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Feinstein Fulfilled: Updated Estimates of UK GDP 1841-1920

Solomos Solomou and Ryland Thomas

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Keywords: Economic History, Economic Growth, Economic Cycles

JEL classification: E01, N13, O47

Solomos Solomou, University of Cambridge, SS19@econ.cam.ac.uk and Ryland Thomas, Bank of England and ESCoE, ryland.thomas@bankofengland.co.uk.

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2 Dean Trench St
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Solomos Solomou[1]
Faculty of Economics
Austin Robinson Building
Sidgwick Avenue
Cambridge CB3 9DD
UK

Ryland Thomas[2]
Bank of England and
Economic Statistics Centre of Excellence (ESCoE)
Threadneedle Street
London EC2R 8AH
UK

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This paper attempts to bring together some of the improvements to C19th national income estimates since the publication of Charles Feinstein's 1972 volume *National Income, Expenditure and Output of the United Kingdom, 1855-1965.* Most of the improvements and refinements were made by Feinstein himself and this paper makes a start in bringing the different elements together focusing chiefly on reconstructing the income-based estimates, but also outlining where improvements might be made on the output and expenditure sides. We have also incorporated the improvements of other scholars and provided a new set of benchmark compromise estimates. We compare the productivity puzzle of the late C19th and early C20th with that of a similar puzzle observed since the Great Financial Crisis and show that many similar measurement issues are present in both episodes. In particular, we argue that further investigation of the GDP deflator and its sub-components over the 1841-1920 period is warranted.

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[1] Communications to: SS19@econ.cam.ac.uk
[2] Communications to: ryland.thomas@bankofengland.co.uk

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Contents

Introduction

The aim of this paper is to redraw the attention of scholars in economics and economic history to some of the reliability issues in the use of historical national accounts data for the UK over the period 1841-1920. The paper is motivated by the fact that most economists and economic historians continue to rely on the use of the Feinstein (1972) estimate of the compromise series for GDP (the average of the output, income and expenditure estimates) to describe the path of UK GDP. There are two major historical data sets that are used in much of recent research: first, the Maddison/Maddison project (2016) data set; and second, the Barro-Ursua data set. Both data sets have chosen the Feinstein 1972 vintage of the compromise estimate as representative of UK GDP. However Feinstein himself was not satisfied with the reliability of the 1972 vintage of his estimates and produced major revisions to many national income components, especially on the income and expenditure sides of GDP. However, apart from a subset of those revisions appearing in the National Accounts section of Mitchell's (1988) *British Historical Statistics*, the revisions by Feinstein have not been brought together in their entirety. The contribution of this paper is to make a start in fulfilling that aim, focusing on Feinstein's revisions to the income measure of GDP but also discussing his improvements to the expenditure and output measures of GDP.

In addition to Feinstein's revisions, other research by Boyer and Hatton (2002) on unemployment and Geary and Stark on Irish and British wages also have significant implications for the income measure of GDP over this period. Broadberry et al. (2015) have also recently made improvements to the output side for Great Britain (up to 1870) and Andersson and Lennard (2019) have provided estimates for Irish GDP from 1841, benchmarked to the decennial estimates of Geary and Stark (2015). Feinstein himself had also attempted to revise the output side estimates of GDP over the 1870-1913 period but these remain unpublished apart from some provisional estimates for industrial production that appeared in a working paper by Hildreth (1992).

Given the problems Feinstein identified and the efforts he went to in seeking to revise the UK historical national accounts implies the 1972 vintage of his compromise estimate should not be used as his final word on UK GDP. The 1988 estimates that appeared in Mitchell's *British Historical Statistics* are also incomplete as they do not include some important improvements to the data Feinstein made subsequently and some revised sub-components remain unpublished. Various revisions to the components need to be brought together to build an accurate picture of UK GDP over the Victorian and Edwardian periods. This paper makes a start by putting together revised estimates of the UK GDP from the income side between 1855 and 1920 and extending them backwards to 1841, so that a comparison can be made with the input-output table estimate for that year by Horrell et al. (1994). Providing a fully consistent estimate of GDP through improving the output and expenditure side remains a longer term aim and we outline what remains to be done in this regard. But refining the income estimates of GDP makes a start at building this broader picture and provides a useful alternative to the 1972 vintage of the compromise estimate. We also incorporate the extensive work by Geary and Stark in a number of papers by providing estimates of incomes in Great Britain and Ireland.

The paper proceeds in two steps: first we derive an updated estimate of nominal GDP using the income approach, incorporating Feinstein's (1988, 1990 and 1998) revisions to: 1) UK wage earnings; 2) the number of wage earners; 3) the employment rate prior to 1870; and 4) capital consumption. These have a number of implications for each of the income components. In the process we provide annual time series for many of the components of the income accounts that were unpublished by Feinstein but are recoverable through the detailed methodological notes he provided[3]. In addition we also incorporate the work of other scholars. First, we use the Boyer-Hatton (2002) revisions to the Board of Trade measure of unemployment after 1870 to reconstruct total employment in the period after 1870. We also push the income measure back to 1841 using the wage and employment estimates for the industrial revolution based on Feinstein (1998) and Geary and Stark (2004), coupled with the income tax data and the manipulations of it by Bowley, Stamp, Prest and Feinstein. We then compare this with the input-output table estimate of that year constructed by Horrell et al. (1994) and the nominal GDP implied by the new output-based estimates for Great Britain by Broadberry et al (2015) and Ireland by Andersson and Lennard (2019).

In the second section we then use the new data to describe some of the cyclical features of the UK economy over this period. In the light of recent concerns about slow UK productivity we review the apparent productivity slowdown in the late C19th and early C20th. Many of the live issues surrounding the appropriate measurement of productivity today are just as valid for this period. We also look at the behavior of the economy in the 1840-1870 period. Here we compare our income measure of GDP with the existing expenditure measure back to 1830 based on Deane (1968) and Feinstein/Mitchell (1988), and also we construct a new real output measure for the UK implied by the British estimates of Broadberry et al (2015) and Irish estimates of Anderson and Lennard (2019). In the concluding section we update Feinstein's "compromise" estimate of GDP and extend it to 1841. We speculate on further research and revisions that may help refine the series further in future. In particular, our results suggest the expenditure estimate of GDP and its implied deflator, which is used to deflate the income estimate, are worth revisiting in the light of recent research.

[3] These are available at the Nuffiled College library https://www.nuffield.ox.ac.uk/media/2212/feinstein.pdf

1. A revised income measure of GDP – GDP(I)

Of the three approaches to measuring GDP the income estimate is normally thought to provide more accurate information about the cyclical time-profile of the UK economy (Feinstein et al. (1982)). It is now well recognized that both the output and expenditure estimates suffer from the extensive use of linear interpolation and artefact cyclicality, limiting their use for cyclical analysis. However as we shall see the income measure is not completely free of timing issues, especially with regard to profits.

Following Feinstein's (1972) approach there are five components of the income side to estimate.

1. The compensation of wage earners

2. The income of salaried workers

3. The income of employers and the self-employed including farmers' income

4. The gross trading profits of companies, non-profit institutions and general government

5. Income derived from rental on dwellings and the operating surplus of the household sector

Component 1 depends on the construction of wages and employment data. Income tax data cannot be used for wage earnings because, prior to World War 1, the vast majority of wage earners were exempt from tax. Components 2, 3 and 4 depend largely on income tax data but also depend on estimates of 'intermediate incomes' – essentially non-wage incomes that were not subject to income tax. Each of these components is reconsidered in the light of later research by Feinstein and others. The components are also extended back to 1841 using similar methods to that used by Feinstein and his predecessors. The estimate of nominal income then needs to be deflated by the GDP deflator obtained from the expenditure measure of GDP to create a volume measure. The next sections discuss revisions to each of these components in turn.

1.1 The Compensation of wage earners

Compensation of wage earners requires estimates of wage earnings, social contributions (after the introduction of national insurance in 1911) and the employment of wage earners in the working population. Two approaches can be followed here. One can first try and create an index of earnings and adjust the earnings series at the component level for losses due to unemployment and short-term working. This earnings series can then be multiplied by the number of wage earners in the working population to get an estimate of the wage bill. Alternatively an index of 'full employment' weekly earnings can be constructed and this can be multiplied by an estimate of employment where the number of wage earners in the working population is adjusted directly for the number unemployed. We follow the second of these approaches in what follows.

The major revisions to full employment earnings and the working population over this period were made by Feinstein himself in a series of papers (1990a, 1990b, 1995 and 1998a, 1998b). The first of these

Feinstein (1990a, 19990b) focused on the period since 1881 and were in part prompted by some of the issues raised in a paper by Greasley (1986). The aim was to re-examine the issue of the Victorian slowdown in output and productivity growth identified by Phelps-Brown and Handfield Jones (1952) in earlier work and which we return to later in the paper.

The second set of estimates (Feinstein 1998a, 1998b) focused on the industrial revolution with an aim of looking at the extent to which the living standards of working class households in Great Britain improved between 1770 and 1880, but also with a longer term aim of reconstructing GDP from the income side (Feinstein (1998b)). As part of this second stream of work he also made estimates of the working population of wage earners for Great Britain and rougher estimates of earnings adjusted for unemployment and for the inclusion of Ireland based on Bowley's original work. Geary and Stark (2004) revisited Bowley's work and created a new full employment series of wages for Ireland which were used to reconstruct earnings for the UK using Feinstein's estimates for Great Britain.

The major revisions to the utilization of labour over this period were made by Boyer and Hatton (2002) who reviewed the Board of Trade measure of unemployment that Feinstein used for his estimates of the wage bill over the 1855-1913 period. They produced new estimates of unemployment for the period after 1870 which can be combined with Feinstein's work on earnings and unemployment over the industrial revolution to create a new estimate of the wage bill for the post-1785 period. Although for our purposes we only need the estimates from 1841, the results from 1785 are provided as a basis for future work.

Together all these revisions allow a revised estimate of wage-earners' compensation from the late-C18th to the early C20th and with a split between Great Britain and Ireland. We consider these revisions in more detail below starting with Feinstein's revisions to earnings in the late Victorian period.

1.1.1 Wage earnings 1880 to 1920

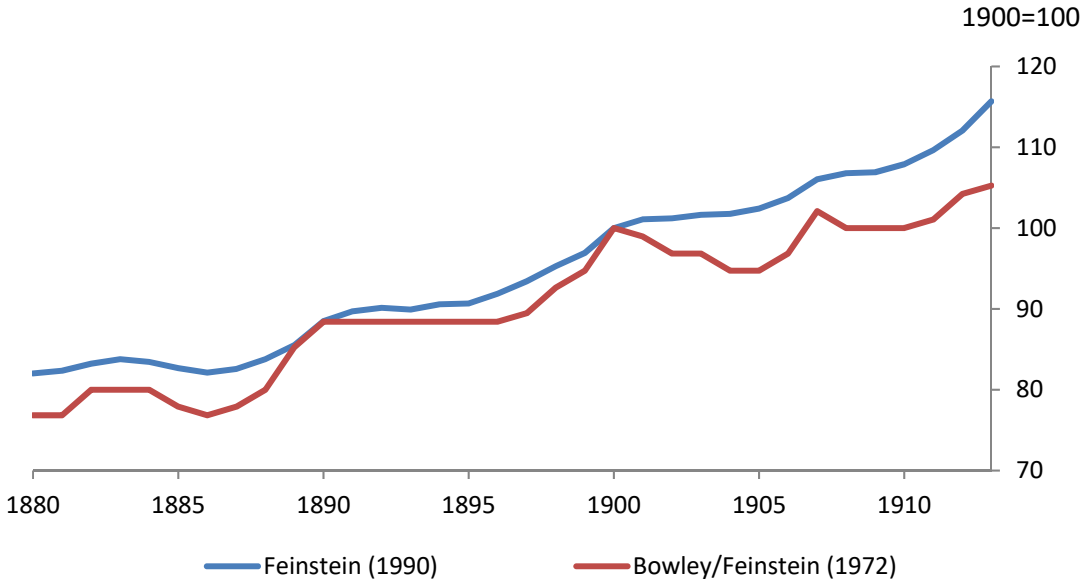
In his 1972 estimates of GDP Feinstein had largely relied on the wage and earnings estimates of Bowley and Wood who were the acknowledged authorities on wages over this period. This was understandable given that Feinstein's task for the 1972 volume was essentially to take the core components of the national accounts that had previously been estimated by the key experts in various fields (including his own contributions on capital formation and national accounts) and then do the (arguably harder) job of filling in all the remaining gaps and bring everything together to make a comprehensive set of estimates for GDP from 1855. In this respect he had relied on Bowley's published index for wage earnings from 1937 which the latter had described as his "final" estimate. Feinstein had initially believed this had brought together all the results of Bowley's previous investigations as well those of others. On a revised examination however Feinstein found that these estimates could not have taken into account some key pieces of information such as the 1906 *Enquiry into earnings and hours* and the *1919 Hankey Report* on earnings in the coal mining industry prior to WWI . Bowley's index also did not cover key sectors of the economy such as steel, clothing and footwear in the manufacturing sector, and the full range of service sector industries. These were very different industries from those covered in Bowley's index in part because they were not as heavily unionized. For these reasons Feinstein undertook a wholesale review of the earnings index for the 1880-1913 period. This consisted of updating Bowley's estimates for the information in the 1906 *Enquiry* and the 1919 *Hankey Report* plus an attempt to extend the coverage to the missing sectors. The final index covered around 85% of the labour force.

