# Relative British and American Income Levels during the First Industrial Revolution

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Summary

We provide estimates of UK and American living standards and output per worker for the crucial years between 1830 and 1870. Our estimates show that the US held the lead in income per capita and output per worker when compared to both Great Britain and the United Kingdom. We use price level benchmarks to compare expenditure on GDP. Our results are consistent with comparisons based on sectoral productivity and "short cut" GDP estimates. They are also consistent with long span projections, such as those of Maddison (1995, 2001) so long as we use a relative price structure that is close in time to the period compared.

July 30, 2004

## 1. Introduction

The active debates surrounding nineteenth century living standards, growth and structural change in the US and the UK highlight the importance of this period in each nation's development. To date, evidence on the performance of these economies during the early and middle 1800's is drawn mostly from information on changes within the domestic economy. We know little about UK/US relative income and productivity before 1870. To fill this gap, we offer a comparison of income per capita and output per worker for the United Kingdom relative to America in five benchmark years between 1830 and 1870. The estimates cover a crucial period during the first industrial revolution for both countries. As such, they provide a new perspective on the nature of the British industrial revolution and the sources of American supremacy.

All international GDP comparisons face the problem that exchange rates do not reflect relative purchasing power. Researchers often get around this problem by adopting a projection procedure, which works as follows. First, they establish a relative income per capita benchmark for a recent year using a purchasing power parity adjusted comparison. Then, they then project this benchmark backward in time using domestic growth rates. The most influential work in this area is Angus Maddison (1995, 2001). Maddison provides an annual series on relative income per capita for the UK and the US between 1870 and 2000. He also covers, 1820, 1830, 1840, 1850 and 1860.

As Gallman (1966) pointed out forty years ago, the projection approach faces a fundamental index number problem since it compares income using relative prices of a single year. Maddison (1995, 2001), for example, uses 1990 prices. The problem is that the goods and services produced in 1990 bear little resemblance to those of, say, 1820.

A second problem with the projection procedure is that the methods used to calculate growth rates are not always comparable across countries. This is especially problematic over very long time spans where small differences in growth rates can cumulate into large differences in projected income levels.

In this paper, we use UK/US price level benchmarks to compare income for five benchmark years between 1830 and 1870. Our estimates are in current international prices. They circumvent the index number problems associated with long span projections since we compare income at a point in time where we can be sure that both economies produce similar goods and services.[1]

Section two introduces our estimates of relative UK/US income and output per worker. Our findings show the US with a lead in income per capita between 1830 and 1870. The US lead is larger for output per worker. We also show the US leading Great Britain for much of the period.

Section three compares our results with alternative approaches. In particular, we provide sectoral GDP comparisons along the lines of Rostas (1948), Paige and Bombach (1959) and Broadberry (1997) for 1860 and 1870. The results support our expenditure comparisons. Next, we reconcile our estimates with Maddison's (1995, 2001) projections. We conclude the section by showing our estimates agree with "short-cut" estimates from Prados de la Escosura (2000). In sum, we find that all methodologies put the US ahead by 1830.

[1] Our work builds on Ward and Devereux (2003) who provide current price benchmarks from 1870 to 1990. Broadberry (2003) and Broadberry and Irwin (2003) criticize these estimates. Our reply is Ward and Devereux (2004a). We shall address their points as they relate to pre-1870 estimates as they arise in later sections.

Section four assesses long run UK/US relative income from 1830 to 1990. The evidence shows the US with the lead in income per capita and output per worker for all years. Section five examines the price benchmarks on which our GDP comparisons are based. Section six concludes with directions for further research.

## 2. The GDP Comparisons

This section provides our benchmark comparisons of income per capita and output per worker. Although our focus is the UK, we also consider Great Britain. Given Irish poverty and its large share in the UK population before the famine, a comparison between Great Britain and the US is also of interest.

We form our comparisons using the OEEC methodology developed by Gilbert and Kravis (1954).[2] Equation (1) gives the benchmark estimates of GDP per capita at time t, $y_t$, in current international dollars where $Y_t$ is ratio of UK/US nominal GDP per capita in US dollars and $p_t$ is the UK/US price level at time t.[3]

$$(1) \qquad y_t = Y_t/p_t$$

There are four points to note about the Gilbert and Kravis approach. First, the price benchmarks used in (1) compare prices of items of identical quality across space at a point in time. They should not be confused with domestic price indices, such as the

[2] Their work forms the basis for both the International Comparison Project and the Penn World Tables. Clark (1940) is a forerunner of the OEEC methodology. He also provides some of the first sectoral comparisons. Maddison (2004) provides an appreciation of Clarks's achievement.

[3] Our task is simplified by the fact that the UK and US have similar patterns of consumption. Van Zanden (2003) compares GDP per capita between Java and the Netherlands where this does not hold.

CPI or the GDP deflator, which compare prices of identical items across time within an economy. For interspatial comparisons, weights and the items compared change for each benchmark. These data therefore cannot be used to compare price levels across time within either economy.

Second, by the nature of their construction, we should not expect benchmarks and projections to agree. For example, using US and UK domestic price indices to project a UK/US price benchmark to another year, will not in general produce a result that is equal to the interspatial price benchmark for that year.[4] They will agree only by chance. This is because the benchmarks and domestic price indices differ in both weights and good sampled. For similar reasons, we should not expect agreement between GDP projections and GDP benchmark comparisons. This point is fundamental to the literature on international comparisons.

The third point is that this approach takes nominal income as given.[5] The interspatial price benchmarks are used to deflate nominal GDP obtained from standard domestic sources. This is the procedure followed for all international expenditure comparisons.

Fourth, this approach inherently imposes checks on the plausibility of the relative GDP comparisons. The explicit recognition that UK/US real GDP is the ratio of UK/US nominal GDP and the UK/US price level forces us to examine the consistency of the real

[4] Broadberry (2003) uses price data from the interspatial price benchmarks of Ward and Devereux (2003) to compute UK and US domestic price indices. This ignores the conceptual differences between interspatial and intertemporal comparisons. Moreover, items in our benchmarks differ so greatly in practice that no comparison is possible across benchmarks.

[5] Broadberry (2003) points out that this assumption is invalid where nominal income is formed by reflating volume indices by a price index. This point does not apply to our comparisons, as our procedures do not affect domestic price or volume indexes. They relate only to *relative* UK/US prices and output.

income comparisons with relative nominal income and international price comparisons. It is then possible to verify that both the price and income comparisons are consistent with independent evidence on UK/US relative performance. Furthermore, sectoral GDP comparisons provide a further check. Operating within this framework increases our confidence in the benchmark estimates.

We provide our GDP per capita comparisons in Table 2. Our price level benchmarks cover 1831, 1839, 1849, 1859 and 1869. These years reflect data availability. In a later section, we outline our sources and methods in more detail. For now, we will concentrate on the results.

Table 1 gives the results for the UK and Great Britain.[6] The second column is the ratio of nominal income per capita calculated with market exchange rates. We form our estimates of nominal GDP for the US, the UK and Great Britain using conventional sources. Our sources and methods are detailed in the notes to Table 1.

[6] It should be borne in mind that our price series are from British sources only.

