and Ireland are slight underestimates while that for Wales is a slight overestimate and that this source of error is eliminated by the end of the period.

Fig. 4. Wage relatives in agriculture (UK = 100)



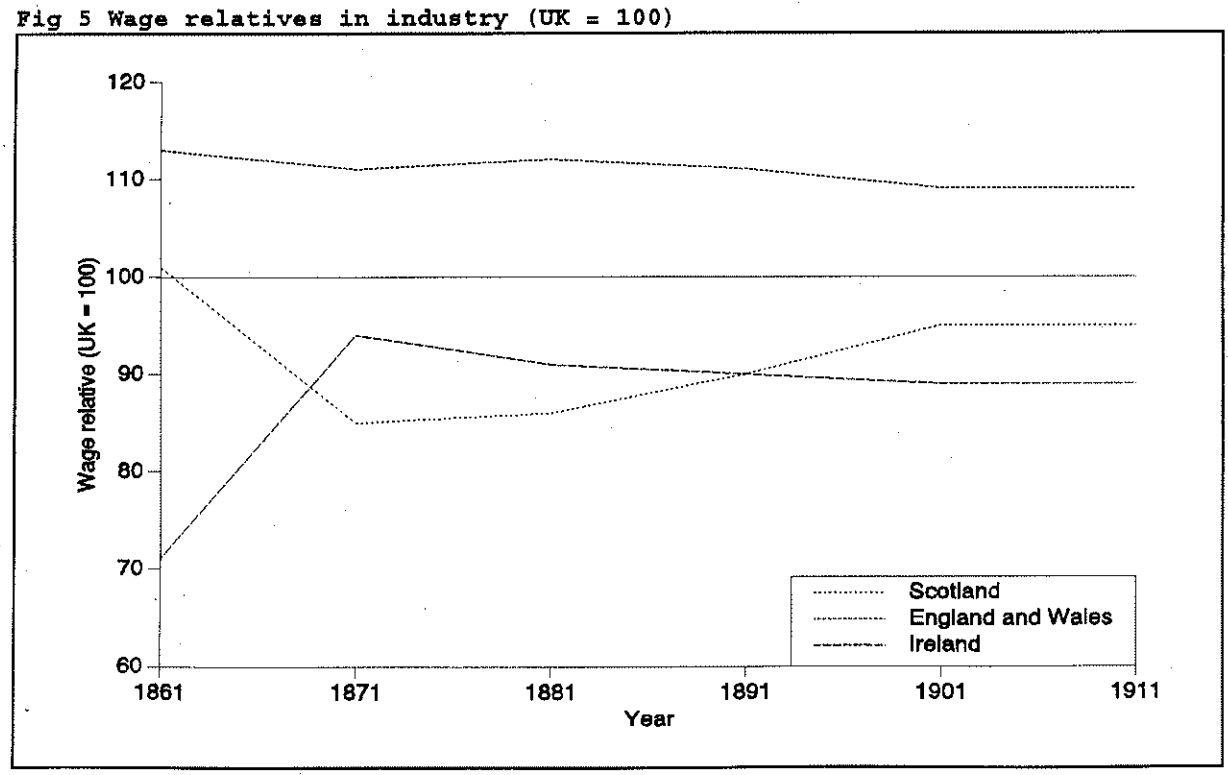
3.3.2. Industry wage relatives

The wage relative for industry is made up of two series: building and shipbuilding and engineering. The building series for the years between 1861 and 1891 is based on Bowley's indices of wages in a number of towns in England and Wales, in Scotland and in Ireland. The separate indices for towns in England and Wales and for Scottish towns were combined using the weights recommended by Bowley to provide indices of wages in the three countries.[22] Benchmark levels of wages in Scotland and Ireland in 1891 were calculated from Bowley's series of weekly wages in Scotland and Ireland and in England and Wales in 1891 from his estimates of wages in London, other large towns and the rest of England and Wales.[23] Wage levels were then projected backwards to 1881, 1871 and 1861 using the country indices of wages. The wage relatives were then constructed, as before, as the ratio of each country's average wage to the UK wage. Wage relatives were calculated for the years 1901 and 1906 from Board of Trade returns of wages in the building trades in various towns.[24] We assume that the wage relatives for 1906 were assumed to remain constant between 1906 and 1911; this seems not unreasonable since Bowley's UK index of building wages remained constant in these years.[25] As with the agricultural wage relatives it is important to note the implicit assumption that Welsh and English wages were on a par; regional data on two groups - carpenters and labourers - in 1886 and 1906 suggest that wage rates for skilled workers in Wales were on or above the English average while rates for unskilled were about 10 per

cent below this in the mid-1880s the gap closing to around 4 per cent in the mid-1900s.[26]

The wage relative for shipbuilding and engineering is calculated from Pollard and Robertson's indices of wages in various districts.[27] The wage relative for industry in each year was calculated as the weighted sum of the two series for construction and for shipbuilding and engineering where the weights are the share of total employment in the industrial sector in each of these two industries in each country.[28] It should be clear that, as with agriculture, the assumption of equality of wages between England and Wales will probably lead to a slight overestimate of value added in the industrial sector in Wales in the early years with the bias being largely eliminated by 1911.

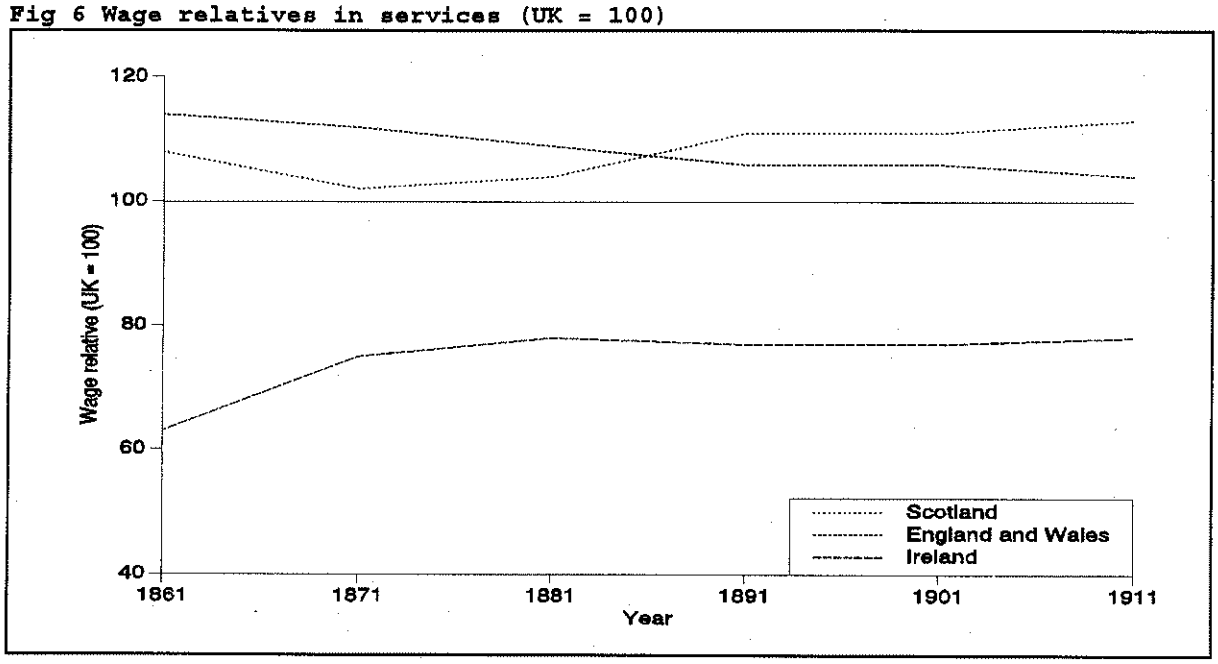
Fig 5 Wage relatives in industry (UK = 100)



3.3.3. Service sector wage relatives

The wage relatives for the service sector are an average of agriculture and industry.