Feinstein's earnings index was based on the formula:

$$\frac{\sum\left(\frac{Wi_t}{Wi_r}\right)Wi_r}{\sum Ni_t} \div \frac{\sum Wi_r Ni_r}{\sum Ni_r}$$

where the time series of occupational wage relatives Wi_t are used to create an index for each occupation which are benchmarked to actual wage earnings measured in a particular reference year, Wi_r . These are then weighted according to employment shares $Ni/\Sigma Ni$ and, importantly, scaled by the earnings in each sector in the reference year (Wi_r) which allows shifts between occupations with different levels of earnings to affect average wage earnings. Like Bowley he used 1911 for his reference year estimates of wage earnings in each industry. **Chart 1.1** shows Feinstein's revised earnings index and compares it with the previous estimates based on Bowley, indexed to 1900.

Chart 1.1: Feinstein's revised earnings index for the UK



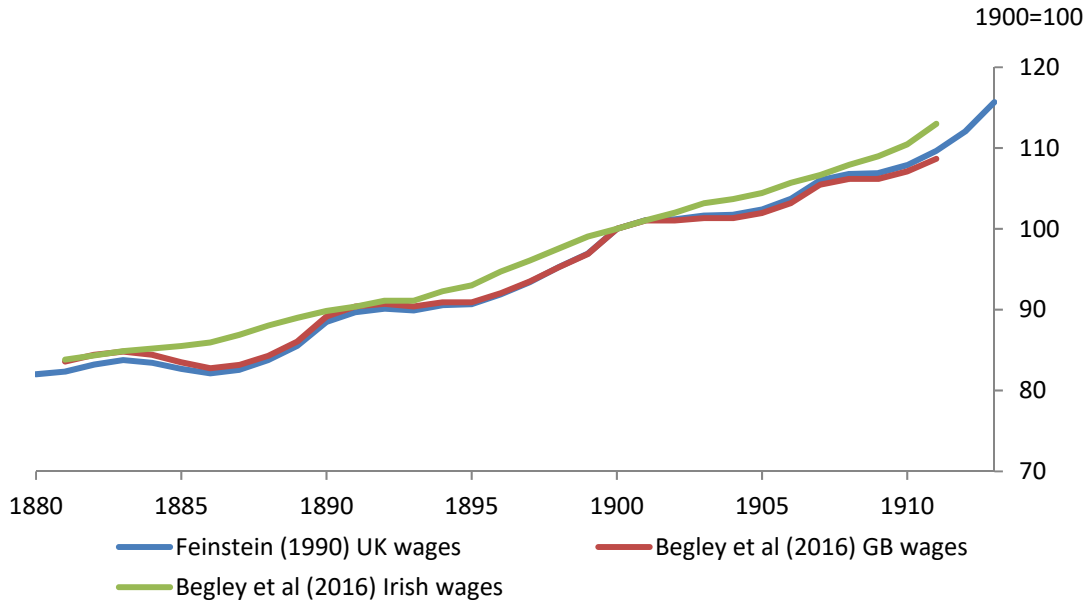
The first notable feature is that Feinstein's improved index is much less volatile than Bowley's for most of the period, reflecting the fact that the addition of more sectors lowers the weight on the relatively more volatile earnings of the coal sector which was subject to sliding scales.

The second key feature is that the new earnings measure grows more slowly over the 1880s than the old index but faster in the period after 1900. The faster post-1900 growth is largely due to the data on coal earnings from the Hankey Report plus the fact that the additional sectors added by Feinstein show a marked improvement in performance relative to the sectors covered by Bowley, especially the earnings of domestic servants. This additional growth in wages in the lead up to WW1 as discussed in Feinstein (1990a) has a significant bearing on the scale and timing of the Edwardian productivity slowdown which we also reconsider later.

The third key factor is that Feinstein's estimate of average wage earnings in the key benchmark year of 1911 was significantly higher than implied by Bowley's. Coupled with revisions to the number of wage earners and unemployment discussed later it implies roughly a 3% increase in the estimated wage bill in 1911.

Following up on Feinstein's work Begley, Geary and Stark (2016) estimate a set of similar indices for Ireland which can then be used to back out an estimate of British earnings over this period. This is shown in **Chart 1.2**

Chart 1.2: GB and Irish Full employment earnings 1881-1911



This allows a separate wage bill for GB and Ireland to be constructed once applied to employment estimates for the two parts of the UK. **Table 1.1** summarises average full time annual earnings in 1881 and 1911 for each part of the British Isles. The annual estimates have been adjusted to incorporate holidays but not sickness or strikes.

Table 1.1: Annual full time wage earnings in GB and Ireland (£ per year)

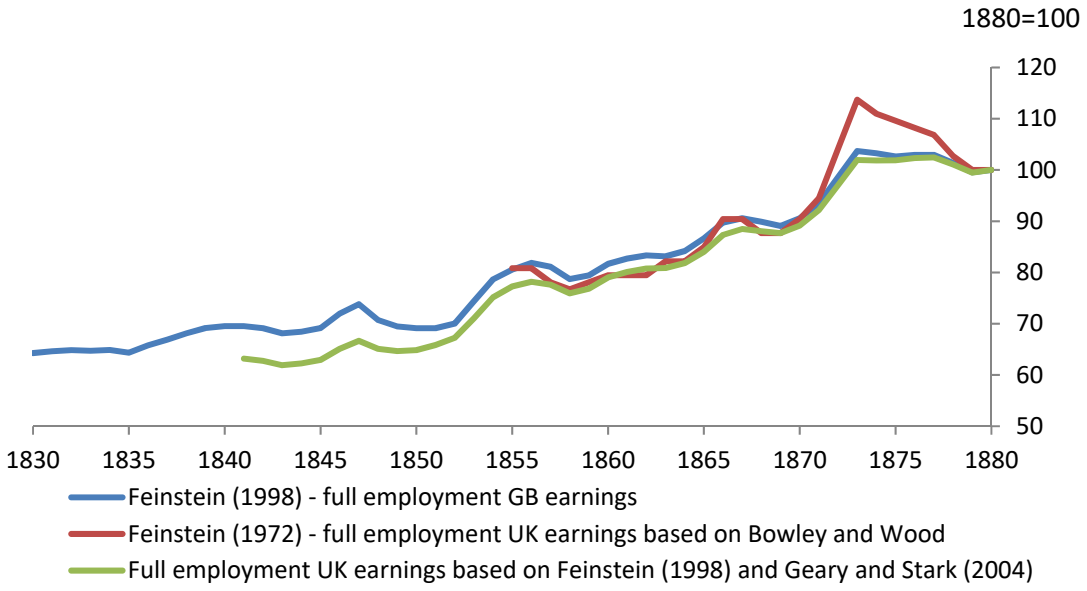
	1881	1891	1901	1911
UK	44.0	47.9	54.0	58.6
GB	46.4	50.3	56.2	60.4
Ireland	27.4	29.5	33.0	36.9

1.1.2 Wage earnings in Great Britain and Ireland 1785-1880

Following the work on late-Victorian earnings Feinstein turned to wages in the industrial revolution and the controversy over whether living standards of the working class improved. As before the indices of Bowley and Wood, constructed at the turn of the C19th, were the initial starting point for the estimates but also later work on coal mining earnings by Mitchell and Church. Again Feinstein decided on a wholesale

reconstruction of the available earnings indices from the available material. For the century or so before 1880 Feinstein was able to construct earnings estimates for 20 sectors covering around 80% of wage earners but those largely reflected wages in Great Britain. However he did make an attempt to capture developments in the UK as a whole through the use of Bowley's index of Irish agricultural wages. Feinstein also constructed an earnings index adjusted for unemployment which we discuss in a later section. Additional work on Irish earnings was carried out by Geary and Stark (2004) who in addition to agricultural earnings collected data on the earnings of construction workers on Ireland and linked the non-contractual earnings of textile workers to prices. They used this information to create a revised UK full employment wage index by replacing the Bowley index used by Feinstein with their new series for Irish wages[4].

Chart 1.3: A revised full employment earnings index for the UK 1841-1880



The resulting series are shown in **Chart 1.3** over the 50 years between 1830 and 1880. The main difference is to smooth out a large rise and fall of earnings in the early 1870s around the time of the panic of 1873 and the beginning of the Long Depression. Feinstein (1988) makes no particular comment on this feature because he did not make a comparison with the Bowely/Wood series over this period. But the new index appears to show a plateau in the level of earnings that carries through to the late 1880s when combined with the estimate in **Chart 1.1**, rather than a reversal of a large increase in the first half of the 1870s. Again this is likely to reflect the broadening of the index to other sectors and the relatively volatile sectors captured in Bowley's index. The new series for Irish earnings shows a stronger trend increase in Irish nominal earnings largely in the years following the famine although this does not necessarily translate into real earnings given the divergent movement in prices discussed in Geary Stark (2004).

1.1.3 Employment and the Working Population 1785 to 1920

The third set of revisions that need to be taken into account are those to the estimated number of wage earners in the UK economy and their utilization over the cycle. As pointed out by Greasley (1986), Bowley's estimate of wage-earners' income used by Feinstein had been incorrectly based on the numbers of wage

[4] We are grateful to Frank Geary and Tom Stark for supplying us with their annual time series for UK wages.

earners in Great Britain rather than the UK as a whole, which was significant to the extent that the number of Irish wage earners had been growing at a slower rate than in Great Britain over this period. In reply to Greasley, Feinstein (1989) developed new estimates of UK wage earners based on reworking the census data from 1861 onwards. And in his subsequent work (Feinstein (1998)) on the industrial revolution he developed new estimates for Great Britain between 1770 and 1851. This can be carried back to 1841 on a UK basis using estimates by Begley et al (2016) and Geary and Stark (2002) for the Irish labour force and wage earners. **Table 1.2** summarises the decadal estimates for the Working Population and Wage Earners in the UK and GB:

Table 1.2 Wage earners in GB and Ireland (mns)

	UK		GB		Ireland	
	Working Pop	Wage Earners	Working Pop	Wage earners	Working Pop	Wage earners
1841	12.1	9.7	8.5	7.0	3.6	2.7
1851	12.2	10.0	9.4	7.7	2.8	2.3
1861	13.1	10.7	10.5	8.6	2.6	2.1
1871	14.1	11.5	11.7	9.6	2.4	1.8
1881	15.1	12.2	12.9	10.7	2.2	1.5
1891	16.7	13.4	14.6	12.0	2.0	1.4
1901	18.7	14.9	16.7	13.5	2.0	1.3
1911	20.4	15.9	18.6	14.7	1.8	1.2

Source: Feinstein (1989, 1998), Geary and Stark (2002), Begley et al (2016).

These revisions also implied changes to the number of salaried and self-employed workers which affect other components of the income accounts (these are discussed separately in later sections).

For the utilization of the labour force the two key pieces of research to incorporate here are: the revisions to the Board of Trade index of unemployment by Boyer and Hatton (2002) for the period 1870-1913; the analysis of unemployment undertaken by Feinstein (1998) of cyclical and seasonal unemployment during the 1770-1880 period; and work by Mackinnon (1986) and Southall (1990) on the use of poor law and union data in the pre-1870 period.

Boyer and Hatton (2002) reviewed both the coverage and weighting of the Board of Trade series used by Bowley in his estimates of wage income and which were relied upon by Feinstein (1972). There were a number of improvements they made to the series:

- First they used the labour force in each industry rather than union membership to weight the data for unemployment in each of the unionized industries.

- They then estimated unemployment in those sectors where the union data was unrepresentative or no union data existed, specifically mining, textiles and transport[5]. These were also industries in which there was considerable short-time working and this was also built into the estimates for these sectors.

[5] For mining very few unions offered unemployment benefits, at least before the 1890s.

- Union-based measures largely reflect unemployed skilled labourers, so poor relief data on the number of male, able-bodied paupers was used to estimate the unemployment of general unskilled labour. This was based on the earlier work of Mackinnon (1986).