Table 1: Per Capita Income

US = 100

| Year | Nominal GDP per Capita | Price Level | Real GDP per Capita |
|---|---|---|---|
| **United Kingdom** | | | |
| 1831 | 106 | 156 | 68 |
| 1839 | 93 | 122 | 76 |
| 1849 | 89 | 123 | 72 |
| 1859 | 83 | 112 | 75 |
| 1869 | 99 | 110 | 90 |
| **Great Britain** | | | |
| 1831 | 129 | 156 | 83 |
| 1839 | 111 | 122 | 91 |
| 1849 | 99 | 123 | 81 |
| 1859 | 98 | 112 | 87 |
| 1869 | 112 | 110 | 102 |

*Notes and Sources*: *UK GDP* at factor cost from C. H. Feinstein as reported in Mitchell (1988) page 823. We form a compromise estimate as a geometric average of income and expenditure estimates for 1859 and 1869. For earlier years, only GDP measured from the expenditure side is available. We reduce this by eight percent to approximate the compromise measure. Eight percent is the average difference between compromise and expenditure based estimates between 1855 and 1885. After 1885, the differences between these measures fall.
*British GDP*. We assume that British GDP is eighty two and a half percent of UK GDP before the famine. After the famine, we assume that it is ninety two point five percent. We take these ratios on the authority of Deane and Cole (1967) page 168. The resulting British GDP estimates accord with Great Britain from Deane and Cole for all years except 1841.
*US GDP* is the implicit GDP from the Gallman (1960) and Gallman and Weiss (1969) sectoral estimates adjusted to a GDP basis. GDP estimates are obtained by increasing the GNP estimates by 3%. This was the average difference between GNP and GDP for 1870-1909. For 1831 we project the 1839 benchmark using the nominal GDP series from Eh.net.
*Population* is from Mitchell (1998).

US nominal income per capita exceeds that for the UK after 1831 reflecting lower Irish living standards. Moreover, the US lead increases over time with the exception of the depreciated dollar for 1869. On the other hand, Great Britain generally has higher nominal income per capita. As the share of Irish population falls, the UK and British measures converge.

The third column gives our price level benchmarks derived from disaggregated price and expenditure data. They cover consumption, investment and government spending. Following Gilbert and Kravis (1954), we use Fisher Ideal price indices.

Two features stand out in the price level comparisons. First, the UK price level is higher for all years. Second, relative UK prices fall over time. The UK starts the period with prices fifty-six percent above US levels. By 1869, this margin is down to ten percent. As shown later, the falling UK price level reflects a decline in British food prices due to greater integration on world markets.

The final column in Table 2 provides relative real income per capita. Once again, there are two points to note. First, the US leads for all years. On average, it has a thirty percent advantage. The improvement in the UK's relative standing between 1859 and 1869 seems to reflect the effects of the Civil War on the US. Second, the US lead over Great Britain is much smaller, just over ten percent on average. The difference between Great Britain and the UK reflects lower income in Ireland.

The results for output per worker are in Table 2. The UK/US comparison is in the top panel, with the GB/US comparison in the bottom.

Table 2: Output per Worker

| Year | Nominal GDP per Worker | Real GDP per Worker |
|---|---|---|
| **United Kingdom** | | |
| 1831 | 79 | 50 |
| 1839 | 69 | 57 |
| 1849 | 69 | 56 |
| 1859 | 68 | 61 |
| 1869 | 73 | 66 |
| **Great Britain** | | |
| 1831 | 96 | 61 |
| 1839 | 83 | 68 |
| 1849 | 77 | 63 |
| 1859 | 78 | 70 |
| 1869 | 80 | 73 |

*Notes and Sources:* Nominal GDP from sources detailed in Table 2. US Labor force estimates are from Lebergott (1964) for 1831. The 1830 labor force is adjusted using the rate of growth of the US population between 1830 and 1831 from Mitchell (1998). US labor force for 1839-1869 is from Gallman and Weiss (1969), Tables 5 and 6. British and UK labor force estimates up to 1849 are from Deane and Cole (1967). British labor force estimates are converted to UK estimates using the difference between British and UK population estimates. UK labor force estimates after 1849 are from Feinstein (1972), Table 57.
Real GDP per worker is calculated as the ratio of UK/US nominal GDP per worker and UK/US price levels from Table 1.

The second column is nominal output per worker. The US has the higher nominal output per worker for all years. The third column gives our estimates of relative real output per worker. The American lead over the UK is larger than for income per capita reflecting lower US labor force participation rates. Note the US advantage falls over time. UK output per worker starts in 1831 at fifty percent of US levels. It increases to sixty-six percent of US levels by 1869. As with the income per capita estimates, the US lead over Great Britain is smaller, and it falls over time.

What are the implications of our estimates for long standing debates on the UK/US economies? We postpone our answer to this question until section six where we consider the longer period from 1830 to 1990. First, however, we provide some independent checks of our estimates.

## 3. Cross-checks

In this section, we evaluate our estimates by comparing UK and US GDP using three alternative methodologies. We begin with a sectoral GDP comparison. Since sectoral estimates are largely independent of expenditure based measures they act as a check on our benchmarks.[7] Next, we reconcile our estimates with Maddison's (2001) projections. Finally, we consider the short-cut estimates of Prados de la Escosura (2000).

### a. Sectoral Estimates

We provide the UK/US sectoral comparisons in Table 3. We draw on the methods of Rostas (1948), Paige and Bombach (1959) and Broadberry (1997). Our estimates cover eight sectors: agriculture, mining, manufacturing, construction, trade, transportation, finance/services and government.[8]

[7] Paige and Bombach (1959) emphasize the importance of sectoral estimates as a check on expenditure comparisons. Broadberry (2003) also makes this point.

[8] An earlier version of the 1870 comparison appears in Ward and Devereux (2004a).

Table 3

Comparative British/US Output per worker.
US = 100

| | 1860 | 1870 |
|---|---|---|
| Agriculture | 52 | 51 |
| Mining | 165 | 97 |
| Manufacturing | 43 | 55 |
| Construction | 60 | 77 |
| *Commodities* | 55 | 60 |
| | | |
| Trade | 71 | 59 |
| Transportation | 50 | 55 |
| Public Utilities | 179 | 179 |
| Finance/services | 100 | 100 |
| Government | 100 | 100 |
| *Services* | 87 | 76 |
| | | |
| Total GDP | 69 | 71 |

*Notes and Sources*: *Benchmark Sectoral Labor Productivity*. We calculate sectoral productivities using UK/US nominal value added per worker and UK/US sectoral price levels. US: estimates for nominal value added for1860 and 1870 are from Gallman (1960) page 43 and Gallman and Weiss (1969). These estimates refer to 1859, 1869. We project them to 1870 etc using growth rates in nominal GDP. UK valued added are rough estimates constructed from Feinstein (1972), Mathews *et al* (1982) and Deane and Cole (1967)

*Agriculture* The US Agricultural labor force is from Gallman (1960) while the UK estimates are from Feinstein (1972). *UK/US Farm Gate Prices.* We use prices for wheat, barley, oats, hay, hops, potatoes, milk, beef, mutton and pigmeat with UK gross output weights for 1870. 1870 UK prices are from Ojala (1952), pp. 193-208 where prices are projected to benchmark years using Sauerbeck wholesale prices. For 1860, we use Clark (2002a) to project the Ojala prices. US prices are from Towne and Rasmussan (1960), pp. 281-312.

*Construction* is obtained using the price index for construction described later. *Trade*: is measured by volume of commodities moving through wholesale and retail trade. We use the UK margins from Jeffreys and Walters (1955) as reported in Feinstein (1972) pg. 12. For the US, we adopted a comparable procedure using Barger (1955) Table 26 pg. 92.