Fig 6 Wage relatives in services (UK = 100)



4. Results: GDP, GDP per capita and GDP per worker by country

The UK sectoral productivity figures were combined with the regional sectoral employment figures and the sectoral wage relatives to generate estimates of GDP in each of the four countries following the method outlined above. The results are set out in tables 4, 5 and 6.

Table 4. GDP, 1861-1911 (£s m. 1900 prices)

	England	Wales	Scotland	Ireland
1861	630 (74)	40 (5)	91 (11)	96 (11)
1871	795 (75)	49 (5)	105 (10)	116 (11)
1881	953 (76)	57 (5)	124 (10)	124 (10)
1891	1142 (76)	72 (5)	159 (10)	129 (8)
1901	1391 (77)	83 (5)	194 (11)	130 (7)
1911	1636 (78)	103 (5)	215 (10)	133 (6)

Note: Figures in brackets set UK=100 in each year.

Table 5. GDP per worker (£s 1900 prices)

	England	Wales	Scotland	Ireland
1861	73 (111)	72 (109)	68 (104)	38 (57)
1871	81 (109)	80 (107)	72 (96)	49 (65)
1881	91 (107)	89 (105)	79 (93)	57 (68)
1891	95 (105)	94 (102)	91 (99)	63 (68)
1901	103 (105)	100 (101)	98 (100)	67 (68)
1911	108 (104)	102 (98)	105 (101)	74 (71)

Note: We do not allow for unemployment. Figures in brackets set UK=100 in each year.

Table 6. GDP per capita (£s 1900 prices)

	England	Wales	Scotland	Ireland
1861	34 (113)	30 (103)	30 (100)	17 (56)
1871	37 (110)	34 (103)	31 (93)	21 (64)
1881	39 (108)	36 (100)	33 (92)	24 (66)
1891	42 (105)	41 (100)	39 (98)	27 (68)
1901	46 (105)	41 (95)	43 (100)	29 (67)
1911	49 (105)	43 (92)	45 (98)	30 (66)

Note: Figures in brackets set UK=100 in each year.

How do these estimates of Ireland's GDP compare with such estimates as are available? Despite the apparent discrepancy, the estimate of GDP for 1911 is nearer Cullen's figure for that year than O'Grada's suggested downward revision to a range between £130-£140m; the figure of £133m is GDP at factor cost in constant 1900 prices while Cullen's estimate for the same year of £150m is of GNP in current market prices. Feinstein's UK figure for factor cost adjustment in 1911 is £135m;[29] if this sum is allocated across the four countries on the basis of their share of GDP then the constant (1900) market price estimate for Ireland in 1911 is about £141m. The GDP deflator increased by around 1.5 percentage points between 1900 and 1911[30] so the current price estimate for 1911 at

market prices would be around £143m. To arrive at GNP we must add in the value of net income flows; Cullen estimates this to be around £3.4m in 1911 giving a figure for GNP at current market prices of around £146m.

The figure of £133m for GDP in 1911 is also consistent with Feinstein's estimate that the share of Ireland in the Gross Domestic Product of the United Kingdom in 1907 was 6 per cent.[31] Over time, though, the indices of Irish and of British output diverge from Feinstein's.[32] The two Irish indices are difficult to compare because Feinstein gives an average for a group of years while the estimates above are for single years. However, setting 1908-13 = 100, Feinstein's index of real output in 1857-66 is 96.0; setting 1911 = 100 our index in 1861 is 72.2. Since output is shared between Britain and Ireland, a lower level of output in Ireland implies a higher level of output in Britain and our index of British output duly rises above Feinstein for the earlier years; setting 1911 = 100 the two move fairly closely together until 1871, but in 1861 Feinstein's index sits at 34.4 and ours at 38.9. The reason for the divergence is fairly easily explained. Feinstein was concerned to generate an index of GB output which was consistent with his estimates for the UK and the Irish index was a 'by-product'; for a number of industries, then, he allocated shares of UK real output between GB and Ireland on the basis of employment share with an adjustment for lower output per head in Ireland. This makes no allowance for the improvement over time in Ireland's relative

productivity (indeed it assumes that the trend in Irish productivity was the same as Britain's) as Feinstein was well aware; 'the main source of error ..... is likely to be inaccurate allowance for differences in output per worker in the many sectors where proportions of output in Great Britain and Ireland were based on employment data. However this will only have a significant effect on the trend in the index numbers.....if there were marked changes in relative labour productivity over time; and in general, this is not likely to have occurred'.[33]

5. Examining Ireland's post-famine economic performance

The estimates of output and productivity are used to examine three aspects of Ireland's post-famine economic performance in both a UK and a wider context. These are: first, an examination of the growth performance relative to the other home countries and in an international setting; second, a discussion of the degree of convergence experienced by the four countries within the UK; third, an examination of the sources of the change in GDP and GDP per worker.

4.1 Some comparisons

The exercise above provides a response to the plea made almost thirty years ago by Butlin for the separation of Irish national income statics from the United Kingdom figures. This plea was made in the belief that the removal of Ireland from the UK figures would reveal that GDP and GDP per head rose faster in the Great Britain than in the United Kingdom.[34]

Table 7 suggests that this proposition doesn't hold; if economic growth in the aggregate in Ireland was less than that of England, Scotland, and Wales, in terms of productivity growth and of growth of GDP per capita, Ireland between 1871 and 1911 outpaced the three other countries of the Union (and since 1861 to 1871 was the decade of Ireland's best growth performance of the period this statement also applies to the longer period 1861 to 1871).

Table 7. Annual percentage growth of GDP, GDP per worker and GDP per capita, 1861 - 1911

	Wales	England	Scotland	Ireland	Great Britain	United Kingdom
	Gross Domestic Product					
1861-71	2.1	2.4	1.4	1.9	2.2	2.2
1871-81	1.5	1.8	1.7	0.7	1.8	1.7
1881-91	2.4	1.8	2.5	0.4	1.9	1.8
1891-01	1.4	2.0	2.0	0.1	2.0	1.8
1901-11	2.2	1.6	1.0	0.2	1.6	1.5
1871-1911	1.9	1.8	1.8	0.3	1.8	1.7
	Gross Domestic Product per worker					
1861-71	1.1	1.0	0.5	2.7	1.0	1.3
1871-81	1.0	1.1	0.9	1.6	1.1	1.2
1881-91	0.6	0.5	1.5	0.9	0.8	0.9
1891-01	0.6	0.8	0.8	0.6	0.6	0.7
1901-11	0.2	0.4	0.6	1.0	0.4	0.5
1871-1911	0.6	0.7	0.9	1.0	0.7	0.8
	Gross Domestic Product per capita					
1861-71	1.2	0.9	0.5	2.6	0.9	1.2
1871-81	0.5	0.6	0.6	1.1	0.6	0.8
1881-91	1.2	0.7	1.8	1.4	1.0	1.1
1891-01	0.2	0.8	0.9	0.6	0.7	0.7
1901-11	0.3	0.6	0.4	0.4	0.6	0.6
1871-1911	0.5	0.7	0.9	0.9	0.7	0.8

Source: tables 4, 5, and 6

One decade's performance is little enough to go on, however comparing the pre-1871 decade to those that followed, it seems possible that, for Ireland, the period 1871 to 1911 may form part of the longer period of slower growth between 1873 and 1913 identified by Mathews, Feinstein and Odling-Smee for the UK as a whole.[35] Table 8 examines growth performance over the period 1841 to 1871 on the basis of three different assumptions about the level of GDP in 1841: the first (A) places Ireland's GDP at around £80 million in current prices; the second (B) places it at £100 million; the third (C) at £120 million.