Chart 1.4: Boyer and Hatton's revised unemployment measure for wage earners

Together these improvements led to an industrial unemployment index that covered just over 50% of the total workforce over this period. **Chart 1.4** shows the Boyer and Hatton estimates compared with the Board of Trade measures. Generally the Board of Trade measure understated the average level of unemployment but overstated its volatility and that is true even if the short-time and unskilled estimates are removed from the picture.

They then make two adjustments to this industrial series to convert it into a broader whole economy series, consistent with national unemployment insurance (UI) and claimant count estimates available from 1920 onwards[6].

- First, over the interwar and post WW2 periods (1923-1939 and 1948-1971) they use the post-1920 data to look at the relationship between overall unemployment and unemployment in the industries they cover in their pre-1914 index. This gives them a regression relationship they apply to the pre-1914 data.

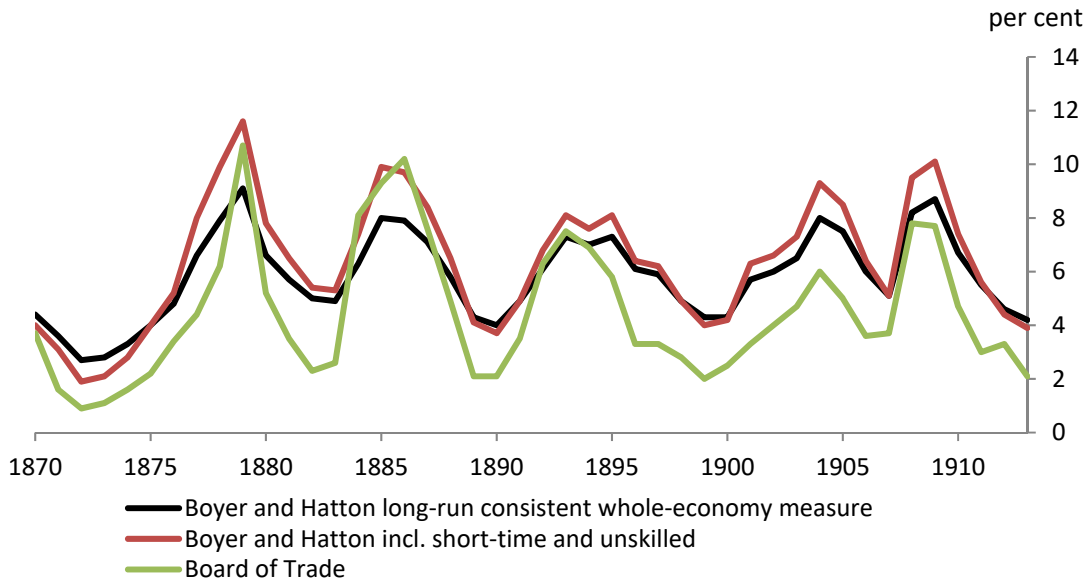
- Second, prior to applying the regression, they scale the pre-war series by a further 21% to reflect the fact that the union-based insurance data appears to understate unemployment in the sector as

[6] The national unemployment insurance scheme was introduced in 1911 but was quite narrow to begin with. It was widened extensively in 1920 and became universal in 1948. Feinstein (1972) however made adjustments to the interwar UI scheme estimate of unemployment to cover missing sectors so his series can be used as measure of overall unemployment over this period.

a whole when they compare it with the equivalent industry in the UI data. This is based on the short period in the early 1920s when both trade union and UI estimates are available.

Chart 1.5 shows the effect of these two adjustments on the unemployment rate over the 1870-1913 period which work to lower the volatility of the series.

Chart 1.5: Boyer and Hatton's whole economy measure of unemployment



Prior to 1870 the information on unemployment is very scarce and scattered. The trade union data published by the Board of Trade and used by Bowley and Feinstein are available back to the early 1860s and for the engineering, metal and shipbuilding unions to 1851 (Southall (1990)). The longest time series is the unemployment rate of the Friendly Society of Ironfounders which records unemployment of its members back to 1831 and is available in Gayer, Rostow and Schwartz (1953). The statistics on indoor pauperism used by Boyer and Hatton for unskilled workers also extend back to the late 1840s. In addition over the period 1848 to 1860 we have statistics from the Poor Law Reports on the number of outdoor paupers who were relieved due "to want of work". Although collectively these statistics only cover a small section of the potential working population, there seems to be agreement from experts in the field (for example Mackinnon (1986) and Southall (1990)) that variation in these series should give some guide to cyclical movements in unemployment and can be used as indicator series. **Chart 1.6** shows an extension of unemployment back to 1831 based on using these indicator variables based on a simple econometric relationship with the relevant components of Boyer and Hatton's unemployment series.

The only explicit attempt to estimate unemployment before 1850 was by Feinstein himself in his 1998 paper on living standards in the industrial revolution. He derives a series for industrial unemployment for Great Britain back to 1770 by using an extended version of the Gayer, Rostow, Schwartz (1953) index of cyclical fluctuations over the 1770-1870 period. He also includes estimates of short-time working in agriculture and how that changed over time.

The Gayer, Rostow Schwartz index grades each year by a number from 0 (depression) to 5 (cyclical peak) based on a core set of cyclical indicators. These indicators include bankruptcies, and the output of key industries such as textiles and construction which the evidence suggest showed cyclical movements in employment. The set of indicators also includes the unemployment rate of ironfounders discussed earlier. For this reason Feinstein argues it can be used as the basis of an industrial unemployment series but also, by using judgement about the relationship between unemployment and the cycle based on the later trade union data, the cyclical indicator can be mapped into numerical estimates of unemployment fluctuations. He then adjusts this in certain periods based on what is known about unemployment in particular years which he derives from a number of secondary sources. For example, a special correction was made to the percentages for 1815/17 to allow for the rise in unemployment that followed the large post-Napoleonic war demobilization. However the complete series was not published in his article. Five year averages can be backed out from a table of adjustments he made to real earnings[7] to account for the effect of unemployment but these include adjustments for short-time working and one or two observations were adjusted for significant peaks and troughs.

Chart 1.6: Estimates of the aggregate unemployment rate 1770-1920

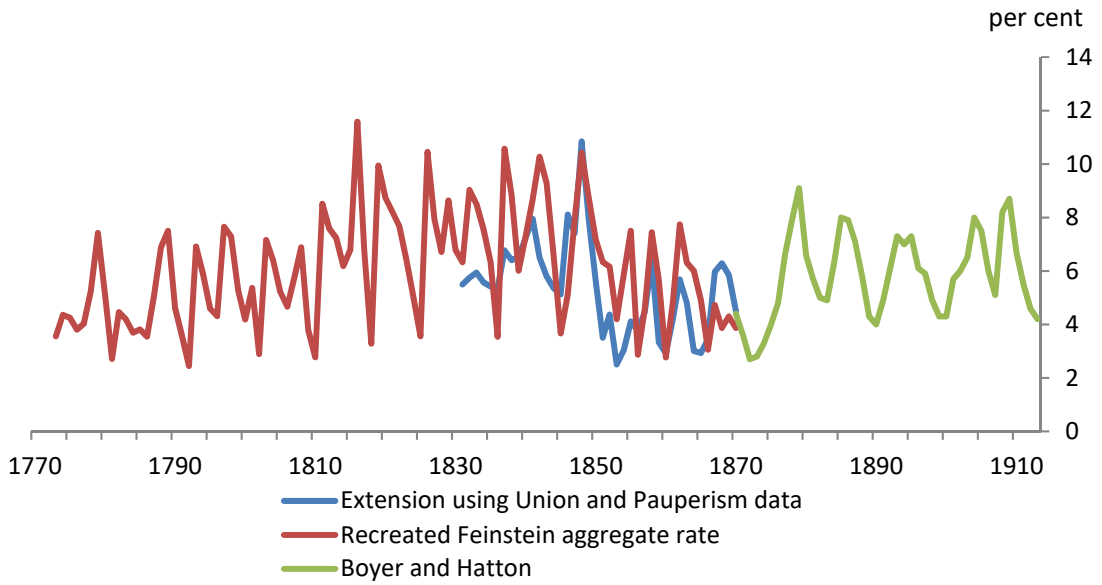


Chart 1.6 shows an attempted reconstruction of Feinstein's aggregate unemployment series for Great Britain and compares it with the extended Boyer and Hatton series using the union and pauperism data. This was derived in two steps. First the implied 5 year average of aggregate unemployment for Great Britain was derived from his series for full employment real wages and the real wage adjusted for unemployment. A reference unemployment rate of 5% was chosen for the 1798-1802 period based on Voth (2001)[8]. This five-year average was then interpolated based on an appropriately scaled version of the Gayer et al (1953) cyclical index to 1850 which was extended using Broadberry et al (2015) industrial production index de-trended with a HP filter. The Chow-Lin interpolation technique was used to derive the annual series. To crosscheck this aggregate measure against the quoted observations in Feinstein (1988)

[7] See Feinstein (1998) Table 5.
[8] See Voth (2001) Table 8.

we then proceeded to derive a series for industrial unemployment based on Feinstein's assumption that agriculture, armed forces and domestic servants are assumed to be non-cyclical, but incorporating Feinstein's adjustments for short time working in agriculture between 1815 and 1870. For this we used workforce shares of agriculture, armed forces and domestic servants based on the sources that Feinstein (1998) uses. We also assume an average unemployment rate of 5% for these sectors based on the 1798-1802 benchmark. The implied industrial unemployment rate conforms very closely to the observations quoted by Feinstein for the years 1816/1817, 1825, 1836 and 1845 and to the averages he quotes for the periods before and after 1815. So we take this as a best guess of Feinstein's aggregate and industrial unemployment rates.

The resulting series is more volatile than the extended Boyer and Hatton series (**Chart 1.6**). It is worth noting however that Feinstein gauged the link between unemployment and the cycle from the trade union data later in the C19th. And as we have seen the trade union data tend to overestimate the volatility in unemployment and understate the level compared to the Boyer and Hatton estimates. For the purposes of obtaining an employment series for 1841-1870 it seems sensible to average the Feinstein estimates with the extended Boyer and Hatton series. This will lower the volatility implied by the Feinstein series but will incorporate broader information than in the narrow range of industries covered by the indicators used to extend Boyer and Hatton series in the 1842-1870 period. The resulting series is shown in **Table A.1.**

Feinstein's series only strictly applies to Great Britain whereas in principle the extended Boyer and Hatton measure does include some Irish data. There is very little additional information on Irish unemployment that can be usefully incorporated. To make real wage estimates for Ireland Feinstein did use Bowley's index of Irish agricultural real wages "adjusted for want of work" to create a UK real wage series adjusted for unemployment. By comparing Bowley's full employment index with the adjusted real wage index we can back out Bowley's estimate of movements in agricultural employment for Ireland. As noted by Geary and Stark (2004) this series implies a large 50pp increase in equilibrium unemployment between 1777 and 1835 followed by a fall to over-full employment between 1850 and the 1890s. Mokyr suggests there is little evidence for this pattern despite the existence of substantial seasonal unemployment. So to create a series for total UK employment we apply the unemployment rate we have derived to the total number of wage earners in the UK. This is summarised in **Table A1.**

1.1.4 The UK Wage Bill 1841 to 1920

Bringing the different elements together these series allow a series for wage income to be constructed back to 1841 and in principle to 1785 which can be used for the basis of a series for UK national income.