*Transportation:* Fisher ideal price index for price per passenger and per ton-mile. US data is from Fishlow (1966) Table 1 pg. 585. Hawke (1970) and Mitchell and Deane (1962) provides British dataTable 5. pg. 225. We calculate average passenger mile and average ton mile from Hawke (1970). *Mining and Manufacturing*. Broadberry (1997) Table 3, pg.7 for 1870. Irwin and Broadberry (2003) for 1860.

For manufacturing and mining, we take our estimates from Broadberry (1997) and Broadberry and Irwin (2003). We provide new estimates for agriculture, construction, transportation and trade derived from relative value added and sectoral price benchmarks. For agriculture, we use farm gate price benchmarks. For construction, our price benchmarks use building wages and input prices. For transportation, we compare train costs per passenger mile and per ton-mile. For Trade, we estimate the quantity of goods flowing through wholesale and retail channels for each country. For finance/services and government, we follow Paige and Bombach (1959) and assume equal labor productivity.

The results show the US leads in terms of overall output per worker for 1860 and 1870. For 1860, relative UK/US output per worker is 71. It is 69 in 1870. These are consistent with our expenditure benchmarks. Turning to the aggregates, the US leads in terms of output per worker for both commodities and services from 1850 to 1870. The US advantage is most marked for commodities. The broad agreement of the sectoral estimates with our expenditure benchmarks is reassuring.[9]

Broadberry (1997) reports strikingly different results for sectoral GDP in 1870. He derives his estimates by projecting Rostas's 1937 UK/US benchmarks backwards with sectoral output indices. He shows UK output per worker for 1870 as eight percent higher than the UK. What explains the fifty percent difference with our estimates? As it turns out, he overstates UK output per worker primarily because of inconsistencies for agriculture. Simply put, he projects UK agricultural output using value added while using gross output for the US. This biases the relative position of the US downwards.

[9] We also constructed sectoral GDP comparisons for Great Britain and the US for 1850, 1876 and 1870. The results are consistent with the GB/US expenditure comparisons in Table 2.

The appendix shows that once we correct agriculture his sectoral estimates imply the US has a large lead for output per worker for 1870.

(b) Reconciling projections with direct comparisons

Next, we consider our benchmarks in conjunction with the estimates of UK/US per capita GDP obtained from Maddison's (2001) projections. The second column of Table 4 shows the Maddison estimates. Strikingly, Maddison (2001) finds that the UK leads by approximately twenty percent for all years. This represents a sixty percent difference with our findings.

There are two problematic features of these estimates that it is important to highlight. First, they imply unrealistically high income per capita for Ireland. To see this, assume that Irish income per capita was one-half that of Great Britain in 1820.[10] For that year, Ireland accounted for a third of the UK's population. It is easy to show that Maddision's estimates imply British income per capita is fifty percent higher than the US. But this implies that income per capita for Ireland is fifty percent of US levels. Given what we know about Irish real wage rates etc, this seems too high.

Second, Maddison's implied UK/US price levels are implausible. To see this, consider the estimates of UK/US nominal income at market exchange rates from Table 1.[11] The US is ahead in nominal terms after 1830. By dividing the ratio of nominal income at market exchange rates from Table 1 by real income from Table 4, we get Maddison's implied price level. Since the US leads in nominal terms but trails in real

[10] See Deane (1968).

[11] Maddison (1995, 2001) does not provide nominal income.

output, this requires a lower US price level. According to Maddison's estimates, the UK should have a lower price level for all years. It is easy to show his estimates imply that UK prices are around eighty percent of US levels between 1830 and 1870. As a largely rural economy exporting food, we would expect lower US prices. Certainly, many contemporary observers were of this opinion.[12]

As mentioned earlier, differences between benchmarks and projections occur in all international comparisons. These differences arise due to differences in weights, goods sampled and the procedures used to calculate growth rates.[13] Nonetheless, the scale of the discrepancies between our estimates and the Maddison (2001) projections is dismaying. Fortunately, we can explain them in a straightforward fashion.

Recall that Maddison compares output in 1990 prices. This means that he projects US and UK output to all years in his series starting from a 1990 benchmark comparison. As it turns out, the choice of base year is fundamental. In third column of Table 4, we project UK/US income per capita using 1950 prices from Gilbert and Kravis (1954).

[12] Senior (1830, page 2) implies a GB/US price level of 156 while Carey (1835, page 223-224) puts it at 132. See also Cairnes (1874).

[13] There is now a substantial literature on reconciling benchmarks and projections. Recent work includes Aten and Heston (2002) and Dalgaard, E. and H. S. Serensen (2002).

Table 4
Comparing Estimates: UK/US Real GDP Per Capita.
US = 100

| | *Maddison Projections* | | Benchmark | Short Cut Estimates |
|---|---|---|---|---|
| | 1990 Prices | 1950 Prices | | |
| 1820 | 127 | 87 | Na | 87 |
| 1830 | 119 | 82 | 68 | 91 |
| 1840 | 118 | 81 | 76 | 88 |
| 1850 | 121 | 83 | 72 | 90 |
| 1860 | 121 | 83 | 75 | 88 |
| 1870 | 122 | 84 | 90 | 91 |

*Notes and Sources:* Updated estimates of real GDP per capita in 1990 prices from http://www.eco.rug.nl/~Maddison/ transformed to Fisher Ideal using information on C-6 page 172 of Maddison (1995). Adjusted from borders of 1990 using Table H-2 page 132 from Maddison (1995). We used 1950 benchmark from Ward and Devereux (2003) as derived from Gilbert and Kravis (1954) to transform the Maddison estimates to 1950 prices. The short cut estimates are from Prados de la Escosura (2000) Table 9 Page 24. His estimates are in US prices. We transform them to a Fisher Ideal basis using information on Fisher and Paasche adjustment factors for 1970, 1975, 1980, 1985 and 1990 from Tables C-2 through C-6 pages 170 to 172 from Maddison (1995)

The projections in 1950 prices show the US ahead for all years. We obtain similar results if we project UK/US GDP using 1925-1934 prices from Clark (1940), 1937 prices from Rostas (1948), 1960 prices from Dennison (1967) or 1965 prices from Maddison (1983). This suggests that for UK/US GDP projections, the important differences are not between direct comparisons and long span projections *per se* but rather the set of base year prices used to compare output.[14] As we have seen, the closer the base year prices to the period compared the more likely the US is ahead.

There are good reasons to prefer 1950, 1937 or 1930 prices to 1990. Most obviously, the structure of relative prices in 1950 is closer to the period in which we are

[14] This explains the results of Clark (1940) and Gallman (1966). Gallman (1966) compares GB/US income using exchange rates, a sectoral comparison and a long span projection with 1950 prices. His projection shows GB/US income as 90 in 1840, Table 1 page 5. Clark (1940) projects output per worker using 1925-

interested. Second, there are well-documented differences between benchmarks and projections for the post-1950 period.[15] For example, using 1990 prices, 1950 UK/US income per capita is seventy. With 1950 prices, income per capita in 1950 is forty-seven.[16] These differences are transferred to projections over longer time spans, distorting the results.

(c) Short-cut estimates

Finally, we consider the "short cut" UK/US GDP comparisons provided by Prados de la Escosura (2000). He derives his GDP comparisons by estimating a reduced form relationship between relative price levels from the International Comparison Project and other economic variables for post-1950. Then he uses his model to estimate price levels and relative GDP for earlier years. His approach is similar to ours in that his GDP comparisons are in current international prices. The final column of Table 5 gives his estimates UK/US comparison. The US is ahead for all years.