Table 8. Annual average rate of growth of GDP, GDP per worker and GDP per capita, 1841- 1871

	GDP			GDP per worker			GDP per capita		
	A	B	C	A	B	C	A	B	C
1841-61	0.6	-0.6	-1.5	2.2	1.1	0.2	2.4	1.3	0.4
1841-71	1.0	0.3	-0.3	2.3	1.6	1.0	2.3	1.6	1.0

Notes: Col. A assumes GDP in 1841 is £85.8m, col. B assumes GDP in 1841 is £107.5m, col C assumes GDP in 1841 is £128.7m all at 1900 prices.

Source: tables 4, 5, and 6

All three figures for Irish GDP in 1841 are consistent with a rate of growth of productivity and of output per capita which accelerates up to 1871 and slows down thereafter. Similarly comparing the period 1841 to 1871 with the period 1871 to 1911 the post-1871 period may be seen to be one of slower growth both of productivity and of output per capita. Notwithstanding a productivity performance, then, which either exceeded or matched that of GB in each decade between 1861 and 1911, the Irish economy, for the most part, followed the path set by the UK of ever lower productivity growth rates in each decade

between 1871 and the outbreak of the Great War. The exception is the decade 1901 to 1911 when the Irish economy alone of the four countries managed to reverse this trend, though the productivity performance of this decade was also associated with the second largest rate of decline of the labour force of any decade between 1861 and 1911.

This evidence of slower growth after 1871 calls into question some of the more optimistic assessments of post-famine economic performance; Willamson's view, for example, that 'Ireland was catching up with the leaders in both the Old World and the New',[36] perhaps needs some qualification. Certainly Ireland was catching up on her partners within the UK but if productivity growth was following the long-term trends set by the UK as a whole is it likely that she was catching up on anywhere else?

Table 9 seeks to answer this question. It compares the performance of the four home countries with that of their European neighbours and of other advanced countries. The basis for comparison is Maddison's estimates of the incomes of the west European economies and their offshoots. His benchmark estimates for this group of countries of 1985 levels of GDP at market prices in US$ at 1985 US relative prices have been projected back to 1911 and 1871 on the basis of his time series of GDP at constant prices; GDP per capita and per worker is calculated from his series on mid-year population and mid-year labour force of each country. The four home

countries and GB are located in this table by scaling their GDP per capita and per worker relative to the UK following table 6.[37]

Table 9. Levels of GDP per capita and per worker, 1871 -1911 ($ at 1985 US relative prices)

	GDP per capita			GDP per worker		
	1871	1911	growth (% p.a.)	1871	1911	growth (% p.a.)
Australia	2903	4492	1.1	7376	10758	0.9
Austria	1523	2589	1.3	3319	5749	1.4
Belgium	2093	3237	1.1	4941	7477	1.0
Canada	1393	3398	2.3	4007	8816	2.0
Denmark	1617	3129	1.7	3537	7100	1.8
England	**2960**	**3900**	**0.7**	**6557**	**8694**	**0.7**
Finland	922	1586	1.4	2068	3683	1.5
GB	**2879**	**3863**	**0.7**	**6437**	**8611**	**0.7**
France	1672	2678	1.2	3392	5507	1.2
Ireland	**1722**	**2451**	**0.9**	**3910**	**5936**	**1.0**
Italy	1251	2040	1.2	2459	4231	1.4
Japan	618[1]	1089	1.4	1135[1]	2203	1.7
Netherlands	2064[1]	3008	0.9	5348[1]	8125	1.1
Norway	1201	1919	1.2	2953	4850	1.2
Scotland	**2503**	**3640**	**0.9**	**5775**	**8444**	**0.9**
Sweden	1332	2375	1.5	2884	5208	1.5
Switzerland	1848[1]	3019	1.2	3814[1]	6266	1.2
UK	**2691**	**3714**	**0.8**	**6016**	**8360**	**0.8**
USA	2301	4634	1.8	6232	11992	1.6
Wales	**2772**	**3417**	**0.5**	**6437**	**8193**	**0.6**

Notes: 1. 1870.

Source: Maddison, Dynamic Forces, Appendices A and B; UK, GB, Scotland Ireland, Wales and England as for tables 5, 6 and 7.

Measuring levels, in a league table of 18 countries Ireland comes a respectable ninth in 1871 falling to thirteenth in 1911 in terms of GDP per capita and ninth in 1871 falling to eleventh in 1911 in terms of GDP per worker. Along with the

other countries of the UK Ireland, though, is at the bottom of the league in terms of growth of output per head and per worker. Only the other countries of the UK performed worse than Ireland in terms of growth of GDP per capita and only these same three plus Australia performed worse in terms of growth of productivity. It would seem then that good as Ireland's post-famine performance was - and it was good enough to locate the Irish economy among the richest in the world in the 1870s - the Irish economy lost ground, relatively speaking, after the 1870s to economies outside the UK.

5.2 Convergence

The relatively superior productivity growth performance of Ireland implies a degree of convergence of the economies within the UK. There has been a recent surge of academic output on regional (intra-country) and national (between-country) convergence and disparities.[38] Maddison argues that, 'a major characteristic of capitalist development has been the post-war convergence in levels of per capita income and productivity between (the) advanced countries'.[39] Williamson has identified convergence for members of the current OECD club between 1850 and 1913; he argues that most of the real-wage convergence occurred between the new world and the old rather than within either.[40]

Our purpose here is to examine the degree of convergence within the UK. The first task is measurement. The most common statistic used is the coefficient of variation, both weighted

and unweighted - the former sometimes known as Williamson's Index.[41] The link between convergence and inequality suggests the possible use of other inequality indices, particularly those that can be decomposed to separate out within group inequality from between group inequality.

The general entropy (GE) family of indices satisfy this condition;[42] the 'between group' inequality component of two members of this family are adopted. These are:

i. The Theil Index (T):

$$T = \lambda i \sum \log \frac{y_i}{y}$$

and ii. The Mean Logarithmic Deviation (MLD):

$$MLD = n_i \sum \log \frac{y}{y_i}$$

where λ_i is the GDP share of group (in this case country) i; n_i the population/employment share of i; and y_i is average GDP per head/worker in each country i and y the equivalent for the nation (i.e. all countries together).

Both of these measures are part of overall inequality measures attributable to Theil[43] and derived from Information Theory. In Table 8 these two measures with the two variants of the coefficient of variation all demonstrate a trend to convergence in per capita and per worker GDP from 1861 to 1901. For GDP per worker all measures record continuing convergence through to 1911 but only one index (the Williamson Index) does so for GDP per capita. In all cases the level of inequality in 1911 is substantially less - by over a factor of

three for the GE indices - than in 1861. The 1911 GE indices are well within the range of recent UK experience.[44]

Table 10. Indices of Convergence: The four countries of the UK, 1861-1911

Year	Weighted CV[3]		Unweighted CV		Theil[4]		Mean Logarithmic Deviation[4]	
	GDPPC[1]	GDPPE[2]	GDPPC	GDPPE	GDPPC	GDPPE	GDPPC	GDPPE
1861	.2233	.2112	.2313	.2297	.2708	.2511	.3551	.2947
1871	.1721	.1623	.1956	.1829	.1749	.1412	.1902	.1515
1881	.1494	.1377	.1701	.1708	.1248	.1079	.1359	.1141
1891	.1243	.1173	.1615	.1541	.0923	.0726	.0778	.0879
1901	.1169	.1132	.1624	.1581	.0741	.0683	.0596	.0825
1911	.1161	.0938	.1706	.1387	.0784	.0478	.0792	.0526