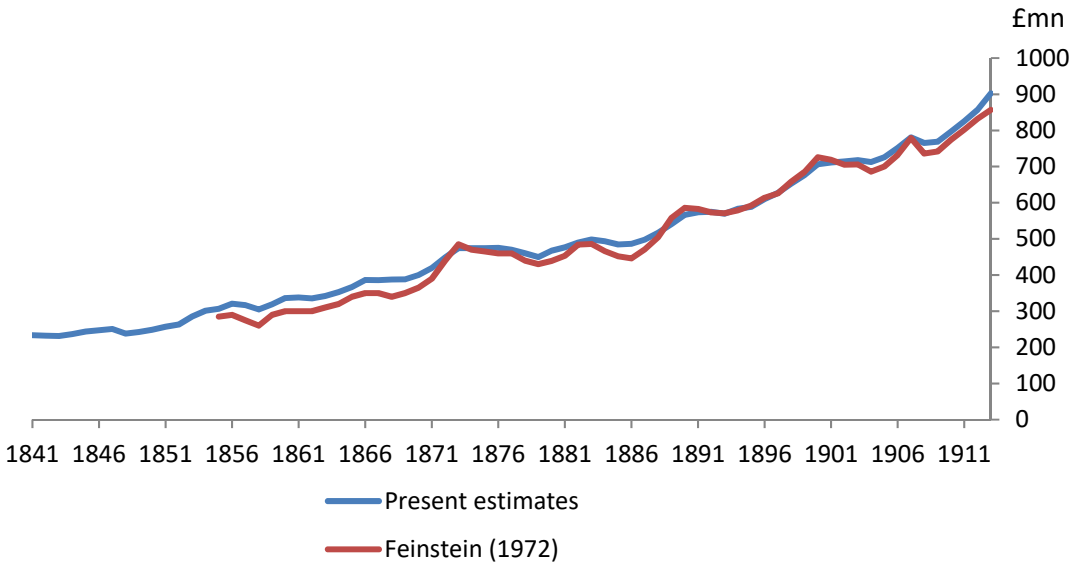
Following Feinstein we begin with the estimated wage bill in 1911. As noted earlier Feinstein's revised estimates of wage earnings and the number of wage earners suggest that Bowley's benchmark of £802mn needs to be revised. **Table 1.3** shows that the revised estimate suggests a wage bill some 3% higher, once unemployment (applied to civilian wage earners), the number of strikes and sickness and the number of old/retired workers are taken into account. This upwards revision was anticipated by Feinstein (1972), but it is still true the benchmark level may be understated because of supplementary earnings earned from second jobs or possibly contributions from retired workers, which would negate the 3% adjustment allowance for older workers somewhat.

Table 1.3: UK Wage bill in 1911

Full employment earnings per head	£58.6
Number of wage earners	15.9mn
Armed forces	0.4mn
Civilian wage earners	15.5mn
Number of weeks lost to strikes and sickness	1.77
Allowance for old/retired workers	3%
Unemployment rate (including short-time)	5.5%
Total UK Wage Bill incl. armed forces	**£826mn**
Memo: Bowley-Feinstein estimate	*£802mn*

From the 1911 reference point a complete series of the wage bill can be constructed using the average earnings indices, number of wage earners, the unemployment series and a series for days lost through sickness and strikes (for as far back as the data exist). **Chart 1.7** shows the series for wage income compared with Feinstein's (1972) measure. Wage incomes are generally higher throughout but less variable owing to the stability of Feinstein's revised earnings estimates. **Table 2.1** contains the new series. For the period after 1914 we extrapolate using Feinstein's explicit estimates of the wage bill for 1915-1920[9].

Chart 1.7: Total wage incomes



1.2 Intermediate incomes

Intermediate incomes are essentially non-wage earnings that were below the eligibility for income tax. This means they are not captured by either the wage and employment data nor the income tax data that

[9] See Feinstein (1972) page 34

are typically used to construct GDP from the income side. These incomes therefore need to be estimated from the number of non-wage earners not subject to income tax and how much they earned. This income also needs to be attributed appropriately to salaries, farm incomes and non-farm self-employment income and profits, so that these components can be estimated appropriately once combined with the evidence from the income tax data.

The main revisions to Feinstein's data here are due to the revision in the number of non-wage earners arising from his re-estimation of earnings and the number of wage earners. This is noted in his 1989 paper[10]. In particular the number of non-wage earners estimated in 1860 (2.67mn) is considerably higher than the numbers he used from Bowley in his 1972 estimates (1.65mn-1.85mn). **Table 1.4** reworks Feinstein's original numbers (based on Appendix 7.3 of Feinstein (1972)) which were based on estimates of the number of non-wage tax payers and their earnings using information from the work of both Bowley (1920) and Stamp (1927).

Table 1.4 summarises the revisions to Feinstein's estimates of intermediate income in 1860, 1880 and 1911. Essentially intermediate incomes are higher by around 40% in 1860 and 30% in 1880. No revisions however are necessary for the 1911 estimates. In addition intermediate benchmarks are calculated for 1870, 1880, 1891 and 1901 based on Bowley and Stamp's estimates.

Table 1.4 Intermediate incomes in key benchmark years

	1860	**1870**	**1880**	**1891**	**1901**	**1911**
No. of Non-wage earners	2.36	2.58	2.83	3.25	3.82	4.5
No. of taxpayers with incomes over £160 (£100 for 1860*)	0.47	0.34	0.62	0.7	0.8	0.9
Non-wage earners exempt from tax	1.89	2.24	2.21	2.55	3.02	3.585
Average income	54	62	70	76	82	88
	102	139	155	194	248	314
1860 Adjustment for those in £100-£160 range*	25					
1911 deduction for wage-earners not exempt from tax*						8
Total intermediate income	**127**	**139**	**155**	**194**	**248**	**306**
Memo: Estimates of Feinstein (1972)	*90*		*120*			*306*

*See Feinstein (1972) Appendix 7.3 for a discussion of these adjustments for 1860 and 1911.

Table 1.5 then allocates these to salaries and other forms of income in proportion to Feinstein's original estimates[11]. The revisions are made only to salaries and self-employment income. Rows 2, 4, 5 and 6 of this table can now be used to augment the estimates of salaries, profits and self-employment data from income tax assessments. Rows 1,3 and 7 are redundant in that they refer either to transfer payments or are covered in other estimated components (for example total farm incomes are estimated separately and implicitly already capture row 3).

[10] See Feinstein (1989) page 244 footnote 5.
[11] See Feinstein (1972) Appendix 7.3, Table 7.19

Table 1.5 Allocation of intermediate incomes, £mn

	1860	1870	1880	1891	1901	1911
Salaries						
1. £160 but not exempt						10
2. Below £160 and exempt	40	48	57	70	88	102
Self-employment income						
3. Farmers' income	17	17	17	23	30	37
4. Other income from self-employment	57	58	61	74	93	107
5. Rent	10	12	15	21	28	35
Interest and dividends:						
6. Assessed but exempt	3	4	5	6	8	10
7. Not assessed						5
Total intermediate income	**127**	**139**	**155**	**194**	**248**	**306**

1.3 Salaries

For salaries subject to income tax Feinstein (1972) provides a detailed method of how this can be obtained from Schedules D and E of the income tax data. Salaries below the exemption limit were estimated in **Table 1.5**. So the only extensions and revisions here are:

- To take back the estimates to 1841 using similar methods and assumptions to Feinstein (1972).
- The increase in the estimate of salaries below the exemption limit due to revisions of the number of non-manual workers already calculated earlier.

Stamp (1927) provides estimates for the gross assessment of salaries taxable back to 1842 under schedule E, adjusted for the inclusion of Ireland and conformable with the later tax data that exempted incomes under £160 from tax. These schedule E estimates are then lowered by 5% to be conformable with Feinstein's adjustments to obtain total taxable income from gross assessments under Schedule E. Following Feinstein we then add in salaries from Schedule D (which were only shown separately from 1898/9) and the salaries exempt from tax already calculated. The data are log-linearly interpolated between benchmark estimates.

Consistent with Feinstein's assumptions these estimates are then simply retropolated with the growth rate of Schedule E assessments from 1855 back to 1842. Wage incomes from section 1.1 are used to project the salaries data back a further period to 1841. The revised data for salaries are summarised in **Table A2**.

1.4 Profits and income from self-employment

Feinstein's (1972) estimates of gross trading profits and non-farm income from self-employment are based on income tax returns under Schedule C and D while separate estimates are made for farmers' incomes and non-wage intermediate incomes that were exempt from tax (discussed earlier). The split between profits and non-farm self-employment income can only be made after 1889. There are four sets of revisions and refinements to Feinstein's (1972) estimates that need to be considered.

- First there are some changes to the estimates of profits and self-employment that appeared in Mitchell's (1988) British Historical Statistics volume which were supplied to him by Charles Feinstein. These changes just need to be sourced and documented.

- Second there is the fiddly issue of working out the time profile of profits given that income tax assessments were made on a moving average of past profits for the majority of industries. Unscrambling the annual profile of profits from this data provided a major headache for the early pioneers of national income accounting. This question needs to be re-examined given the contribution of Greasley (1986). This also needs to be taken back to 1841.

- Third the estimates for 1861 need revising upwards for Feinstein's (1989) revisions to the number of non-wage earners discussed earlier[12].

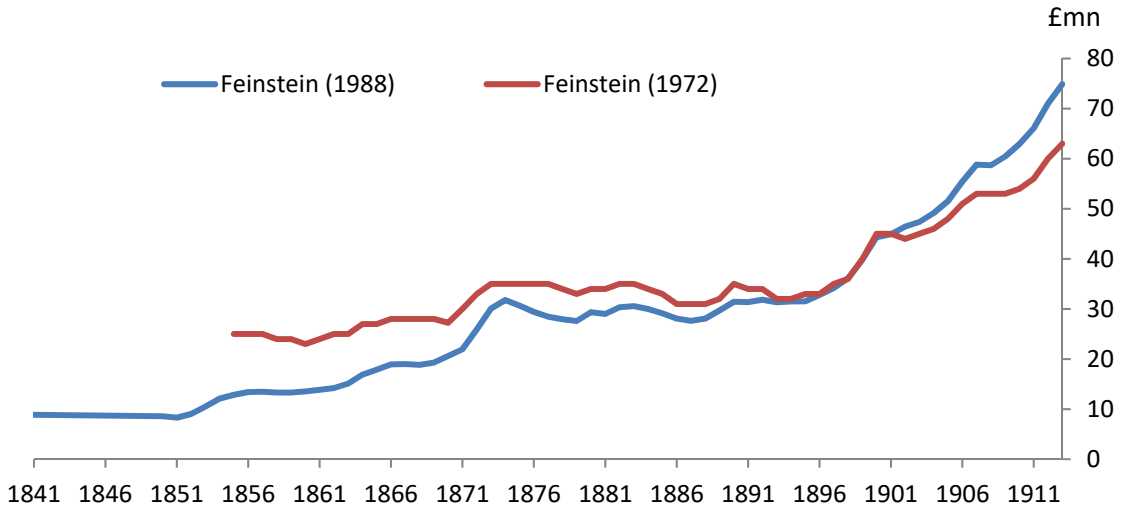
- Finally there is also the underlying problem of evasion and how much to add back on to the tax data to correct the undervaluation of incomes. Some assumption needs to be made for the period back to 1841.

1.4.1. Revisions to capital consumption

These are essentially the result of revisions to depreciation or capital consumption arising from the Feinstein's revisions to the investment and capital stock data in his chapter in Feinstein and Pollard (1988). An estimate of capital consumption is necessary to add back to the estimate of profits derived from income tax data because assessments were made on profits after accounting for depreciation. The Feinstein (1988) estimates imply a different amount of capital consumption due to a revision in the lifetime assumptions for each of the assets. These appear to have been supplied to Mitchell for the 1988 British Historical Statistics volume. This however is not straightforwardly verified because Feinstein uses the capital consumption of assets excluding building and works for this series, but he does not provide both gross and net capital formation in current prices at the asset level in his published estimates. However we have been able to retrieve the numbers from Feinstein's working notes held at the Nuffield Library. This estimate is almost identical to the revisions to profits and self-employment income in Mitchell (1988) (**Chart 1.8)** so we assume this is the main reason that Feinstein supplied a changed income estimate to Mitchell.

[12] See Feinstein (1989) page 244, footnote.

Chart 1.8: Revisions to Capital Consumption



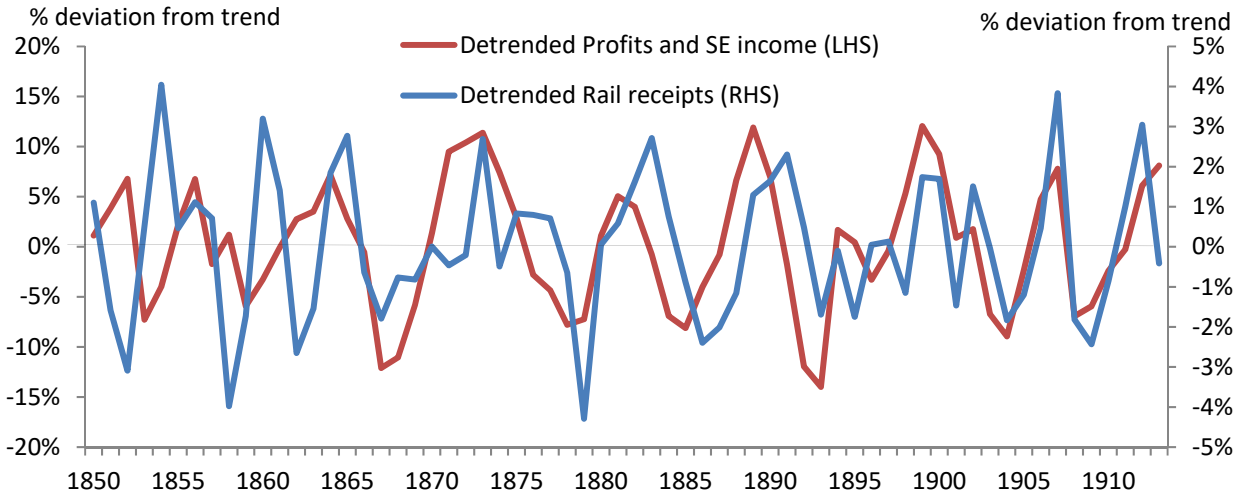
1.4.2. The timing of profits and (non-farm) self-employment income

Feinstein's measurement of profits and non-farm self-employment income were derived from Schedules C and D of the income tax returns. Schedule C represents interest on British and Foreign Government securities but is a necessary part of the calculation because Schedule D also contained various interest and profit income earned from abroad. Feinstein adds Schedules C and D together then deducts both interest payments on British securities and an estimate of total net property income from abroad to leave an estimate of profits on domestic production and non-farm self-employment income.