To sum up, the results from four standard approaches to long run income comparisons, long span projections, direct expenditure benchmarks, sectoral comparisons and "short cut" methods, yield similar results. They show the US leads the UK in terms of income per capita and output per worker between 1830 and 1870. Heartened by these

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1934 prices for 1860 and 1870. His estimates imply income per capita was equal while US output per worker was higher, see Clark (1940) pages 79, 83 and 147.

[15] See Prados de la Escosura (2000).

[16] This is discussed in Ward and Devereux (2004b). In addition, Daalgard and Serensen (2002), and Varjonen (2001) provide evidence of differences between benchmarks and projections for OECD countries between 1990 and 1998.

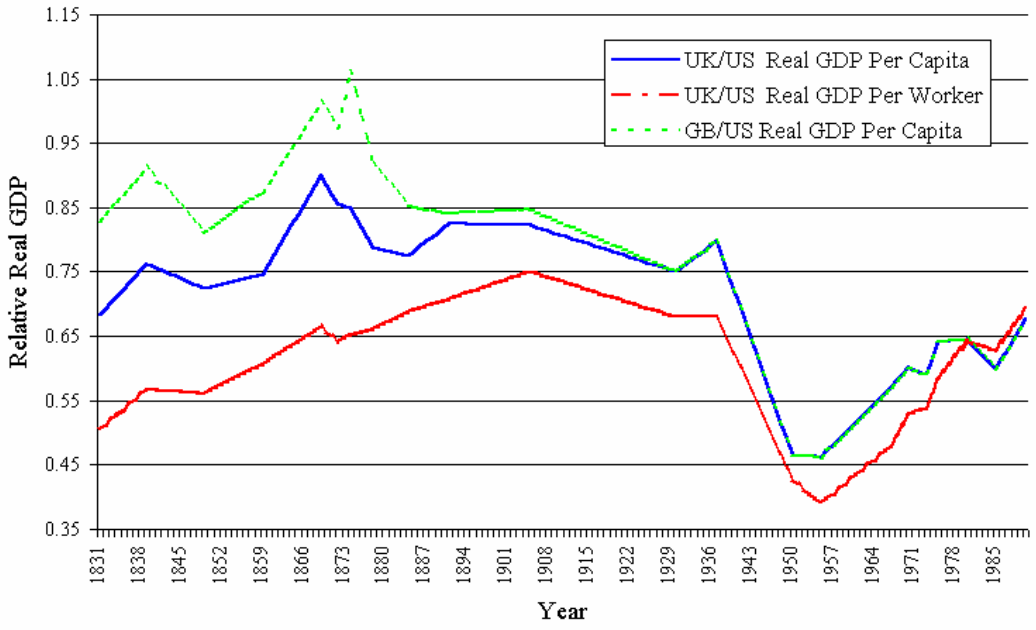
results, we now turn to long run trends in UK/US income per capita and output per worker.

## 5. A Longer Run Perspective

Figure 1 tracks income per capita and output per worker from 1831 to 1990 by linking our UK/US and GB/US estimates for 1831-1869 to Ward and Devereux (2003).

Figure 1

Relative Income, 1831-1990




Consider first the UK case. The US begins the period with a commanding lead in income per capita and output per worker. Strikingly, the UK improves in a relative sense after 1830. UK catch-up in terms of output per worker is more impressive than income per capita. UK output per worker is half US levels in 1931. It reaches seventy-five

percent of US levels by 1891. During the same period, per capita incomes increased from seventy percent of US levels to eighty percent.

These income and productivity levels are maintained until the First World War. It is then that the UK begins its relative decline. The low point is 1950 where UK incomes are forty-five percent of US levels. The UK recovers in the post-war period reaching seventy percent of US levels by the 1970's, a position maintained to the present.

The British experience relative to the US was different in several respects. First, notice that the per capita US lead over Great Britain at the beginning of the period is much smaller than for the UK.[17] In addition, Britain draws even with US income levels by the early 1870s. This is followed by a decade of rapid decline relative to the US. By the 1890s, the gap between British and UK income levels is all but gone. As with the UK, Britain maintains its position relative to the US until the eve of World War One. Thereafter, British and UK income levels follow similar paths relative to the US.

Figure 1 suggests that American leadership in living standards and productivity is long standing. It dates at least to the early part of the nineteenth century. These results raise questions about the sources of American prosperity. The literature on American primacy, guided perhaps by Maddison, has focused on the period after 1870 and in particular on industrialization. It may well be that the real issue lies in explaining the high levels of income per capita and output per worker early on when the US was a largely agricultural economy.

From the British perspective, its position relative to the US in Figure 1 adds fuel to long-standing debates about growth and living standards. The evidence regarding the

[17] Recall, however, that looking at per capita incomes places Britain in the best possible light. In terms of output per worker, British incomes relative to the US are much lower see Tables 1 and 2.

relatively slow rates of output and productivity growth during this period has long raised questions about the revolutionary character of the British industrial revolution. The higher income and productivity in the US raises yet more questions. On the other hand, the UK's performance relative to the US is impressive for the Victorian era considering the UK either improves or maintains its position relative to the US for most of this period.[18]

## 6. The Price Benchmarks

To this point, we have provided few details about the price benchmarks on which our expenditure comparisons are based. It is to this task that we now turn. We discuss our price data, expenditure shares and the adjustment for urban-rural price differences.

We begin with prices. Table 5 shows our UK/US relative prices. With the exception of food, we give aggregated results. As far as possible, we use retail price data. For the US, the Weeks Report provides comprehensive coverage after 1851. Before 1851, we use data for Massachusetts from the pioneering study of Carroll D. Wright (Mass (1885)) supplemented by Adams (1986, 1992) for Maryland and West Virginia.

The British sources are more scattered. Ashton (1949), Neale (1966) and Brassey (1873) provide retail price series for particular localities. They cover only a small portion of our period. We supplement them with retail prices from Caird (1878), Burnett (1965), Chadwick (1860), Dodd (1951), Edmonds (1839), McKenzie (1921), Mitchell (1971,1988), Porter (1850) and Purdy (1861) as well as the institutional sources used by Feinstein (1995, 1998).

[18] McCloskey (1970) argues the UK performed well relative to the US during this period.