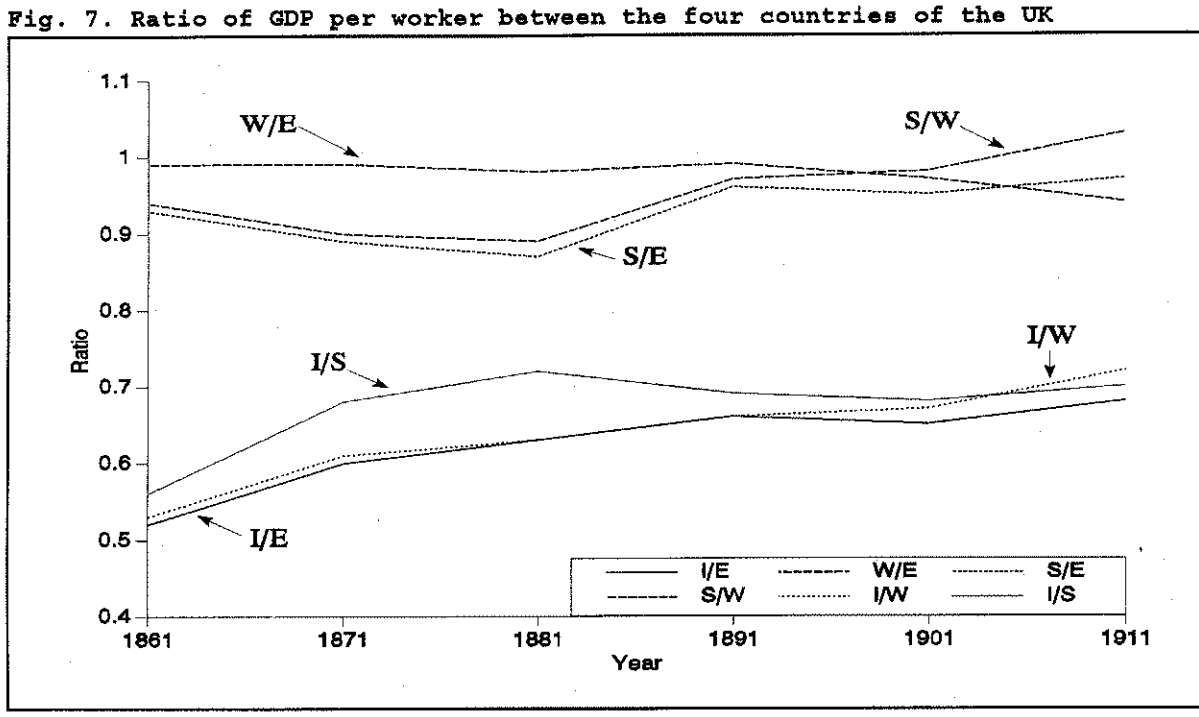
Notes: 1. GDP per capita. 2. GDP per worker. 3. Williamson's Index. 4. x10

A problem with summary measures of convergence is that they hide underlying patterns and can be quite misleading if convergent pairs 'cross'. Moreover there can be problems with outliers. A number of statistical techniques have been devised to deal with these problems - the most recent being time varying parameter techniques. With only four observations each year, involving no more than six pairings, it was decided however to adopt graphic techniques.

Two concepts of convergence were defined. The first is a 'relative' or 'weak' convergence concept; the ratio of GDP per capita or GDP per worker of any pair of countries, which should move to unity for convergence. The second is measured as the absolute difference in GDP per capita or GDP per worker between pairs of countries, which should move towards zero. The latter will imply the former and may be called 'strong' convergence or absolute 'catching-up'. The former, though

eventually leading to the later, does not necessarily imply it between any given points of time. This may be called relative convergence. Figure 6 traces out this 'relative convergence' with respect to GDP per worker.

Fig. 7. Ratio of GDP per worker between the four countries of the UK

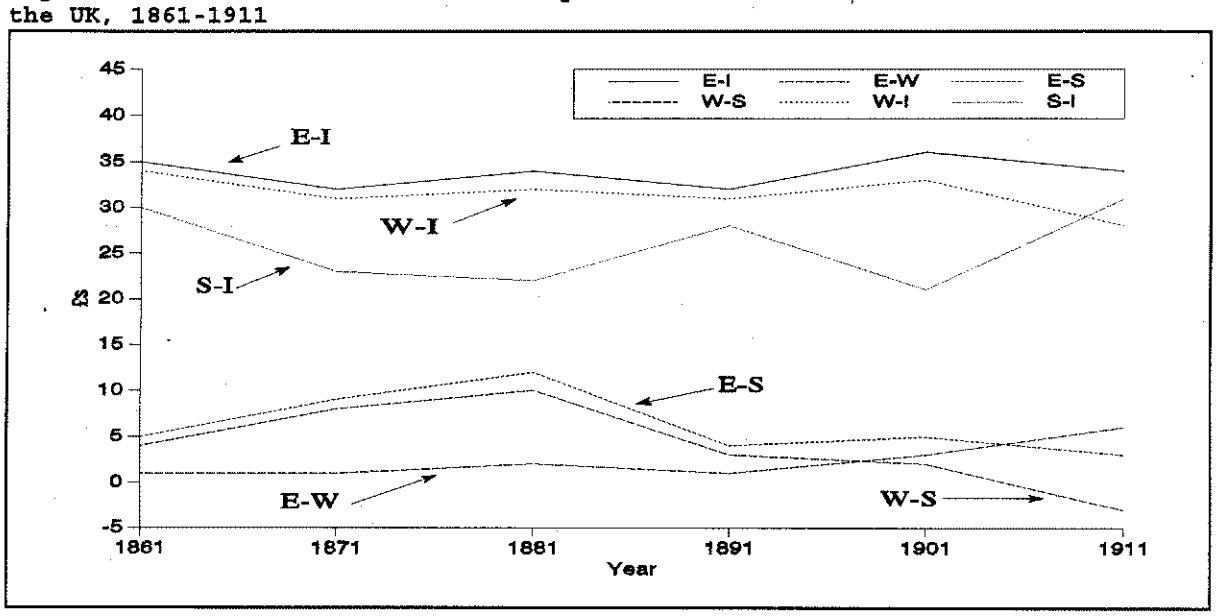


Source: Table 5.

Only on two occasions does Ireland fail to converge on the other countries - Scotland between 1881 to 1891 and England in the following decade. The most forceful convergence for Ireland is in the 1861-71 decade. This is reflected in relatively much higher Irish growth rates for this period (see Table 7). The patterns between the other countries are less uniform. Scotland's ratio to England worsens till 1881 and then improves irregularly. Scotland actually 'catches up' Wales and continues to diverge away in the last decade. The Welsh-English ratios decrease over this period. The upshot is that 'relative convergence' is far from clear-cut for all possible pairs during all periods. This conclusion is

reflected in the absolute differences (Figure 8). There appears to be no long-term movement of the difference to zero. A conclusion of no 'strong convergence' does not seem unreasonable.