The most important issue is with the timing of profits contained in Schedule D. Income tax assessments were largely made on a moving average of past profits. Unscrambling the annual profile of profits from the averaged tax assessments provided a major headache for the early pioneers of national income accounting. A 'least squares' solution to recovering the annual estimates from the moving averages was suggested by Champernowne and implemented by Prest (1948) and Feinstein (1972) in their estimates. Prest (1948) and, later, Greasley (1986) argued that the profits derived via this method appear to be a year 'too early' given other cyclical indicators of profitability especially in the 1880s. As an example **Chart 1.9** compares the de-trended profits and self-employment income series using this method with a similarly de-trended series for railway receipts (from Klovland (2001)[13]) which is thought to be a good cyclical indicator for the second half of the C19th.

[13] Klovland uses a HP filter to detrend railway receipts so we apply the same filter to profits.

Chart 1.9: De-trended profit and self-employment income and rail receipts



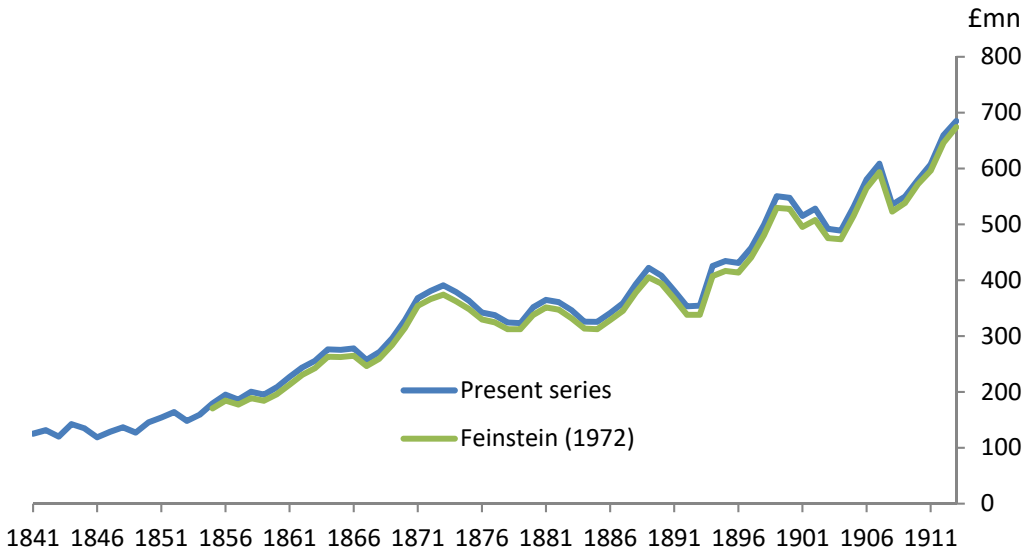
Present and Greasley therefore shifted their data one year into the future. Feinstein (1972) on the other hand preferred to leave the data unadjusted on the basis that there was no single reason to justify this shift over the whole period.

Rather than introducing an arbitrary lag of one year an alternative approach might be to use the cyclical indicators directly to adjust the averaged profit data. Many of these indicators of the cycle, such as bankruptcies and bank clearings over this period do not directly feed into the alternative output or expenditure estimates of GDP over this period. So it might be argued that the profits part of the income estimate is the best place to incorporate some of this information given the rather arbitrary procedure required to unscramble the annual estimates from moving averages. Alternatively however the cyclical indicators might be better used once the income, output and expenditure estimates are compared and could then be used to weight the different estimates appropriately. Here we follow Feinstein and use the unscrambled profits based on the Champernowne/Prest method and make no additional timing adjustments. The only additional task we attempt is to apply the unscrambling method back to 1841 using the Schedule D assessments. This requires splitting the Schedule D assessments into those which were based on current and previous year's profits and those based on moving averages of previous years (5 years for coal mining and 3 years for other industries).

Those assessments based on previous year's profits obviously only require lagging the data a period. For coal mining it is possible to work backwards from Stamp's estimates of annual coal-mining profits and use the five-year moving average assessments to back out the underlying annual estimates all the way back to 1841. The unscrambling method for the other industries on a three-year assessment basis is more complicated because there are no direct observations of profits to work from and one has to use an additional condition that chooses a set of initial values to minimize the squared deviations of the annual series from the moving average. This assumption due to Champernowne is arbitrary and imposes the condition that there is no three-year cycle in profits and is also very sensitive to potential breaks in the tax assessment as discussed in Prest (1948). For this reason Feinstein applies the unscrambling method to sub periods to get sensible results and then uses interpolation between them. Following this approach, we apply the unscrambling method for the period 1841 to 1867. We use Stamp's estimates of Schedule D

assessments that attempts to add back in Ireland over the 1842-1852 period (which was not subject to income tax over this period) and adjusted to be consistent with the later £160 tax exemption threshold.

Chart 1.10: Non-farm profit and self-employment income from Schedule D assessments



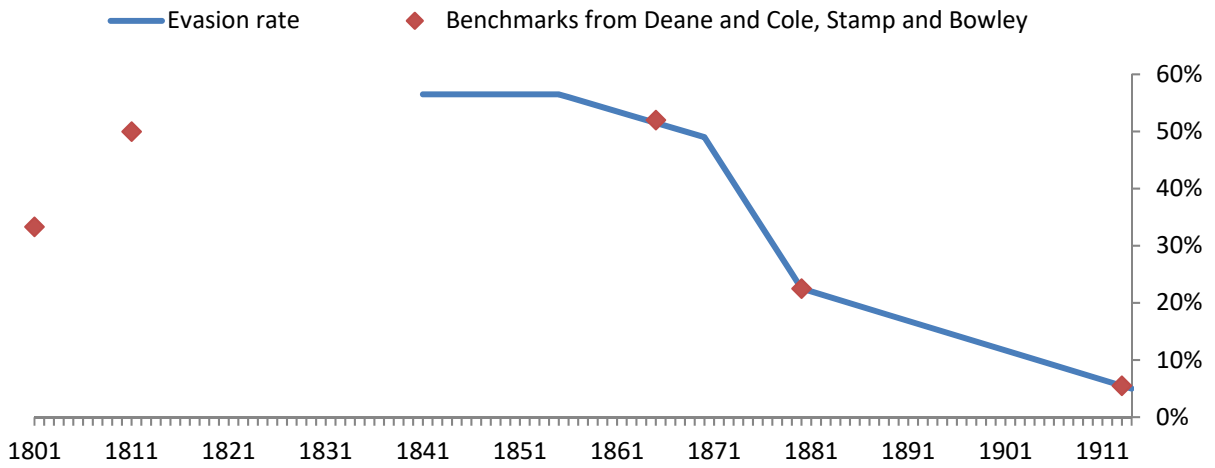
The estimates over the 1840s suggest that much the same issue arises as that identified in the post-1885 data, namely that the peak in profits appears to be a year too early. The peak in profits occurs in 1844 when the peak of the cycle is generally associated with 1845 given the indicators suggested by Gayer, Rostow and Schwartz (**Chart 1.10**).

1.4.3. Evasion

A key uncertainty about the reliability of the tax data is the amount of evasion. Feinstein uses several benchmarks. The most reliable source of information is the *12th Inland Revenue Report* where a comparison was made between profits returned for taxation in 1864/5 and those submitted by the same parties as the basis for compensation claimed in connection with a redevelopment programme. The estimate made by the Commissioner was that the gross Schedule D assessment should be increased by 52%. The next available estimate is a figure of about 22 % of Schedule D taxable income given for 1880 by Bowley (1920) and a 5.5 % estimate given by Stamp (1927) for 1913. Feinstein takes these benchmarks and he retropolated the 1864 estimate back to 1855 giving a figure of 57% in that year. All we do here is carry this rate of 57% back to 1842. The only other benchmark we have is that of Deane and Cole (1967) and their analysis of income taxes during the Napoleonic wars[14]. They estimated that evasion amounted to about 1/3 in 1801 and around 50% in 1811. So assuming a flat 57% benchmark for 1842-1855 seems more reasonable than retropolating Feinstein's trend back even further with an increasing level of evasion. Such retropolation would imply a rate of evasion of 64% in 1841 well above that in 1811. The series is shown in **Chart 1.11**.

[14] See Deane and Cole (1967) page 328.

Chart 1.11: Evasion rates



1.4.4. Self-employment, profit and dividend income not subject to tax

As discussed earlier Feinstein's revisions to the number of wage earners has implications for the amount of self-employment income not captured in Schedule D of the income tax assessments (Rows 4 and 6 of **Table 1.5**)[15]. **Table 1.6** highlights the revisions to Feinstein's (1972) series at several benchmark years. To interpolate between benchmarks and to extrapolate back to 1841 we follow Feinstein's method[16] of using schedule D assessments relative to trend.

Table 1.6 Revisions to income not subject to tax, £mn

	1860	1870	1880	1891	1901	1911
Feinstein (1972)	38	42	48	63	81	117
Implied by Feinstein (1989)	60	62	66	80	101	117

1.4.5. Total self-employment and gross trading profits

Bringing all the revisions together allows a complete calculation of non-farm self-employment and profits (shown in **Chart 1.10**.) Feinstein does not provide an annual time series of all the components used to calculate the aggregate in his 1972 volume, but having consulted Feinstein's underlying worksheets we have been able to produce this in **Table A3**. In addition Feinstein (1972) was also able to make estimates of the split between self-employment income and gross trading profits from 1889 onwards. In **Table 2.1** and **Table A5** we update these sub-components by allocating the revised capital consumption data in line with the revised estimates Feinstein supplied in Mitchell (1988). The revisions in **Table 1.6** are applied just to the self-employed component. We also provide a rough split back to 1841 by assuming non-farm self-employment incomes are a constant share of total profits and non-farm self-employment income and then adding this to farmers' incomes. Given these are very tentative they are shown in italics in the tables and remain subject to plausibility checks in future work. **Table A5** also provides details of the gross trading surplus of private companies, local authorities and central government.

[15] Note that Row 6 the dividend component represents a transfer payment but is necessary to include here given that total interest and dividends will be removed in the calculation of self-employment income and gross trading profits.
[16] See Feinstein (1972) page 175.

1.5. Farmers' profits

For the period after 1855 Feinstein made a detailed analysis of the profits of self-employed farmers. There is no need for these to be revised in the post-1867 period given these were made using the meticulous calculations of Bellerby and his colleagues at the Oxford Agricultural Economics Research Institute. Feinstein retroplates this back to 1855 using rents to capture the trend in profits together with wheat prices and grain yields for the cyclical element. To take this back to 1841 we have used benchmark estimates of farmer's profits made by Bellerby (1959) for the year 1851[17] which he compares with later estimates beginning in 1870. Because Bellerby's concept of "Farmer's incentive income" is a slightly different concept of farmer's profits than that used by Feinstein for national income purposes we apply Bellerby's ratio of 1851 income to 1870-3 incomes and apply this to Feinstein's series. We then use Broadberry et al's (2015) data on agricultural output and prices for Great Britain to interpolate between 1851 and 1855 and retropolate prior to 1841. This method will obviously not be able to capture the impact of the Irish famine. Later we will compare our estimates of UK GDPI with estimates for GDP of Ireland based on Andersson and Lennard (2019) which will give some guide to the discrepancies. **Table A.4** shows the complete series.