Table 5: Relative UK/US Consumption Prices, 1831-1869

US = 100

| | 1831 | 1839 | 1849 | 1859 | 1869 |
|---|---|---|---|---|---|
| Food | 229 | 177 | 168 | 145 | 151 |
| Bread | 130 | 165 | 94 | 95 | 93 |
| Wheat Flour | 273 | 140 | 168 | 133 | 234 |
| Potatoes | 338 | 178 | 86 | 109 | 114 |
| Beef | 253 | 174 | 179 | 170 | 170 |
| Mutton | 313 | 275 | 323 | 187 | 180 |
| Pork | 193 | 128 | 169 | 147 | 127 |
| Bacon | 264 | 165 | 236 | 186 | 179 |
| Milk | 121 | 111 | 107 | 101 | 102 |
| Butter | 175 | 104 | 123 | 140 | 127 |
| Cheese | 269 | 177 | 169 | 135 | 123 |
| Tea | 280 | 260 | 252 | 159 | 88 |
| Coffee | 341 | 366 | 309 | 214 | 156 |
| Sugar | 212 | 203 | 161 | 132 | 88 |
| Alcohol | 138 | 92 | 88 | 90 | 101 |
| Tobacco | 718 | 460 | 385 | 350 | 486 |
| Housing | 82 | 98 | 112 | 100 | 74 |
| Fuel | 111 | 48 | 65 | 59 | 54 |
| Light | 111 | 84 | 92 | 89 | 83 |
| Soap | 101 | 116 | 154 | 84 | 106 |
| Clothing | 62 | 62 | 71 | 71 | 71 |
| Domestic Service | 87 | 104 | 162 | 155 | 125 |
| Transportation | 90 | 92 | 89 | 91 | 104 |
| **Consumption** | 172 | 134 | 137 | 121 | 123 |
| **Investment** | 46 | 54 | 50 | 69 | 52 |
| **Government** | 60 | 57 | 56 | 61 | 59 |
| **Overall** | 156 | 122 | 123 | 112 | 110 |

*Notes and Sources*: See text.

Our price data refer to mostly urban prices. To compare GDP, we need national prices. We change just food and rent, as we find no evidence for urban/rural spreads for other items. We estimate UK urban rents as twice rural rents based on evidence in Hunt (1973). We found no differences between UK urban and rural food prices. The US food price adjustments are from Brady (1972) and Hatton and Williamson (1991). We estimate the urban-rural food price spread as twenty-three percent for 1831-1849 and fifteen percent for 1859 and 1869. For rent, we use Hatton and Williamson's (1991) estimate of an urban-rural rent spread of one hundred and thirteen percent for Michigan in 1891.[19] Urbanization rates are from Bairoch and Goertz (1986).

From Table 5, food prices are higher in the UK. The largest price gaps are early suggesting increased market integration as the nineteenth century proceeds. UK food prices are twice American levels in 1831. Forty years later, the gap is down to fifty percent.[20]

UK prices for tobacco are consistently higher due to taxes.[21] Alcohol prices are lower in the UK for most years. Our alcohol comparison is for beer as we are unable to adjust for quality differences between American and British whiskey. This understates

[19] Seamen (1852) page 278, finds a spread of fifty percent between rural and urban prices. This is greater than our estimates. It appears that Seamen's refers to farm-gate/urban price differences for food rather than the urban/rural retail spread. Nonetheless, we suspect that our estimates understate US rural/urban retail spreads. Evidence in support of this comes from Adams (1986, 1992) who shows much lower rural prices for Maryland and West Virginia as compared to our US estimates.

[20] Using the methods explained in Table 3, we compared UK/US farm gate prices from 1830 to 1870. The results are close to Table 5. We find UK/US farm gate prices are 230 for 1830, 206 for 1840, 167 for 1850, 162 for 1859 and 148 for 1870. This supports our food price benchmarks. There is also close agreement for individual food items.

[21] The higher British prices of tea and coffee are also due to taxes.

the relative British alcohol price level since the price of American whiskey is extraordinary low. [22]

Fuel and light prices are similar for both countries. We use the relative price of candles for light prices. We proxy fuel costs by coal. The drawback of our approach is that the main source of US fuel is firewood. We omit firewood, as we were unable to obtain a satisfactory British series.[23] This biases the relative British/US cost of fuel downwards.

For clothing, US prices are higher due to protection. Fearon (1818) supplies an estimate for 1818. We have a second clothing benchmark for 1872 from Ward and Devereux (2003b). We use US tariff rates to interpolate between these benchmarks. Our estimates likely overstate the British advantage as they exaggerate the protection afforded to American cottons.[24]

We have information on urban US rents from the Weeks Report, Margo (1996) and Brady (1964) among other sources. We found no similar data for the UK. In the absence of this information, we projected 1872 UK rents from Young (1875) backwards using Feinstein's (1998) rent index. The results show slightly higher overall US rents

[22] Contemporary observers note the low US prices for spirits, see Rorabaugh (1979).

[23] Data on firewood prices is limited for Great Britain. In addition, units of measurement are not always clear. There is no doubt, however, that US firewood is cheaper.

[24] The US cotton industry appears to be competitive at least in the lower quality items early on. Of course, this is the view of Taussig (1931). For a restatement of the Taussig thesis, see Irwin and Temin (2001).

except for 1849 and 1859.[25] Remember our estimates are for the overall economy. The relative housing costs in US urban areas is above UK levels for all years.[26]

We have two service items, transportation and domestic services. Before 1849, we base our transportation costs on coach rates from Hawke (1970) and Fishlow (1965, 1966). For 1859 and 1869, our estimates refer to passenger rail rates per mile.

Following the tradition in the international comparison literature, we compare costs of domestic service using wage rates and including board. We use Lebergott (1964) for the US and Feinstein (1996) for Great Britain. We expected higher American wages for domestics. As it turned, these sources show substantially higher UK wages. We believe that our estimates overstate relative British wages. The overall bias is minor, however, given the small share of domestic service in total expenditure.

For investment, we use bilateral Fisher indices for construction plus equipment and machinery. We estimate the construction benchmark with materials prices and construction wages. The materials prices are wholesale prices for pig iron, bar iron, and copper. We take the UK prices from Mitchell (1971) and the Aldrich Report. US prices are from Cole (1938), Temin (1964) and the Aldrich Report. Our British construction wages are from Bowley (1901) and Feinstein (1996) while US wages are from Adams (1970), the Aldrich Report and Coelho and Sheppard (1976). The equipment and machinery benchmarks use wholesale price data for iron. For all years, wages and iron prices are lower in the UK. As a result, the UK investment price level is below the US.

[25] Clark (2002b) provides an alternative British rent series. Using his series, we find higher relative UK rents.

[26] As shown later, US construction costs are higher, which is consistent with the higher rental costs. Wage costs accounted for fifty percent of US housing costs during this period, see Adams (1975) and David and Solar (1977). Henry Carey (1835) emphasizes higher US interest rates as a factor explaining higher rents.

For government, we use UK/US relative prices for civilian and defense expenditures. The civilian price index is a weighted average of relative nominal wages and the geometric mean of rent, fuel and light prices from the consumption index. The defense price index is a weighted average of relative nominal wages and the geometric mean of the construction, equipment and machinery, fuel and clothing relative prices.

We took the overall British consumption, investment and government weights from Deane and Cole (1967) and Feinstein (1972). For the US, we take investment shares from Gallman (2000) and government shares from Trescott (1960). Consumption shares are calculated as a residual.

We had more trouble finding studies relating to economy-wide consumption patterns. In general, there is more information for Britain. This is because of greater British interest in poverty. Starting from the investigations of Eden (1795), each economic downturn spawned a host of budget studies for the poor and the working class. There is less information on the consumption patterns of the middle class or the well to do. For food and other consumption weights we relied heavily on Horrell (1996) supplemented by Feinstein (1998) and the consumption weights from Ward and Devereux (2003).

For the US, there are no systematic investigations of consumption patterns before the 1870's. Brady's (1972) individual weights for 1830 were later incorporated in the weights provided by David and Solar (1977). We take our US consumption item weights from David and Solar (1977) and Ward and Devereux (2003).

Table 6 provides the expenditure weights for the main consumption categories.