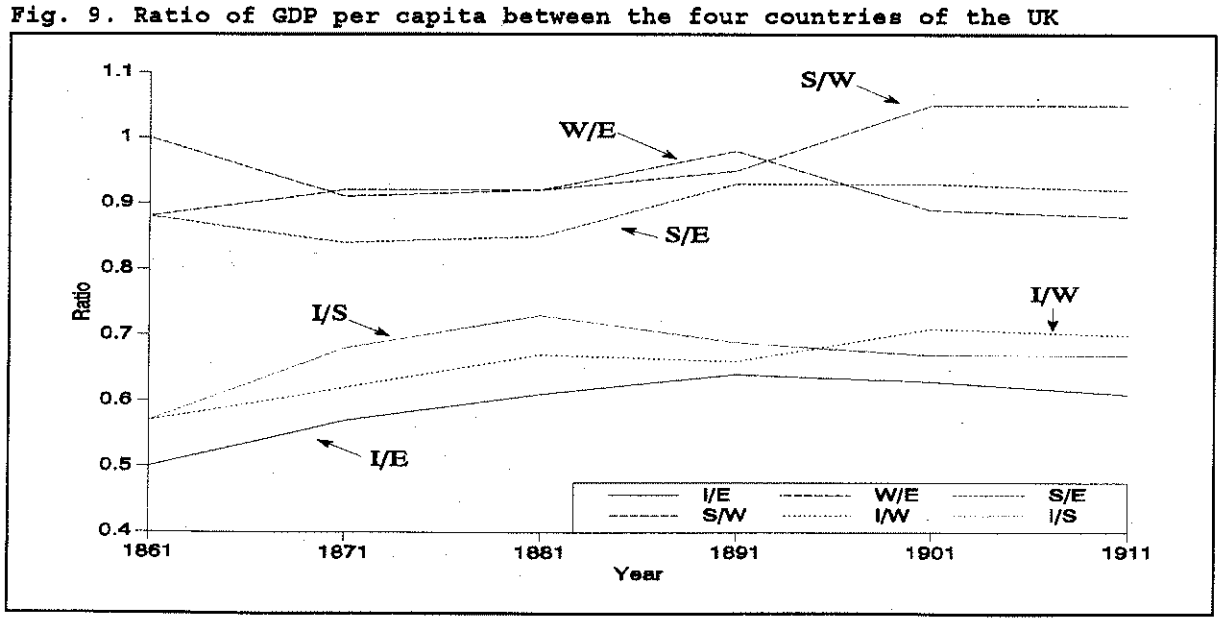
Fig. 8. Absolute differences in GDP per worker between the four countries of the UK, 1861-1911



Source: Table 5.

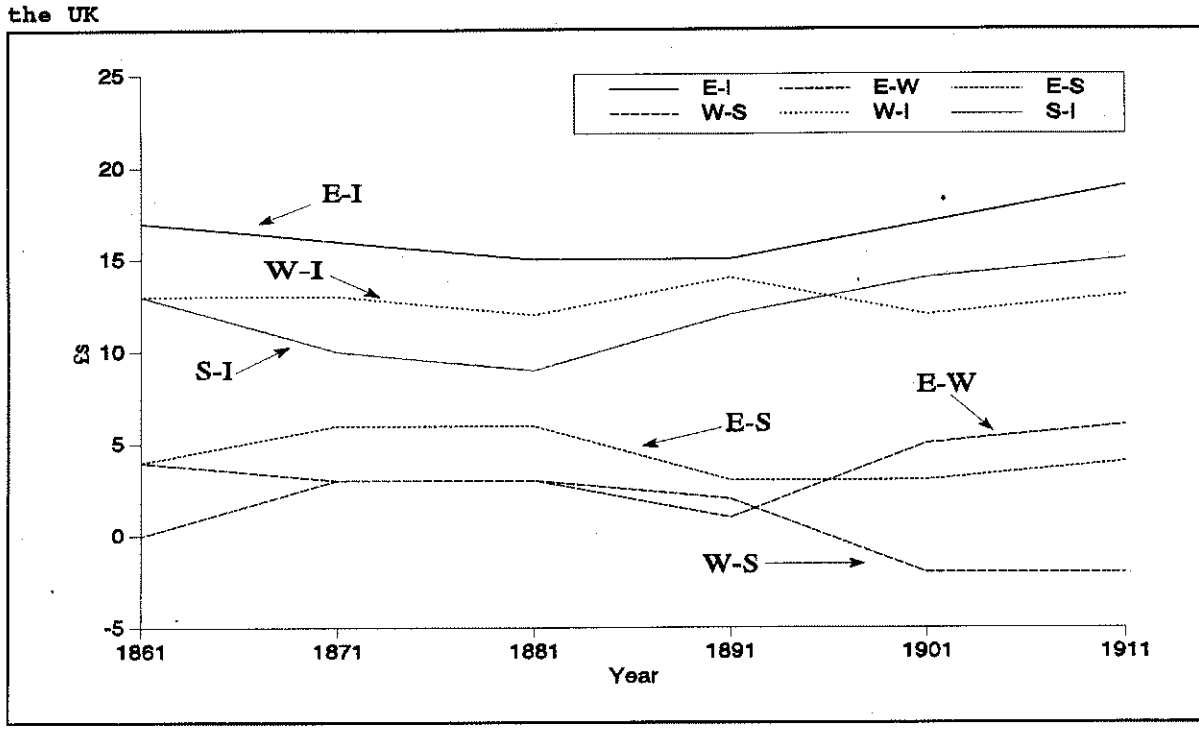
Figures 9 and 10 trace the same analysis for GDP per capita.

Fig. 9. Ratio of GDP per capita between the four countries of the UK



Source: Table 6.

Fig. 10. Absolute differences in GDP per capita between the four countries of the UK



Source: Table 6.

Between 1871 to 1891 all countries were 'relatively' converging on England (Fig. 9) but not after. Ireland converged on all countries up to 1881 (England until 1891) - quite rapidly in the 1861-71 decade - but by 1911 her ratio to Wales was the only one greater than in 1911. Outside Ireland there is clearly no long-term relative convergence. Figure 9 also illustrates no long-term 'strong' convergence. This view of the evidence, then suggests that the observed convergence by the summary measures may be quite misleading; on balance the 'advanced' countries of the UK - England, Wales and Scotland - conform to Williamson and O'Rourke's observations about the absence of any significant convergence within the Old World, while relatively backward Ireland catches up on all three.

4.2 Sources of change

Output and labour input figures by country and by sector enable us to examine the contribution of the different countries to UK output growth and the sources of growth within countries over the period. The model used here for this purpose is adapted from Blackaby and Hunt[45] and is:

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

where Δ 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.

There are three elements to the model. The first element 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. It is the outcome, in a Neo-Classical framework, of either a rise in the capital labour ratio or a shift in the production function, due to technical progress, or both simultaneously. Perhaps misleadingly, this element is termed the 'productivity effect'.

The second element is the change due to the change in the numbers employed in each sector/country cohort whilst keeping the output per worker constant. This impact is called the 'Employment Effect'.

The third element is an interaction factor and is usually estimated as a residual. This factor picks up changes within cohorts and diminishes as the level of disaggregation increases. Two further components can be computed. These are a sector distribution factor which is:

$$\sum_i \sum_j N_{i1861} \left[\frac{N_{ij1911}}{N_{j1911}}\right] . Y_{ij1861} - \sum_i \sum_j N_{ij1861} . Y_{ij1861}$$

and is broadly the effect of transposing the 1911 country sector employment patterns to 1861 and a national distribution factor which is:

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

and is the equivalent transposition of the 1911 sector-country employment pattern. The outcome of these exercises is set out in Table 10.[46]

Table 10. Percentage contribution to the change in UK GDP, 1861-1911

Type of Change	By Country				United Kingdom
	England	Wales	Scotland	Ireland	
Productivity Effect	20.1	1.2	3.7	6.7	31.7
Employment Effect	44.3	2.7	4.3	-1.9	49.4
Interaction/Residual of which	17.4	1.2	1.9	1.9	18.9
Sectoral	2.9	0.0	0.2	0.5	3.6
National	4.8	0.4	-0.1	-2.9	2.1
Remainder	9.8	0.8	1.8	0.6	13.1
Total	81.9	5.1	10.1	2.9	100.0[1]
Share of UK GDP[2]	77.0	4.9	10.4	7.8	100.0
Share of UK employment[2]	71.9	4.7	10.2	13.8	100.0

Note: 1. Total change in UK GDP was £1229m. 2. Average of 1861 and 1911. 3. We include the sector and national distribution factors as part of the interaction/residual. However it could be argued that they are subsumed within the employment effect.