1.6. Rent

The final component required to construct nominal GDP is rent essentially covering actual and imputed receipts from the ownership on buildings and dwellings net of expenditures on maintenance, repairs and insurance. For the 1855 -1913 period Feinstein obtained these largely from Schedule A income tax assessments and it appears no revisions were made as a result of the Feinstein and Pollard (1988) work on the capital stock. The estimates of rent not subject to income tax obviously needed to be added back (see **Table 1.5**) as does Feinstein's arbitrary 2% to cover depreciation. Neither of these assumptions is revised. Feinstein's estimates are simply retropolated back to 1841 using Stamp's estimates of Schedule A gross assessments including an adjustment for Ireland.[18] The new estimates are shown in **Table 2.1**.

2 Implications and analysis

Given the set of components constructed in earlier sections, we are now in a position to construct a revised estimate of nominal GDP extended back to 1841. **Table 2.1** summarises the nominal GDPI series and its key components. **Tables A1 to A5** in the Appendix provide more details on the various sub-components including some annual time series that were not shown in Feinstein (1972) but we have recovered from the underlying worksheets. Spreadsheets of the data will be made available in the National Accounts section of the ESCoE historical data repository[19]. In the next section we assess the plausibility of the new estimates first in nominal terms and then in volumes.

[17] We are grateful to Professor Mike Turner for pointing us to Bellerby's work on 1851.
[18] Stamp (1927), page 51.
[19] https://www.escoe.ac.uk/research/historical-data/

Table 2.1 Nominal GDPI 1841-1920

	GDPI	Wage income	Salaries	Employers' contributions		Self-employment income	Gross trading profits		Rent	Stock appreciation adjustment
				NICs	other		Private	Public		
1841	509	229	41			*115*	*38*		86	
1842	514	228	40			*119*	*40*		86	
1843	506	227	48			*109*	*37*		85	
1844	536	233	46			*128*	*44*		86	
1845	537	239	48			*122*	*41*		87	
1846	526	243	49			*111*	*36*		87	
1847	549	247	50			*125*	*39*		88	
1848	539	234	51			*123*	*42*		90	
1849	532	239	49			*115*	*39*		90	
1850	551	245	48			*123*	*44*		90	
1851	566	252	48			*130*	*47*		89	
1852	586	258	48			*141*	*50*		89	
1853	597	281	49			*131*	*45*		91	
1854	641	297	52			*151*	*49*		92	
1855	668	303	57			*162*	*54*		93	
1856	706	319	60			*175*	*59*		94	
1857	707	316	61			*177*	*56*		97	
1858	705	304	64			*178*	*61*		99	
1859	714	318	63			*172*	*60*		102	
1860	746	335	65			*181*	*64*		102	
1861	781	336	66			*203*	*69*		106	
1862	801	334	68			*217*	*74*		108	
1863	828	341	70			*230*	*78*		109	
1864	855	351	72			*234*	*85*		112	
1865	878	366	75			*237*	*85*		115	
1866	904	385	76			*242*	*85*		116	
1867	888	384	77			*232*	*79*		117	
1868	901	386	78			*236*	*83*		119	
1869	917	386	82			*238*	*90*		121	
1870	982	398	84			*273*	*101*		127	
1871	1049	418	85			*303*	*113*		130	
1872	1093	447	90			*307*	*116*		133	
1873	1147	474	92			*325*	*120*		137	
1874	1133	474	94			*309*	*116*		140	
1875	1120	474	97			*295*	*111*		143	
1876	1109	476	99			*280*	*105*		149	
1877	1095	471	102			*268*	*103*		152	
1878	1072	461	104			*253*	*99*		155	
1879	1047	450	105			*237*	*99*		156	

	GDPI	Wage income	Salaries	Employers' contributions		Self-employment income	Gross trading profits		Rent	Stock appreciation adjustment
				NICs	other		Private	Public		
1880	1103	468	107			*264*	*107*		157	
1881	1135	477	110			*277*	*112*		159	
1882	1154	490	113			*279*	*111*		161	
1883	1145	498	117			*263*	*106*		161	
1884	1125	493	119			*250*	*100*		162	
1885	1113	485	121			*244*	*99*		165	
1886	1140	487	123			*260*	*104*		166	
1887	1168	498	126			*268*	*109*		166	
1888	1228	517	129			*294*	*120*		168	
1889	1288	541	134			315	125	4	170	
1890	1312	566	135		1	310	122	5	172	
1891	1303	574	137		2	299	115	5	172	
1892	1274	575	141		3	269	107	5	174	
1893	1273	570	143		4	259	114	6	177	
1894	1369	583	151		5	299	141	6	184	
1895	1392	589	151		6	301	151	6	189	
1896	1425	610	156		7	297	157	6	192	
1897	1481	627	160		8	309	176	6	196	
1898	1557	653	165		9	323	201	7	200	
1899	1646	676	170		9	353	226	7	204	
1900	1685	707	179		10	343	229	8	209	
1901	1664	711	184		10	322	216	8	213	
1902	1697	714	189		10	333	224	10	217	
1903	1666	718	194		11	302	209	11	221	
1904	1665	713	199		11	298	205	14	225	
1905	1733	726	204		11	323	229	13	227	
1906	1822	752	210		12	346	259	14	230	
1907	1893	781	218		12	361	274	15	233	
1908	1819	765	228		12	319	244	15	235	
1909	1837	769	233		13	321	248	17	237	
1910	1904	797	240		13	333	265	17	239	
1911	1986	826	249		14	358	278	18	243	
1912	2089	857	263	5	14	371	313	21	246	
1913	2178	902	279	9	15	372	332	20	249	
1914	2222	990	296	9	15	689		21	252	-50
1915	2582	1285	310	10	16	876		26	259	-200
1916	3064	1538	370	10	18	1175		31	272	-350
1917	3866	1991	420	11	19	1348		49	278	-250
1918	4741	2476	500	11	20	1482		71	281	-100
1919	4986	2508	660	11	25	1662		36	284	-200
1920	5524	2760	850	14	41	1380		20	259	+200

2.1 A comparison with other estimates of nominal GDP 1841-1870

Table 2.2 shows the present estimates with estimates of nominal GDP from the expenditure and output side of the accounts. For the expenditure estimate we use Feinstein's unadjusted[20] expenditure estimate at current factor cost from Mitchell (1988), updated for the revisions made to capital formation and net trade in Feinstein (1988).

For the output side we use Broadberry et al's (2015) estimates of nominal GDP for Great Britain added to a nominal estimate of Irish GDP based on the constant price estimates of Andersson and Lennard (2019). To construct a nominal GDP estimate for Ireland we construct a proxy GDP deflator for Ireland based on existing indices. This was based on a simple average of two indicators. The first is Irish unit labour costs, based on Geary and Stark's estimates of aggregate wages and numbers employed combined with Andersson and Lennard's real GDP figures to get labour productivity and unit labour costs. The second indicator is an adjusted CPI measure based on Geary and Stark's (2004) estimates up to 1870 and Brunt and Cannon's average estimate (2004) after that. The Irish CPI measures are adjusted by the ratio between Feinstein's estimated UK GDPE deflator at factor cost and his UK cost of living estimate from Feinstein (1998). This is a crude attempt to factor out import prices, indirect taxes and other wedges between the CPI and GDP deflator[21]. The resulting proxy GDP deflator is used to construct nominal GDP for Ireland and, coupled with Broadberry et al's (2015) GB data, for the UK between 1841 and 1870. As a final comparison we also add in the input output table benchmark for 1841, based on Horrell et al (1994).

Table 2.2: Nominal GDP at factor cost estimates (£mn)

	Present GDP(I)	GDP(E)	GDP(O)	Input-Output
1841	509	481	554	526
1851	566	565	549	
1861	781	821	804	
1870	982	1079	1124	
1880	1103	1297		
1890	1312	1373		
1900	1685	1794		
1910	1904	2052		

The estimates of nominal GDPI are broadly comparable at some of the key benchmark dates prior to 1870. The estimate for 1841 is only 3% below the Horrell et al (1994) benchmark. However the income measure ends up roughly 7% below the expenditure measure by 1910. This is slightly closer than the GDPI estimates in Mitchell (1988) which were 8% lower than the expenditure measure.

[20] To construct his compromise measure Feinstein adjusted both the trend and cyclical pattern of the expenditure estimate to make it more conformable with the other two approaches. We use the clean measure here as this adjustment may no longer be necessary.
[21] A more elaborate approach here might make use of textile (linen) prices given it accounted for a large share of Irish employment after agriculture.

2.2 Real GDP growth 1856-1913 and the late Victorian productivity slowdown

To construct real GDP(I) over the 1841-1920 period we deflate the nominal estimates by the GDP expenditure deflator from Mitchell (1988), which extends back to 1830. The estimates for real GDP(I) are compared with Feinstein's (1972) original real GDP(I) both in terms of levels and growth rates in **Charts 2.1 and 2.2** between 1855 and 1913. **Table 2.3** compares growth rates in various sub periods. Overall the estimates suggest slightly lower growth on average over the whole period. Generally growth before the 1890s is estimated to be weaker than the previous income estimate and growth after 1907 is slightly stronger, with similar growth rates in between. Overall it suggests less of a marked slowdown in output growth in the late Victorian era which has an important bearing on the debate about productivity growth over this period.

Table 2.3: GDP(I) estimates old and new, average growth rates

	New GDP(I)	GDP(I) Feinstein (1972)
1855-1873	2.2	2.5
1873-1882	1.9	1.8
1883-1889	2.5	2.8
1889-1899	2.4	2.4
1899-1907	1.0	1.0
1907-1913	1.6	1.4
1855-1913	**2.0**	**2.1**