Table 6: US and British Consumption Weights, 1831-1869.

| **US** | 1831 | 1839 | 1849 | 1859 | 1869 |
|---|---|---|---|---|---|
| Total Food | 0.404 | 0.404 | 0.427 | 0.427 | 0.427 |
| Alcohol | 0.031 | 0.031 | 0.081 | 0.081 | 0.081 |
| Tobacco | 0.017 | 0.017 | 0.026 | 0.026 | 0.026 |
| Housing | 0.184 | 0.184 | 0.171 | 0.171 | 0.171 |
| Fuel | 0.062 | 0.062 | 0.021 | 0.021 | 0.021 |
| Light | 0.010 | 0.010 | 0.003 | 0.003 | 0.003 |
| Soap | 0.003 | 0.003 | 0.004 | 0.004 | 0.004 |
| Clothing | 0.216 | 0.216 | 0.200 | 0.200 | 0.200 |
| Domestic Service | 0.031 | 0.031 | 0.029 | 0.029 | 0.029 |
| Transportation | 0.042 | 0.042 | 0.037 | 0.037 | 0.037 |
| | | | | | |
| **Great Britain** | | | | | |
| Total Food | 0.667 | 0.597 | 0.597 | 0.502 | 0.502 |
| Alcohol | 0.101 | 0.117 | 0.117 | 0.133 | 0.133 |
| Tobacco | 0.012 | 0.009 | 0.009 | 0.017 | 0.017 |
| Housing | 0.059 | 0.103 | 0.103 | 0.102 | 0.102 |
| Fuel | 0.061 | 0.026 | 0.026 | 0.045 | 0.045 |
| Light | 0.011 | 0.012 | 0.012 | 0.014 | 0.014 |
| Soap | 0.011 | 0.012 | 0.012 | 0.004 | 0.004 |
| Clothing | 0.061 | 0.086 | 0.086 | 0.114 | 0.114 |
| Domestic Service | 0.007 | 0.015 | 0.015 | 0.027 | 0.027 |
| Transportation | 0.011 | 0.023 | 0.023 | 0.041 | 0.041 |

*Notes and Sources: US weights*: We use the 1872 consumption weights from Ward and Devereux (2003) for 1849, 1859 and 1869. Excluded items were distributed proportionately among the remaining categories of food and non-food items. Individual item weights for 1831 and 1839 are taken largely from David and Solar (1977). Fuel, Light, Soap and Domestic Service are taken from the 1872 weights in Ward and Devereux (2003). Remaining weights were distributed proportionately across all consumption categories. 1872 weights are used for 1869.
*British weights*: We use the 1872 weights from Ward and Devereux (2003) for 1859 and 1869.Individual item weights for 1831-1849 are from Horrell (1996). Alcohol and clothing are from Feinstein (1998). Services were taken as a residual after adding up all other categories. Domestic service and transportation are distributed in the same portions as the 1872 weights. 1801 weights are used for 1831, and 1841 weights are used for 1839 and 1849.

The most striking difference between the US and British consumption patterns is the smaller US share of food. This reflects lower US food prices. It may also be due to higher US living standards and lower levels of urbanization. Other notable differences in consumption patterns are the higher portion of British budgets devoted to alcohol and the lower shares for housing and clothing.

## 7. Concluding Comments

We have offered tentative estimates of UK and American living standards and output per worker for the crucial years between 1830 and 1870. During this period, the UK experienced the full force of the industrial revolution and the US became an economic powerhouse. Our estimates reveal that the US held the lead in income per capita and output per worker for this period when compared to both Great Britain and the United Kingdom. We have shown that these findings are consistent with the various approaches to international GDP comparisons. They are consistent with comparisons based on sectoral productivity and "short cut" GDP estimates. They are also consistent with long span projections, such as those of Maddison (1995, 2001) so long as we use a relative price structure that is close in time to the period compared.

The next step in our research is to refine our estimates. In particular, the fact that we have to rely on price data not collected specially to compare prices internationally hampers our work. One way around this problem may lie in the many emigrant guides published for potential immigrants to the US during these periods. These may partially substitute for the price surveys that form the basis for modern international GDP

comparisons.[27] Our expenditure shares also need work as do our urban/rural adjustments. We suspect however that these extensions will not change our conclusion regarding the relative standing of the US. In the first place, our price data are consistent with wholesale and farm gate price data. Second, the results are not sensitive to changes in expenditure shares.

Can we extend our estimates further back in time? Here we are less optimistic. The constraint we face here is nominal GDP.[28] We do not possess a US series for nominal GDP before the 1830's.[29] The British and UK nominal GDP estimates before 1830 remain controversial.[30] Without nominal GDP, we cannot provide direct expenditure comparisons between Britain and America.[31] Further progress on UK/US comparisons will have to depend on GDP projections complemented by real wage comparisons. Our estimates can help in both regards by providing benchmarks for GDP projections or real wage comparisons that reflect patterns of relative prices relevant to the period compared.

[27] Fearon (1818), for example, provides detailed price benchmarks for the major US cities of the period.

[28] For this study, we managed to construct price benchmarks for the UK/US back to 1801. But without nominal GDP we cannot compare real GDP

[29] David (1967) and Weiss (1994) provide GDP for earlier years but their procedure does not yield nominal GDP estimates.

[30] See Clark (2001).

[31] We can make progress before 1831 for individual industries. Consider agriculture. Using Towne and Rasmussan (1960) and Weiss (1993) for the US and Deane and Cole (1967) for Great Britain, we can compare agricultural output per worker back to 1801.

References

Adams, D. (1968). "Wage Rates in the Early National Period: Philadelphia, 1785-1830" *Journal of Economic History* 28: 404-426.

_____ (1970) Some Evidence on English and American Wage Rates, 1790-1830 *The Journal of Economic History*, 30: 499-520.

_____ (1975) Residential Construction Industry in the Early Nineteenth Century *The Journal of Economic History*, 35: 794-816.

_____ (1986) "Prices and Wages in Maryland, 1750-1850" *The Journal of Economic History*, 46: 625-645.

_____ (1992) "Prices and Wages in Antebellum America: The West Virginia Experience" *The Journal of Economic History*, 52: 206-216.

Aten, B. and A. Heston (2002) "Benchmark Reconciliations Revisited" Unpublished Manuscript. University of Pennsylvania.

Ashton, T. S. (1949)"The Standard of Life of the Workers in England. 1790-1830" *The Journal of Economic History*, Vol 9. 19-38.

Bairoch, P. and G. Goertz. (1986) "Factors of Urbanization in the Nineteenth Century Developed Economies: A Descriptive and Econometric Analysis" *Urban Studies* 23, no. 4: 285-305.

Barger, Harold. (1955) *Distributions Place in the American Economy since 1869.* Princeton: Princeton University Press,

Bowley, A.L (1901). "The Statistics of Wages in the United Kingdom during the Last Hundred Years (Part VIII) Wages in the Building Trades—Concluded. London" *Journal of the Royal Statistical Society* 64: 102-112.

Brady, D, (1964) "Relative Prices in the Nineteenth Century" *The Journal of Economic History*, Vol 24: 145-203.

_____. (1972) "Consumption and the Style of Life" in *American Economic Growth*. Lance Davis, Richard Easterlin and William Parker (eds) Harper and Row.

Brassey, T. (1872) *Work and Wages Practically Illustrated*. London.

Broadberry, S. (1997) "Forging Ahead, Falling Behind, and Catching-Up: A Sectoral Analysis of Anglo-American Productivity Differences, 1870-1990", *Research in Economic History*, 17: 1-37.