The contributions of employment growth and of productivity growth to growth in GDP in England and in Wales are just over 50 per cent and 20 per cent respectively. The employment effect in Scotland accounts for around 40 per cent of GDP growth while in Ireland it is negative. The contribution of productivity growth to GDP growth is over 35 per cent for Scotland and 130 per cent for Ireland. In all countries the contribution of 'sectoral' interaction changes is minimal as is that of 'national interaction' except in the case of Ireland.

The Irish experience was quite different from the other countries. The very large productivity gain more than offset negative effects elsewhere. The negative 'employment effect' results from a 29 per cent decline in employment in Ireland between 1861 and 1911. This reduction, amounting to nearly three-quarter of a million persons, is matched by a 25 per cent decline in population in the same period.[47] None of the other 'home' nations experience a decline in overall employment and population.

There is also a large negative 'national interaction' effect for Ireland. This effect picks up some of the impact of the decline in employment levels but is picking up also the shift of industrial and service sector employment away from Ireland. In other words, not only did Ireland lose workers but the loss was relatively greater in the high productivity sectors and hence for the more productive Irish workers. A similar but

much smaller effect occurred in Scotland. Given the well-documented emigration from Ireland (and Scotland) to England over the period and that England was a net gainer in the 'national interaction' effect, then it is reasonable to conclude that Ireland was 'exporting' some of her more productive workers to England.

Table 7 identified Ireland's relatively high productivity growth rates. Growth in productivity in Ireland was particularly notable in the agricultural and industrial sectors.[48] In the former a 34 per cent decline in employment did not prevent an 18 per cent increase in output. However, even with this productivity growth in agriculture, Irish output per worker levels had only increased to 65 per cent of that in Great Britain, by 1911.[49] The performance of the Irish industrial sector was also impressive - a 40 per cent decline in employment counteracted by a 30 per cent increase in output between 1861 and 1911.

Measurement of the country contributions to UK output and labour input enables the introduction of an element of space into a discussion which has been largely dominated by discussion of economy-wide concepts of factor inputs. 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 per cent. 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 Mathews, Feinstein and Odling-Smee that over the period 1873 to 1913 factor inputs accounted for around 70 per cent of the growth of GDP.[50] What is surprising is the respective contributions of Ireland and of England to the productivity effect: at around 20 per cent of the total UK effect, Ireland's contribution considerably exceeded her share of both UK employment and UK GDP; at around 63 per cent England's contribution to the productivity effect was considerably less than her share of both UK employment and output.

This leads to some observations about the origins of Ireland's remarkable productivity performance in these years. In seeking to explain Ireland's post-famine process of convergence Williamson has recently emphasised the effects of migration over more traditional explanations such as capital accumulation and diffusion of technology.[51] If this is correct the emergence of global labour markets accounts not only for much of Ireland's productivity gain but also for an impressive proportion of UK GDP growth. So 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 total factor productivity growth?

It seems reasonable to present post-famine Irish economic growth in terms of a standard neo-classical growth accounting model; growth of output arises from increase in factor inputs and from increase in total factor productivity. 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 total factor productivity. In the Irish case, a rise in the capital to labour ratio may have resulted either from (with capital stock and hence the aggregate production function constant) a movement down the total product curve as the labour force declined, or from capital accumulation which shifted the aggregate production function upwards *ceteris paribus*. However with capital stock and the production function constant a decline in labour inputs would have had two effects: it would have raised the capital to labour ratio increasing the marginal and the average product of labour, but it would also have lowered total output. The likely amount by which total output would have fallen in the absence of either capital accumulation or total factor productivity gain is approximated by the percentage fall in labour inputs times the partial elasticity of output with respect to labour . Table 11 sets out the likely level of output and productivity as a result of employment fall and the actual level of output and productivity. The difference is attributed to a shift in the aggregate production function.

Table 11. The contribution of migration and of capital accumulation and technology to output and labour productivity between 1861 and 1911

	1861 (1)	1911 (emigration effect) (2)	1911 (actual outcome) (3)
GDP	100	86	139
Labour	100	71	71
GDP/Labour	100	121	195

Note: The partial elasticity of output with respect to labour is assumed to have a value of 0.5.

Column two answers the question, what would output and labour productivity have been in 1911 given a 29 per cent fall in employment with no capital accumulation or total factor productivity gain and an elasticity of output with respect to labour of 0.5? The answer is that output would have been about 53 per cent less and that labour productivity would have been more than 75 per cent less than they turned out to be. Less than twenty-five per cent of Ireland's labour productivity gain was due to labour force decline and more than three-quarters to the effects of capital accumulation and total factor productivity. Note than even if all of the labour which left Ireland between 1861 and 1911 was surplus labour i.e. with a marginal product of zero, in the absence of capital accumulation and total factor productivity the increase in labour productivity would have been around 46 per cent of its actual outcome, leaving more than 50 per cent to be explained by capital and residual productivity gain.

This result is not entirely unexpected; O'Grada calculates that total factor productivity growth in Irish agriculture after 1850 was higher than in Britain and the USA.[52] 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;[53] in the industry which displayed the fastest growth of TFP in the UK between 1873

and 1913 - gas, electricity and water[54] - employment increased by over 500 per cent between 1861 and 1911; taking three so-called 'new' industries - chemicals, electrical engineering and vehicles - employment increased by 16, 106 and 18 per cent 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%).[55]

Emigration and the effects of globalization of labour markets appear to have relatively little explanatory power in accounting for Ireland's remarkable post-Famine growth and productivity performance; it would seem that the more traditional explanations of capital accumulation and total factor productivity growth are the key to the convergence process in this case. This said, if Ireland's convergence on the UK's level of productivity was dominated by the traditional forces of capital, technology and economic structure, these were in turn drawn from within the UK. The UK after 1870 lost ground to the other advanced countries; whether, then, we ascribe Ireland's productivity gains to an exodus of workers or to increases in capital inputs and total factor productivity, the productivity regime towards which the Irish economy was moving was the UK one; its overall poor productivity performance set limits to the productivity gains that were available to the Irish economy, either from losing labour or from 'modernizing' along GB lines.

6. Conclusion

This paper sets out a short-cut method for allocating aggregate GDP across the four countries of the UK; GDP is estimated for each country for each census year between 1861 and 1911. The data are then used to examine Ireland's post-Famine economic performance. The results suggest a degree of convergence by Ireland on the other three countries but not on other advanced economies. The Irish experience is one of declining employment but of superior growth of output per worker relative to the rest of the UK. Ireland is seen to have made a disproportionate contribution to UK productivity growth both directly and possibly through the emigration of high productivity workers to England. Irish productivity growth is explained only partly by the effects of emigration; the dominant contribution came from the combined effects of capital accumulation and total factor productivity.

Appendix

Table A.1. Sectoral output in the UK by country, 1861 - 1911 (£m, 1900 prices)

	Wales			Scotland		
	Agric	Indust	Servs	Agric	Indust	Servs
1861	9.2	11.9	19.3	18.6	31.2	41.6
1871	8.6	16.4	24.4	23.9	38.5	42.1
1881	7.7	21.0	28.7	21.2	43.8	58.6
1891	8.3	27.2	36.3	22.5	58.1	78.6
1901	8.0	34.9	39.7	22.0	74.4	97.4
1911	8.2	45.5	49.7	22.4	78.7	113.7

	England			Ireland		
	Agric	Indust	Servs	Agric	Indust	Servs
1861	96.2	206.6	326.7	38.0	20.1	38.2
1871	94.9	285.5	415.6	39.1	29.9	46.7
1881	85.5	362.7	505.0	45.2	28.0	51.3
1891	91.2	431.4	621.2	47.5	28.9	52.2
1901	82.9	545.1	763.5	42.3	29.2	58.1
1911	86.5	628.4	920.8	44.8	26.3	61.6

Source: see text

Table A.2 compares the figures for agricultural output in Ireland with recent estimates made by various researchers in the field. The figures for the twentieth century are reasonably close to more careful and more detailed estimates of O'Connor and Henry. For the nineteenth century the estimates for 1861 and 1881 are within 5 per cent of Vaughan's estimates and that for 1871 is within 10 per cent.