Chart 2.1: GDP(I) estimates old and new

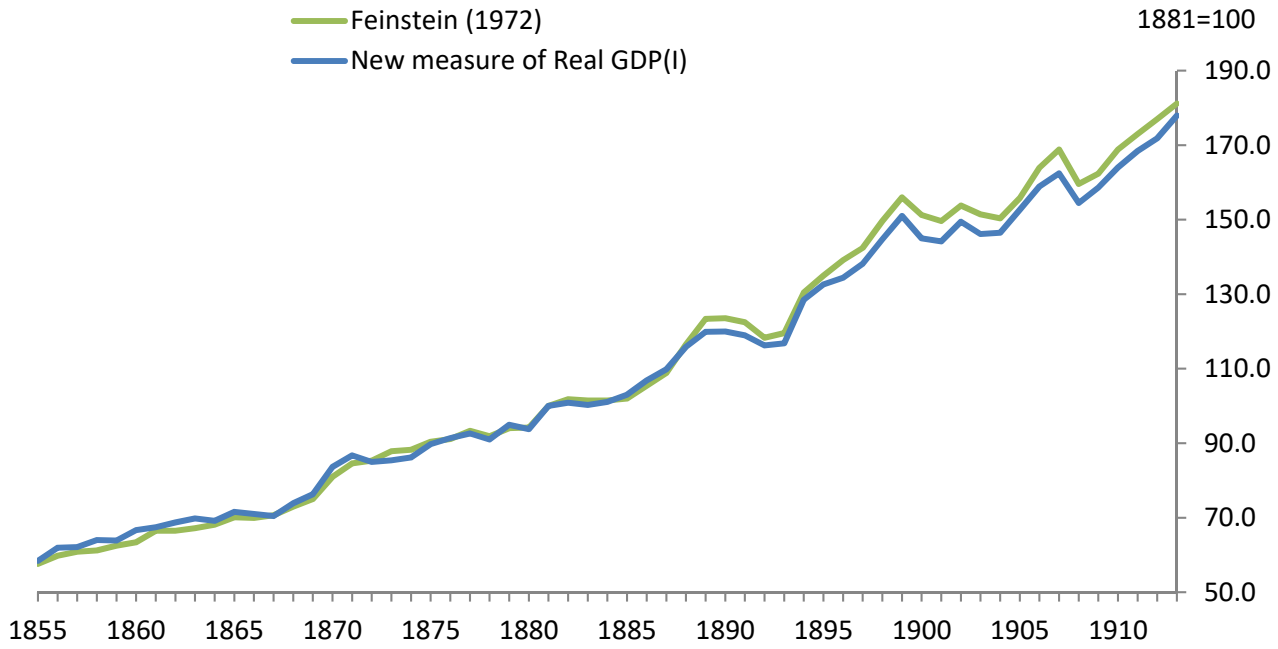


Chart 2.2: Real GDP(I) estimates old and new

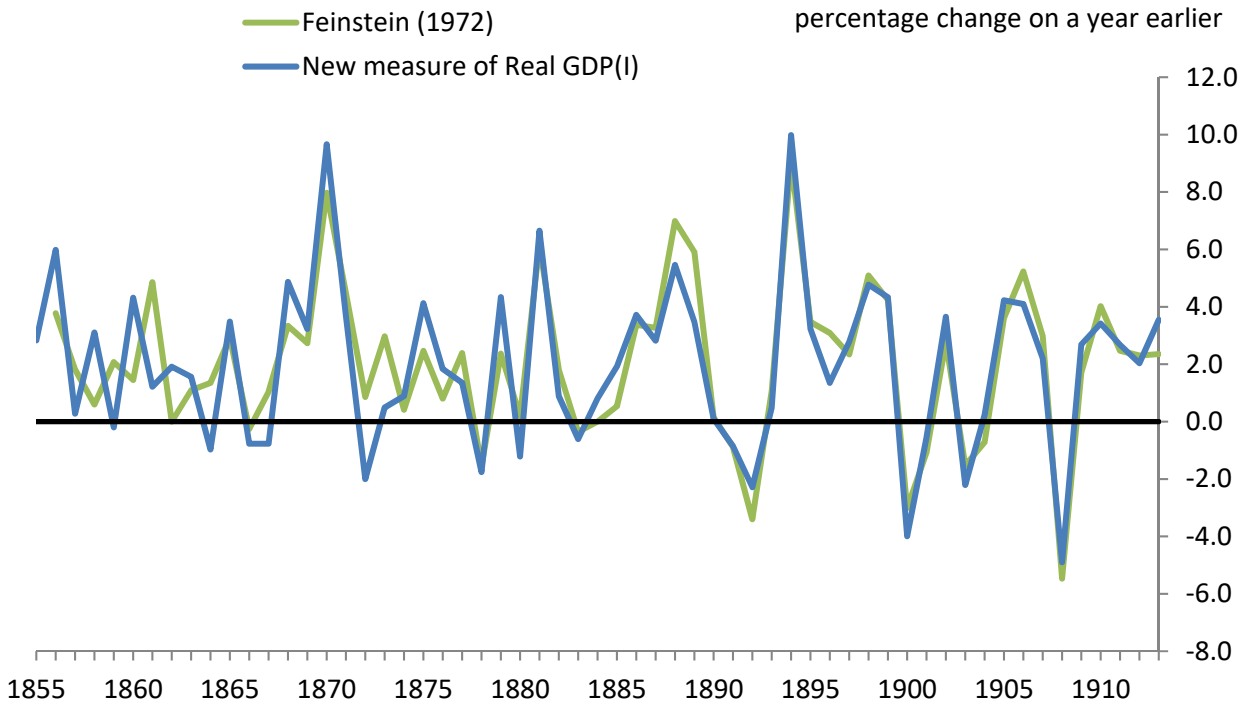
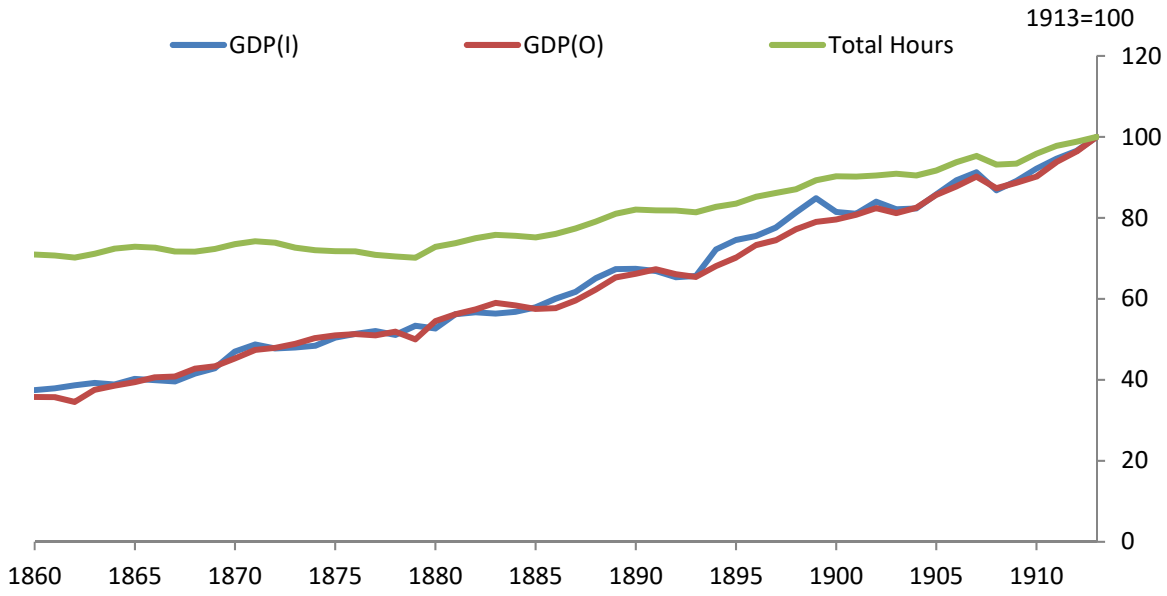


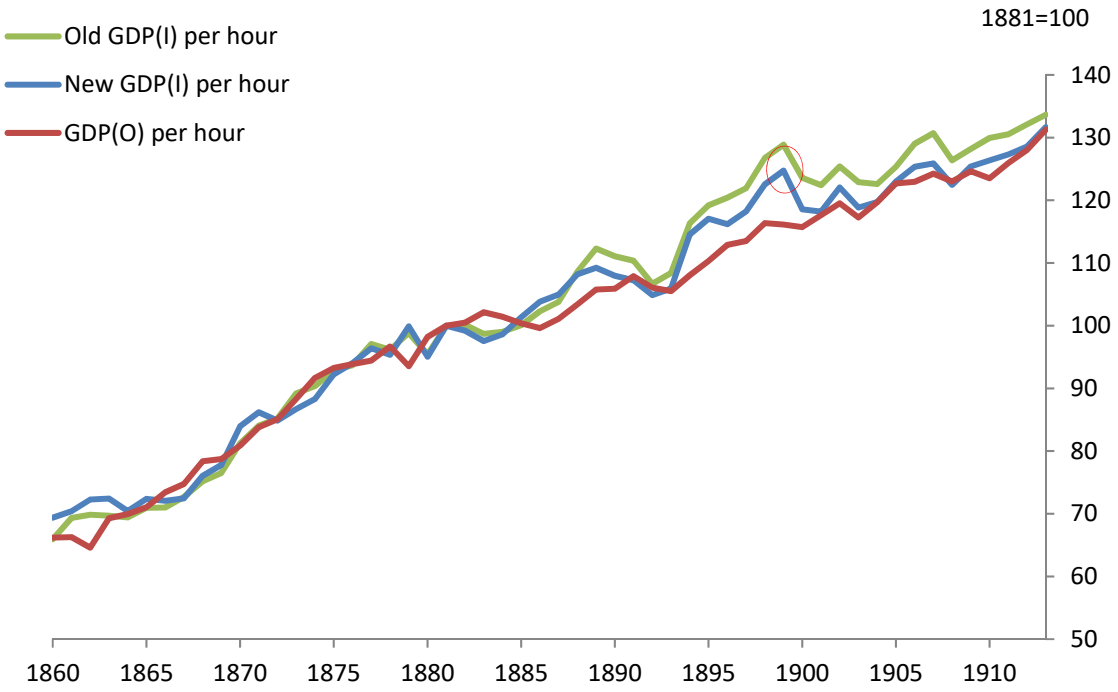
Chart 2.3: GDP and Total Hours worked 1860-1913



The issue for the late-Victorian economy was similar to the problem faced in the wake of the financial crisis of 2007/8 – productivity growth was unexpectedly and persistently weak given previous performance. This was examined in detail by Phelps Brown and Handfield Jones (1952). To examine the productivity issue we look at GDP per hour worked using total hours data sourced from Thomas and Dimsdale (2017) shown in **Chart 2.3**. Total hours worked grew very little in the twenty years leading up to 1880, in part due to a reduction in average hours worked in the early 1870s. Between 1880 and 1913 however growth in the workforce was not offset by a fall in hours worked. This pick up in total hours worked was not matched by a similar pick up in GDP growth. Indeed GDP growth appeared to weaken. As a result **Charts 2.4 and 2.5**

shows that labour productivity growth, as measured by GDP per hour worked, slowed relative to that experienced in the previous twenty years when both using the new GDP(I) measure and the output-based measure. However a key debating point in the literature has been the timing of the slowdown that occurred after this point. As has been well documented in the literature, Feinstein's (1972) estimates suggested that the output-based measure of GDP implied a much more gradual slowdown in productivity after 1880, whereas the income-based measure appeared to show a sharper slowdown around the turn of the century. The new estimates of GDP(I) have moved the income measure closer to the output measure but the differences between the two estimates remain **(Chart 2.4)**.

Chart 2.4: Productivity comparison between the income and output measures



The output-based measure suggests the slowdown in productivity growth might represent a natural waning in performance as older technologies such as the steam engine matured and their impact on productivity wore off whereas newer technologies such as electricity had yet to have much impact. The sharper slowdown in the income measure in the first decade of the C20th might suggest other supply-side causes are to blame such as the well-known increase industrial and labour unrest over this period (Feinstein (1990a)). So the profile of productivity growth matters for the interpretation of the performance of the Victorian economy.

One could draw many parallels here with the performance of the UK economy in the ten or so years since the Great Financial Crisis of 2007/8. A comparison of Charts 2.5 and 2.6 shows that in the twenty years prior to both 1881 and 2007 productivity per hour had grown at a robust rate of around 2% per annum. But in the years following both periods productivity growth slowed to such an extent that a productivity gap of 10-15% emerged after about ten years when compared with a counterfactual path based on the previous 20 year trend. Note that by 1913 the productivity gap that emerged after 1881 is the same on both a GDP(I) and GDP(O) basis.

However like today the there are various measurement issues to consider. As an example **Chart 2.5** appears to show that the experience of one year in 1900 (circled in the chart) is enough to account for the much of the difference between the output and income measures of productivity. The income measure falls by 5% in 1900 (as in fact does the expenditure measure of GDP) whereas the GDP(O) measure is fairly static. In an accounting sense this seems to be driven by a 6% increase in the GDP deflator (**Chart 2.7**). Without this fall, GDP(I) and GDP(O) would have delivered similar output and productivity growth in the 1899-1913 period and the puzzle between the GDP(I) and GDP(O) data would entirely be in the 1893-1899 period. The movement in the deflator requires further examination. It occurs during the Boer War and Feinstein himself made adjustments to the weights for the constant price trade data in this period because of the sharp movements in prices[22] . So further investigation into the GDP deflator (and the expenditure measure of GDP from which it is derived) is warranted over this period. Measurement issues to do with the output and expenditure measures are considered in Section 2.5