_____ (2003) "Relative Per Capita Income Levels in the United Kingdom and the US since 1870" *Journal of Economic History* 63: 852-863.

Broadberry, S. and D. Irwin (2003) "Labor Productivity in Britain and America during the Nineteenth Century." Working paper,

Burnett, J. (1966) *Plenty and Want*. Nelson. London.

Carey, H. C. (1835) *Essay on the Rate of Wages*. Philadelphia.

Caird, J. (1878) *The Landed Interest and the Supply of Food*. London. Cassel

Cairnes, (1874) *Some Leading Principles of Political Economy Newly Expounded*. New York. Harper.

Chadwick, D. (1860) "On the Rate of Wages in Manchester and Salford, and the Manufacturing Districts of Lancashire, 1839-59" *Journal of the Statistical Society of London*, Vol 23: 1-36.

Clark, C. (1940) *The Conditions of Economic Progress* First Edition. London, Macmillan.

_____ (1957) *The Conditions of Economic Progress* 3rd ed. London: Macmillan.

Clark, G. (2001) "The Secret History of the Industrial Revolution" Working Paper.

_____ (2002a) "Shelter from the Storm: Housing and the Industrial Revolution 1550-1912" *Journal of Economic History* 62, no. 2.

_____ (2002b) "The Price History of English Agriculture" Unpublished. Davis.

Cole, A. (1938) *Wholesale Commodity Prices in the United States, 1700-1861: Statistical Supplement* Harvard University Press. Cambridge. Mass.

Coehlo, P. and R, Shepherd (1976) "Regional Differences in Real Wages: The United States, 1851-1880" *Explorations in Economic History* 13: 203-230.

Dalgaard, E. and H. S. Serensen (2002) "Consistency Between PPP Benchmarks and National Price and Volume Indices" Unpublished OECD.

David, P. (1967) "The Growth of Real Product in the United States before 1940; New Evidence, Controlled Conjectures" *Journal of Economic History* 27:151-197.

David, P. and P. Solar, (1977). "A Bicentenary Contribution to the History of the Cost of Living in America," Pages 1-80 in Volume 2 of *Research in Economic History*, Greenwich: JAI Press, Inc.

Deane. P. (1968) "New Estimates of Gross National Product for the United Kingdom, 1830-1914" *Review of Income and Wealth* 14, No. 2.

Deane. P. and W.A.. Cole, (1967) *British Economic Growth, 1688-1959* Cambridge. Second edition.

Dennison, E. (1967) *Why Growth Rates Differ*. Brookings. Washington.

Dodd, A. H. (1951) *The Industrial Revolution in North Wales*. University of Wales Press.

Eden, F. M. (1797) *The State of the Poor* London. J. Davis.

Edmonds, R. (1839) "A Statistical Account of the Parish of Madron" *Journal of the Society of London* 4: 198-223

Fearon, H. (1818) *A Narrative of a Journey Through America*. Longman. London

Feinstein, C. H. (1972) *National Income, Expenditure and Output of the United Kingdom 1855-1965* Cambridge University Press. Cambridge.

_____. (1995) "Changes in Nominal Wages, the Cost of Living and Real Wages in the United Kingdon over Two Centuries, 1780-1990" in P. Scholliers and V. Zamagni (eds) *Labour's Reward: Real Wages and Economic Change in 19th and 20th Century Europe* E. Elgar. Brookfield VT.

_____. (1996) "Conjectures and Contrivances: Economic Growth and the Standard of Living in Britain during the Industrial Revolution" Unpublished.

_____. (1998) "Pessimism Perpetuated: Real Wages and the Standard of Living in Britain During and After the Industrial Revolution" *Journal of Economic History* 58:3, 625-658.

Fishlow, A. (1965) *American Railroads and the Transformation of the Ante-Bellum Economy*. Harvard University Press. Cambridge. Mass.

_____(1966) "Productivity and Technological Change in the Railroad Sector, 1840-1910" *NBER Studies in Income and Wealth* 30 : 583-646.

Gallman, R. (1960) "Commodity Output, 1839-1899" *NBER Studies in Income and Wealth* 24: 13-71.

_____.(1966) "Gross National Product in the United States, 1834-1909" *NBER Studies in Income and Wealth* 30 (1966): 3-76.

_____ (2000) "Economic Growth and Structural Change in the Long Nineteenth Century" in *The Cambridge Economic History of the United States,* edited by Stanley Engerman and Robert Gallman. Cambridge University Press.

Gallman, Robert and Thomas Weiss (1969) "The Service Industries in the Nineteenth Century" *NBER Studies in Income and Wealth* 34: 287-365.

Gilbert, Milton, and Irving Kravis. (1954) *An International Comparison of National Products and the Purchasing Power of Currencies.* Paris: OEEC.

Hatton, T. and J. Williamson. (1991) "Wage Gaps Between the Farm and the City: Michigan in the 1890s" *Explorations in Economic History*. 51: 605-632.

Hawke, G. (1970) *Railways and Economic Growth in England and Wales 1840-1870.* Oxford University Press.

Horrell, Sara (1996) "Home Demand and British Industrialization" *Journal of Economic History* 56:3, 561-604.

Hunt, E. H. (1973) *Regional Wage Variations in Great Britain: 1850-1914* Oxford: Clarendon Press.

Irwin, D. and P. Temin. (2001) "The Antebellum Tariff on Cotton Textiles Revisited" *Journal of Economic History* 61: 777-798.

Jefferys, J. and D. Walters "National Income and Expenditure in the United Kingdom:1870 -1950" (1955) *Income and Wealth,* Series V, edited by Simon Kuznets. London: Bowes and Bowes.

Kendrick, John W. (1961) *Productivity Trends in the United States*. Princeton: Princeton University Press.

Lebergott, S. (1964) *Manpower in Economic Growth* McGraw-Hill, New York.

Maddison, A. (1995) *Monitoring the World Economy 1820-1992*, Paris: Development Center of the Organization for Economic Co-Operation and Development.

_____ (2001) *The World Economy: A Millennial Perspective*, Paris: Development Center of the Organization for Economic Co-Operation and Development, 2001.

_____ (2004) "Macro-measurement before and after Colin Clark" Unpublished.

MacKenzie, W. A. (1921) "Changes in the Standard of Living in the United Kingdom, 1860-1914" *Economica* 3: 211-230.

McCloskey. D. (1970) “Did Victorian England Fail” *Economic History Review* 23: 446-459

Margo, R. (1996) "The Rental Price of Housing in New York City" *Journal of Economic History* 56: 605-625.

Massachusetts Bureau of Statistics of Labor (1885). “*Sixteenth Annual Report of the Massachusetts Bureau of Statistics of Labor* Boston: Wright and Potter Printing Co., State Printers.

Matthews, R.C.O., C.H. Feinstein, and J. C. Odling-Smee. (1982) *British Economic Growth 1856-1973.* Stanford: Stanford University Press.

Mitchell, B. R and P. Deane (1962). *Abstract of British Historical Statistics* Cambridge University Press.

Mitchell, B. R. (1971). *Abstract of British Historical Statistics* Cambridge University Press.

Mitchell, B.R. (1988) *British Historical Statistics* Cambridge University Press.

Mitchell, B. R. (1998). *International Historical Statistics: Europe, 1750-1993* New York: Stockton Press

Neale, R. S. (1966) "The Standard of Living: A Regional and Class Study" *Economic History Review*. 29:

Neild, W. (1842) "Comparative Statement of the Income and Expenditure of Certain Families of the Working Class in Manchester and Dukinfield, in the Years 1836 and 1841" *Journal of the Statistical Society of London*, Vol 4: pp. 320-334.