Table A.2. Estimates of Irish Agricultural Output

	Geary & Stark	O'Connor & Henry	Geary & Stark	Vaughan	Solow
	(constant 1900 prices)		(current prices)		
	(1)	(2)	(3)	(4)	(5)
1861	38.0		37.8	35.6	
1871	39.1		40.7	44.4	
1881	45.2		44.2	43.1	40.4
1901	42.3	41.0[1]			
1911	44.8	43.4[2]			

Notes: 1. 1900/1. 2. 1912/13.

Source: Col. 1. from table A.1 above; Col. 2. from O'Connor and Henry, 'Estimates of Gross and Net Output', Tab. 6. The relevant measure is net output which accords with the gross value added estimates of col. 1. Their current price estimates are expressed in 1900/1 prices using their price index for net output (O'Connor and Henry, 'Estimates of Gross and Net Output', Tab. 7); Col. 3. is col. 1 expressed in current prices using a GDP deflator derived from Feinstein's current and constant price estimates of GDP(E) reported in Mitchell, British Historical Statistics, pp. 831-3 and 837-9; Col. 4. Vaughan, Landlords and Tenants, App. 9, p. 149; Col. 5. Solow, The Land Question, p. 179.

Table A.3. Shares of employment by sector and by country, 1861-1911

	Wales			Scotland		
	Agric	Indust	Servs	Agric	Indust	Servs
1861	28.52	47.60	23.89	22.23	49.24	28.52
1871	20.09	43.53	36.37	22.19	49.96	27.84
1881	17.10	45.53	37.37	16.69	50.67	32.64
1891	14.13	47.58	38.28	13.98	51.24	34.78
1901	12.13	53.16	34.71	11.50	54.25	34.25
1911	10.39	55.97	33.64	10.60	54.63	34.77

	England			Ireland		
	Agric	Indust	Servs	Agric	Indust	Servs
1861	17.81	49.29	32.90	50.49	25.81	23.70
1871	13.87	47.43	38.70	48.59	24.28	27.13
1881	11.58	48.25	40.16	49.79	22.21	27.99
1891	9.95	48.29	41.76	48.49	23.15	28.36
1901	7.74	51.17	41.09	47.33	22.97	29.71
1911	7.29	51.36	41.35	46.83	22.10	31.08

Note: Services includes unclassified general labourers.

Source: see text

Endnotes

1. Cullen, 'Irish National Income'; O'Grada, Ireland: A New Economic History, pp. 379-382; Feinstein, National Income, pp. 212-214.

2. Bairoch, 'Europe's Gross National Product'; Beckerman and Bacon, 'International Comparisons of Income Levels'; Crafts, 'New Estimates of GNP'; idem, 'Patterns of Development'.

3. Lee, Regional Employment Statistics.

4. The inclusion of those not classified in the service sector will probably tend to inflate the numbers in the service sector by those general labourers and others who were probably engaged in the industrial sector. If the error is the same across countries, which seems a not unreasonable assumption, then relative shares of UK GDP will not be affected. Some idea of the likely impact on the sectoral shares of employment may be gained by comparing the UK employment shares generated by the country data used in this study with those reported by Maddison and by Deane and Cole. If any thing the sectoral shares used in this study overestimate the share of the labour force in industry.

		Agric.	Ind.	Servs.
Maddison	1870	22.7	42.3	35.0
Geary & Stark	1871	20.8	43.7	35.6
Deane & Cole	1881	16.6	39.5	43.9
Geary & Stark	1881	17.9	44.6	37.5
Deane & Cole	1911	11.4	42.1	46.5
Geary & Stark	1911	11.3	49.3	39.4

Source: Maddison, Dynamic Forces, Tab. C5, p. 248-9; Deane and Cole, British Economic Growth, Tab. 33, p. 147.

5. See General Report 1871 Census, pp. 62 - 94.

6. 1871 Census p. 66

7. 1871 Census, p. 67.

8. 1871 census p.67 and p. 71.

9. 1871 census, general report, tab. 20 pp. 242. These tables are available only at the aggregate level so, even after removal of those females returned as following their husband's occupation, all county returns are out by each

county's share of the 86 thousand females wrongly located in Class II as 'wife of other specified occupation'.

10. 1871 census general report, tab. 24 p. 299.

11. 1881 census, general report, p. 22.

12. Vaughan and Fitzpatrick, Irish historical statistics, Tab. 9, p.27.

13. We have a simple check on the reliability of the estimated figure for general labourers. The one year in which we have a return which differentiates between agricultural and non-agricultural labourers is 1851. The return of 'labourers (not agricultural)' for 1851 was 59 thousand, the estimate for 1851 is 62 thousand. The error arising from wrongly assuming that all labourers were agricultural (which we would do in subsequent years if all general labourers were regarded as agricultural labourers) would be to overestimate those in agriculture by 59 thousand; the error arising from using the estimate of 62 thousand is to underestimate the agricultural labour force by 3 thousand. A third possibility would be to treat only those general labourers returned in towns and cities as 'general labourers'; in 1851 there were 31 thousand general labourers returned in the towns and cities covered by the census so this procedure would lead to an overestimate of the agricultural labour force in that year of about 28 thousand.

14. The average of the share of female domestic servants in 1851 and 1871 in the female population is 7.4%. If we assume that this was the proportion of the female population active as domestic servants in 1861 then the number of domestic servants in 1861 was 222 thousand. The number returned in the census was 296 thousand so that 74 thousand have been excluded on the grounds that they were wives and other near relatives of the heads of families who were returned as housekeepers.

15. Mitchell, British historical statistics, p. 839.

16. Feinstein, 1972 tab. 10.2, p. 208.

17. Feinstein (1972) Tab. 8, T24.

18. Bowley, 'Statistics of wages: Pt. IV, agricultural wages, general averages', pp. 562-567.

19. ibid, p. 562.

20. Board of Trade, 17th Abstract of Labour Statistics, p. 383

21. Hunt, Regional Wage Variations, Tab.1-4, p. 64. Bowley's figures for agricultural wages in the English regions and in Wales suggest that Welsh wages were on a par with

English wages in the 1860s and slightly below by the 1890s (Bowley, Statistics of Wages: Pt. I. Agricultural Wages, pp. 702-707). Clearly the computation of a separate series for England and Wales is necessary.

22. Bowley, 'Statistics of Wages. Pt. VII.' p. 107-111.

23. Bowley, 'Statistics of Wages. Pt. VII', pp. 490-497; Bowley, 'Statistics of Wages. Pt. VIII, p. 111.

24. Board of Trade, Rates of Wages

25. Bowley, Wages and income, p. 8.

26. Hunt, Regional Wage Variations, p. 70.

27. Pollard and Robertson, The British Shipbuilding Industry, pp. 246-7.

28. Clearly in the composite index Wales is strongly represented by construction; a more representative wage relative for industry would include at least mining and textiles

29. Mitchel, British Historical Statistics, p. 839

30. ibid, pp. 833 and 839.

31. Feinstein, National income, p. 212, fn. 2.

32. Feinstein, National income, T118, Tab. 54.

33. ibid, p. 212.

34. Butlin, 'Separation of Ireland', p. 282.

35. Mathews, Feinstein and Odling-Smee, British economic growth, ch. 2.

36. Williamson, 'Economic convergence', p. 12.

37. Note that Maddison's estimates are at market prices while the estimates of table 6 are at factor cost. We are assuming that the move from factor cost to market prices does nothing to alter the scalars.

38. Button, K. and Pentecost, E., 'Regional Economic Convergence'; Dunford, M., 'Regional Disparities in the European Community'.

39. Maddison, Dynamic Forces, p. 48.

40. Williamson, 'Economic convergence', p. 11.

41. Orsagh, 'Probable geographical distribution of German income', p. 291.

42. Mookherjee and Shorrocks, 'Decomposition Analysis'.

43. Theil, Economics and Information Theory.

44. Stark, McKinney and Johnston, 'Regional Price Level Variations'. The values for between group inequality for regional household gross income in the UK range from .047 in 1979/80 to 0.09 in 1993.

45. Blackaby and Hunt, 'The Manufacturing "Miracle"'.

46. The calculations in Table 9 are with respect to an 1861 base. Similar calculations were undertaken for a 1911 base. Though these are equally valid the 1861 base was selected for three reasons. First it is normal to examine dynamic changes moving forward through time, rather than backwards; secondly the 1911 base produced negative interaction effects which made the interpretation of the proportions a little more complex, and finally it also produced an 'outlier' result for the Irish 'national interaction' effect. Besides this factor, all other relative contributions, both across countries and by size, were robust to the base change and the conclusions were not invalidated. It is our intention at a later stage to extend the analysis to a decade by decade basis.

47. Interestingly, what is now Northern Ireland - which was a less agriculturally orientated area - only accounted for 10% of this population decline, but accounted, initially, for one quarter of Ireland's population.

48. We do not reproduce output per employee per sector per country in this article. However they can be estimated from the country-sector output and employment data in the appendix.

49. The agricultural output per employee was only 50% of Scottish levels. In 1911 Scotland had the highest productivity levels in both agriculture and services according to our estimates. This was not the case in 1861.

50. Mathews, Feinstein and Odling-smee, British Economic Growth, ch. 7. tab. 7.2, p. 209.

51. Williamson, 'Economic convergence', pp. 24-5.

52. O'Grada, Ireland before and after, p. 153.

53. Geary and Johnson, 'Shipbuilding in Belfast', Tab. 1. p. 45.

54. Mathews, Feinstein and Odling-Smee, British economic growth, Tab. 8.3, pp. 228-9.

55. Census of Ireland, 1861, 1901 and 1911.

References

Official Publications

Board of Trade, Rates of wages and hours of labour in various industries in the United Kingdom for various years (unpub. 1908)

Board of Trade, 17th abstract of labour statistics in the United Kingdom (P.P. 1914-16, LXI)

Census of Ireland, 1851, (B.P.P.1856, XXXI) Pt. vi., General report

Census of Ireland, 1861, (B.P.P.1863, LXI) Pt. v., General report

Census of Ireland, 1871, (B.P.P.1876, LXXXI) Pt. iii, General report

Census of Ireland, 1881, (B.P.P.1882, LXXVI) Pt. ii, General report

Census of Ireland, 1891, (B.P.P.1892, XC) Pt. ii., General report

Census of Ireland, 1901, (B.P.P.1902, CXXIX) Pt. ii, General report

Census of Ireland, 1911, (B.P.P.1912-13, CXVIII) Pt. ii., General report

Secondary sources

Bairoch, P., 'Europe's Gross National Product: 1800-1975', Journal of European Economic History, (1976), Vol. 5, pp. 273-340.

Beckerman, W. and Bacon, R., 'International comparisons of income levels: a suggested new measure', Economic Journal, (1966), Vol. 76, pp. 519-536.

Blackaby, D. and Hunt, L., 'The Manufacturing "Miracle". A Sectoral Analysis' in F. Green (ed), The Restructuring of the UK Economy (Brighton, 1989).

Bowley, A. L., 'Statistics of wages in the United Kingdom during the last hundred years. (Part IV.) Agricultural wages - concluded and general averages', Journal of the Royal Statistical Society, (1899), Vol. LXII, pp. 555-570.

Bowley, A. L., 'Statistics of wages in the United Kingdom during the last hundred years. (Part I.) Agricultural wages', Journal of the Royal Statistical Society, (1898), Vol. LXI, pp. 555-570.

Bowley, A. L., 'Statistics of wages in the United Kingdom during the last hundred years. (Part IV.) Wages in the building trades - Scotland and Ireland', Journal of the Royal Statistical Society, (1900), Vol. LXIII, pp. 485-497.

Bowley, A. L., 'Statistics of wages in the United Kingdom during the last hundred years. (Part VIII.) Wages in the building trades - concluded', Journal of the Royal Statistical Society, (1901), Vol. LXIV, pp. 102-112.

Bowley, A. L., Wages and income in the United Kingdom since 1860, (Cambridge, 1937)

Butlin, N., 'A new plea for the separation of Ireland', Journal of Economic History, (1968) Vol. XXVIII, pp. 274-291.

Button, K. and Pentecost, E., 'Regional Service Sector Convergence', Regional Studies (1993), Vol.27, No.7, pp.623-636.

Button, K. and Pentecost, E., 'Regional Economic Convergence in Great Britain and Germany', CREEF Research Paper 94/5, Loughborough University (Dept. of Economics), July 1994.

Crafts, N., 'Gross National Product in Europe 1870-1910: Some New Estimates', Explorations in Economic History, (1983), Vol. 20, pp. 387-401.

Crafts, N., 'Patterns of development inn nineteenth century Europe', Oxford Economic Papers, (1984), vol. 36, pp. 438-458.

Cullen, L. M., 'Irish national income in 1911 and its context', Economic and Social Research Institute, Working Paper 63, 1995.

Deane, P. and Cole, W., British economic growth, (2nd. ed., Cambridge, 1967)

Dunford, M., 'Regional Disparities in the European Community: Evidence from the REGIO Databank', Regional Studies (1993), Vol.27, No.8, pp.727-743.

Feinstein, C., National income, expenditure and output of the United Kingdom, 1855-1965, (Cambridge, 1972).

Geary, F. and Johnson, W., 'Shipbuilding in Belfast, 1861-1986', Irish Economic and Social History, Vol. XVI, 1989, pp. 42-63.

Hunt, E., Regional wage variations in Britain, (Oxford, 1973).

Lee, C.H., British regional employment statistics 1841-1971, (Cambridge, 1979).

Mitchell, B., British historical statistics, (Cambridge, 1988).

Maddison, Dynamic forces in capitalist development, (Oxford, 1991)

Mathews, Feinstein and Odling-Smee, British economic growth, 1856-1973, (Oxford, 1982).

Mookherjee, D. and Shorrocks, A., 'A decomposition analysis of the trend in UK income inequality', Economic Journal (1982), Vol. 92, pp.886-902.

O'Grada, Ireland before and after the famine, (2nd. ed., Manchester, 1993)

Orsagh, T. J., 'The probable geographical distribution of German income 1882-1963', Zeitschrift fur die gesamte Staatswissenschaft, (1968) Vol. 124, pp. 280-311.

Pollard, s., and Robertson, P, 'The British shipbuilding industry, 1870-1914, (Cambridge, Mass. 1979).

Stark, T., McKinney, M. and Johnston, R., 'Regional price level variations and real household incomes in the United Kingdom, 1979/80-1993', Regional Studies (forthcoming 1996, Vol.30).

Theil, H., Economics and information theory (Amsterdam, 1967).

Vaughan, W., Landlords and tenants in mid-victorian Ireland, (Oxford, 1994)

Vaughan, W. and Fitzpatrick, A., Irish historical statistics: population, 1821-1971, (Dublin, 1978).

Williamson, J. G., 'Economic convergence: placing post-famine Ireland in comparative perspective', Irish Economic and Social History, 1994, Vol. XX1, pp. 5-27.