Ojala, E.M. (1952) *Agriculture and Economic Progress*. Oxford: Oxford University Press,

Paige, D. and G. Bombach. (1959) *A comparison of National Output and Productivity of the United Kingdom and the United States*. Paris: Organization of European Economic Cooperation.

Porter, G. R. (1850) "On a Comparative Statement of Prices and Wages During the Years from 1842 to 1849" *Journal of the Statistical Society of London*, Vol 13: 210-218.

Prados de la Escosura, L. (2000) “International Comparisons of Real Product, 1820–1990: An Alternative Data Set” *Explorations in Economic History* 37: 1-41.

Purdy, F. (1861) "On the Earnings of Agricultural Labourers in England and Wales" *Journal of the Statistical Society of London*, 24: pp. 328-373.

Rorabaugh, W. J. (1979) *The Alcoholic Republic: An American Tradition*. New York: Oxford University Press,

Rostas, Lazlo. (1948) *Productivity Prices and Distribution in Selected British Industries*. Cambridge: Cambridge University Press.

Seaman, E. (1852) *Essays on the Progress of Nations* Scribner. New York.

Senior, N. (1830) *Three Lectures on the Cost of Obtaining Money*, London: John Murray.

Towne, Marvin W. and Wayne D. Rasmussen (1960) "Farm Gross Product and Gross Investment in the Nineteenth Century" *NBER Studies in Income and Wealth* 24: 255-312.

Taussig, F. W. (1931) *The Tariff History of the United States* New York.

Temin, P. (1964) *Iron and Steel in Nineteenth Century America* M.I.T. Press.

Trescott, P. (1960) "The United States Government and National Income, 1790-1860" *NBER Studies in Income and Wealth* 24: 337-361.

Turner. M. (1996) *After the Famine: Irish Agriculture 1850-1914*. Cambridge University Press.

United States Congress. House of Representatives. (1886) *Reports on the Average Retail Prices of the Necessaries of Life in the United States.* Report prepared by Joseph D. Weeks for the Tenth Census of the United States. Washington: GPO.

United States Congress. Senate. Committee on Finance (1893). *Wholesale Prices, Wages and Transportation* Washington. GPO. Aldrich Wholesale Price Report.

Van Zanden, J. (2003) Rich and Poor Before Industrial Revolution: A Comparison between Java and the Netherlands at the Beginning of the Nineteenth Century" *Explorations in Economic History*. 40: 1-23

Varjonen, Seppo. (2001) "Consistency Between GDP Based on PPPs and National Accounts Time Series" OECD Unpublished.

Ward, M. and J. Devereux. (2003) "Measuring British Decline: Direct Versus Long Span Income Measures" *Journal of Economic History*. 63, no. 3: 826-851.

_____ (2004a) "A Reply to Professor Broadberry" Forthcoming, *Journal of Economic History*.

_____ (2004b) "Why America? UK/US Productivity Estimates Reconsidered. Working paper.

Weiss, T. (1992) "U.S. Labor Force Estimates and Economic Growth, 1800-1860." In *The Standard of Living in the United States before 1860*, R. Gallman and J. Wallis, editors. Chicago: University of Chicago Press.

_____(1993) "Long Term Changes in US Agricultural Output per Worker 1800-1900" *Economic History Review* 46: 324-341

_____ (1994) "Economic Growth Before 1860: Revised Conjectures" in T. Weiss and D. Schaefer *American Economic Development in Historical Perspective*. Stanford University Press.

Young, E. (1875). *Labor in Europe and America: A Special Report on the Rates of Wages, the Cost of Subsistence, and the Conditions of the Working Classes in Great Britain, France, Belgium, Germany, and other countries of Europe, also in the United States and British America*. Philadelphia: S. A. George and Company.

## Appendix Reconciling the Sectoral Estimates

Broadberry (1997) provides UK/US sectoral productivity estimates for 1870. Table 1a compares his estimates to ours.[32]

Table 1a
Comparing Sectoral Productivity Estimates for 1870.
US = 100

| | Broadberry (1997) | Benchmark |
|---|---|---|
| Agriculture | 115 | 51 |
| Mining | 97 | 97 |
| Manufacturing | 55 | 55 |
| Construction | 104 | 77 |
| *Commodities* | 95 | 60 |
| | | |
| Trade | 149 | 59 |
| Transportation | 91 | 55 |
| Public Utilities | 179 | 179 |
| Finance/services | 156 | 100 |
| Government | 87 | 100 |
| *Services* | 111 | 76 |
| | | |
| Total GDP | 108 | 71 |

**Notes and Sources**: Table 4 for the benchmark estimates. Broadberry (1997) Table 3, pg.7

Broadberry (1997) derives his estimates by projecting Rostas's 1937 benchmark with sectoral output indices. The results show overall UK/US output per worker at 108.

[32] Broadberry and Irwin (2003) provide a benchmark for 1860 but similar problems apply.

At the sectoral level, he shows much higher levels of UK output per worker for agriculture, construction, trade, transportation and finance and services.

The key sector is agriculture. Broadberry places relative UK output per worker for agriculture at 115 for 1870. This is more than double our estimate. We have strong reasons to skeptical of this estimate. First, since his results apply to the United Kingdom they imply substantially higher labor productivity for British agriculture as compared to the UK.[33] They also imply that output per worker for Irish agriculture was seventy percent of US levels. We doubt whether this is the case.

Second, the Broadberry estimates have the implausible implication that UK farm gate prices were lower than the US. Using standard estimates of value added in agriculture, Gallman (1960) for the US and Feinstein (1972) for the UK, we find that Broadberry's agricultural estimates require a UK/US price level of 66. This is highly unlikely given what we know about transport costs and wholesale price levels. Our estimates suggest UK farm-gate prices were fifty percent higher.

Why does Broadberry overstate UK labor productivity for agriculture? The explanation is straightforward. For the US, he projects his 1937 benchmark using gross output from Kendrick (1961). For the UK, he uses valued added from Feinstein (1972). As US agriculture increased the use of inputs from outside agriculture after 1870, gross output grew much faster than valued added. Thus, Broadberry overstates the growth of US value added and understates the level of output per worker for 1870. If we replace gross output with the correct measure, valued added, we get estimates that are close to

[33] Turner (1996) puts output per worker in agriculture at forty eight percent of British levels for 1871 Table 5.2 page 129. Given that Ireland comprised thirty-six percent of the UK agricultural labor force, this implies that labor productivity in British agriculture was forty percent higher than the US!

our agricultural benchmarks. This removes most of the differences in overall output per worker

Table 2a reconciles the estimates of output per worker.

Table 2a
A Reconciliation
US = 100

| | UK/US Output per worker |
|---|---|
| Broadberry (1997) | 108 |
| Replacing agriculture with our benchmark | 82 |
| Replacing construction, trade transportation, services etc and government | 71 |
| Benchmark Estimates | 71 |

We start with his estimate of 108. Next, we replace his agricultural projection with our agricultural benchmark. This yields a UK/US output per worker of eighty-two. Thus, accepting Broadberry's estimates and correcting agriculture we get the US with a substantial lead in overall output per worker for 1870. The next line replaces his projection for other sectors with our benchmarks to yield our estimate in Table 3.