Chart 2.5: GDP per hour worked 1860-1913

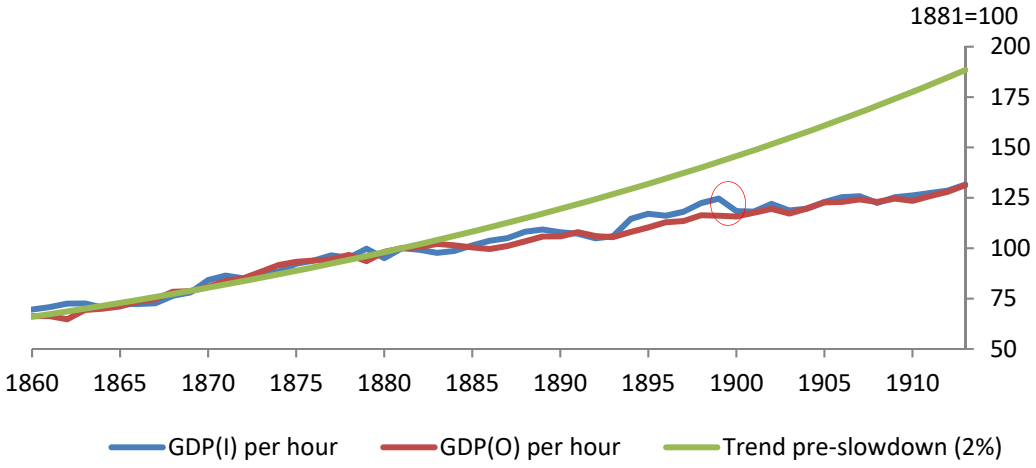
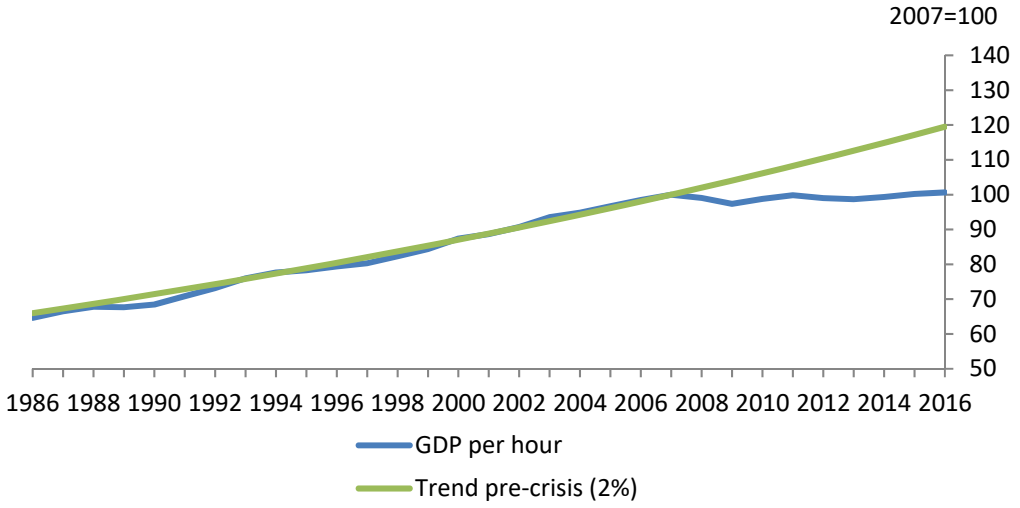
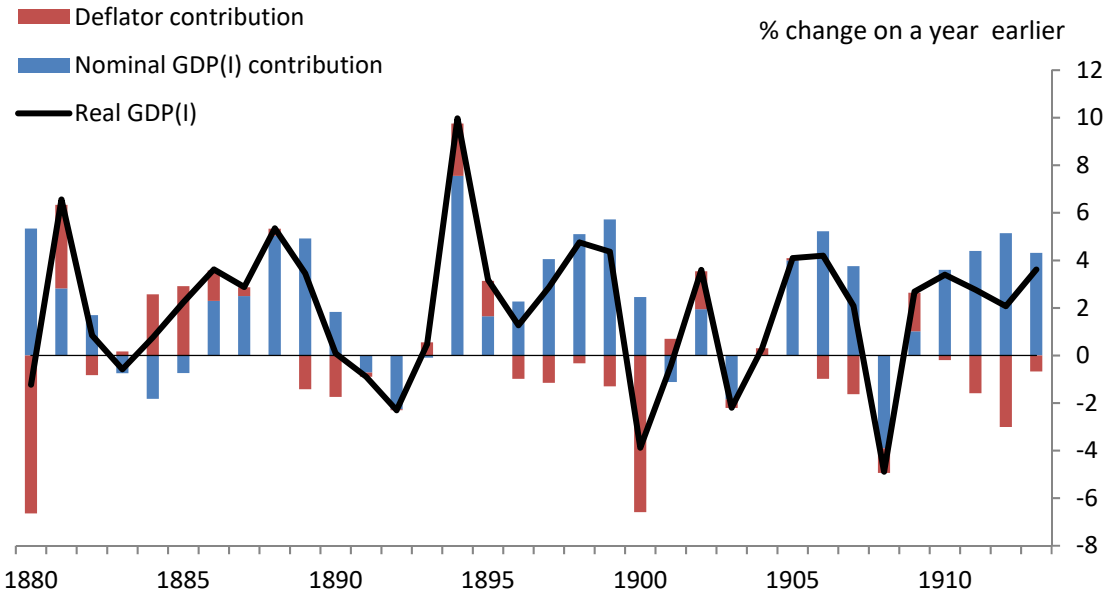


Chart 2.6: GDP per hour worked 1986-2016



[22] Feinstein (1972) page 117.

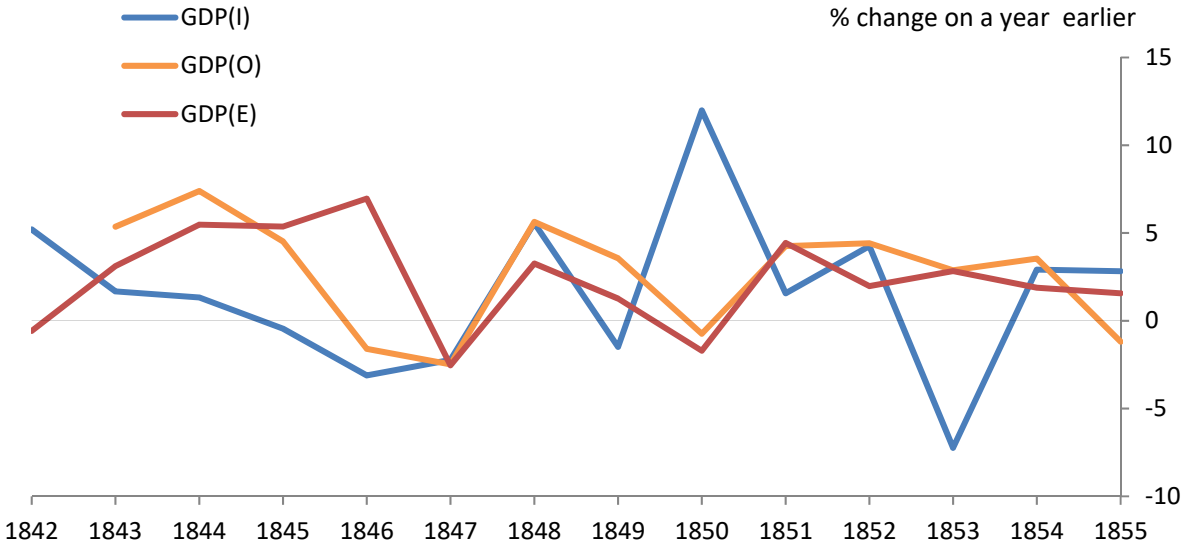
Chart 2.7: Contribution of the deflator to real GDP(I) growth



2.3 Real GDP growth - divergences in the 1840-1856 period

Given we have extended the GDPI data back to 1841 we are also now in a position to compare real GDP with the constant price GDP(E) measure from Mitchell (1988) and an output-based estimate for the UK based on Broadberry et al (2015) and Andersson and Lennard (2019). **Chart 2.8** compares the annual growth rates.

Chart 2.8: Real GDP measures compared 1842-1855

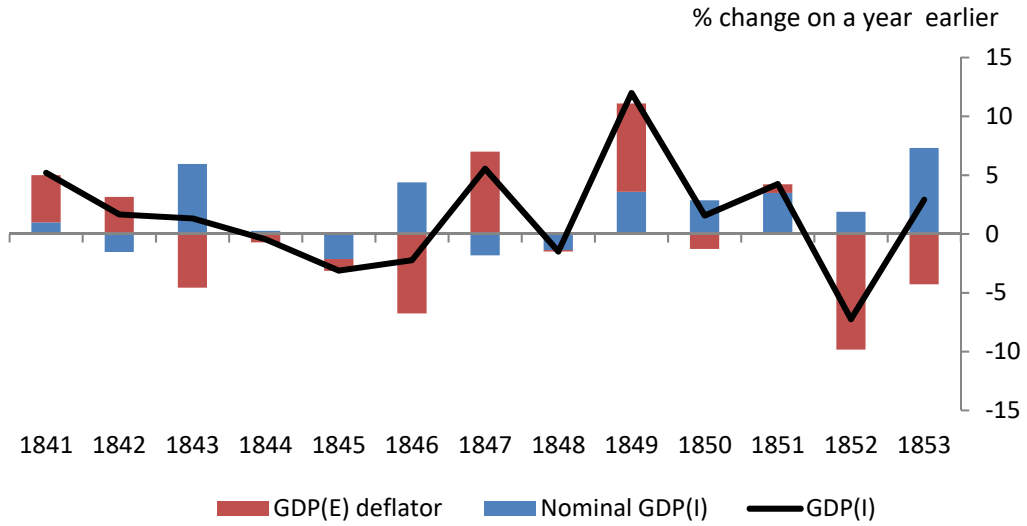


The chart shows that our estimates of real GDP(I) over this period have very different properties to the GDP(O) and GDP(E) measures. In particular there are very erratic movements in real GDP(I) in 1849 and

1852 which are not apparent in the other measures. However it is important to note that the GDP(O) and GDP(E) measures are not completely independent. For example real consumption expenditure in the GDP(E) measure is largely based on a combination of output indicators and overseas trade data (see Deane (1968)) which are the same or similar to those used in the Broadberry et al (2015) GDP(O) index. For example the consumption of domestic manufactures in constant prices is estimated as the output of manufacturing less exports. So it is not surprising they are close. Perhaps the main problem with the real GDP(I) estimates is that they show little growth in the mid-1840s railway boom unlike the expenditure and output measures.

Chart 2.9 suggests that the main issue here may again be the GDP(E) deflator used to deflate the GDP(I) data to get real GDP(I). The nominal GDP(I) data is relatively smooth compared to some of the more erratic movements in the GDP(E) deflator, which then necessarily implies volatile volumes as a residual. This contrasts with the approach used in the GDP(O) and GDP(E) data where the estimates are largely constructed using volume indicators with the nominal obtained by reflating the components with a price index. This means most of the volatility in the price series goes into the nominal GDP rather than real GDP component. This suggests some reconciliation analysis on the three measures should be carried out over this period in future work.

Chart 2.9: Contributions to Real GDP(I), 1842-1855



2.4 A new compromise estimate for 1841-1920

As a basis for future work we reconstruct a new compromise estimate for UK GDP for the post-1841 period, by taking simple averages of the three measures in constant price terms. Table 2.3 shows how the compromise estimate has evolved over time. The first column shows Feinstein's original compromise measure from his 1972 NIEOUK estimates. The second column shows the compromise estimate that appeared in Mitchell's (1988) volume which contained revisions to the expenditure side (investment and net trade) from Feinstein and Pollard (1988). The third column updates this estimate to include the recent revision to the GDP(O) estimate for the UK arising from the work on Great Britain by Broadberry et al.

(2015) and on Ireland by Andersson and Lennard (2019). So these are included in the calculation of the compromise estimate up to 1870 at which point the Broadberry et al (2015) series ends. Finally the new GDP(I) data from this paper is then included in column 4 and together with the recently revised output data and the existing expenditure measure back to 1830 allows a new compromise estimate for UK GDP to be constructed back to 1841. The balanced measure of Solomou and Weale (1991) from 1870 is shown for comparison.

Given the analysis in Section 2.3 however the real GDP(I) series is probably not worthy of a 1/3 weight until more work on the deflator is carried out over this period. And, as discussed in the next section, there are further improvements to the expenditure and output measures to be made. So we carry out no further analysis of the new compromise estimate here but merely document it as a benchmark for future research.

Table 2.3 – Updated Compromise Estimates of Real GDP, 1913=100

	Feinstein's Compromise Measure (1972)	Updated Compromise Estimate in Mitchell (1988)	Updated Series using newer GDP(O) estimates 1855-1870	**Present estimate based on new GDP(I) data**	Memo: Solomou and Weale's (1991) Balanced measure
1841				23.8	
1842				24.2	
1843				25.0	
1844				26.1	
1845				26.9	
1846				27.0	
1847				26.4	
1848				27.6	
1849				27.9	
1850				28.8	
1851				29.8	
1852				30.9	
1853				30.6	
1854				31.5	
1855	32.7	31.7	31.2	31.8	
1856	34.0	33.2	32.8	33.6	
1857	34.6	33.2	32.8	33.8	
1858	34.7	33.3	32.7	33.8	
1859	35.6	34.7	34.2	35.0	
1860	36.4	35.3	34.6	35.6	
1861	37.4	36.1	35.3	36.2	
1862	37.7	36.5	35.1	36.1	
1863	38.0	37.4	37.0	37.9	
1864	39.0	38.0	37.4	38.3	
1865	40.2	39.7	38.9	39.6	
1866	40.8	40.0	39.2	40.0	
1867	40.4	39.5	39.2	40.0	
1868	41.7	40.8	40.7	41.7	
1869	42.0	41.6	41.8	42.7	
1870	44.6	45.1	45.1	45.9	46.2
1871	47.0	46.8	46.8	47.5	48.5
1872	47.1	46.9	46.9	47.3	48.6
1873	48.2	48.4	48.3	48.4	48.9
1874	49.0	48.7	48.8	49.0	51.0
1875	50.2	50.0	50.0	50.4	51.4
1876	50.7	50.3	50.3	50.8	51.8
1877	51.2	51.0	51.0	51.4	52.0
1878	51.4	50.7	50.8	51.3	52.5
1879	51.2	51.1	51.2	51.7	51.3
1880	53.6	53.0	53.0	53.7	55.3
1881	55.5	55.2	55.2	55.8	56.4

	Feinstein's Compromise Measure (1972)	Updated Compromise Estimate in Mitchell (1988)	Updated Series using newer GDP(O) estimates 1855-1870	**Present estimate based on new GDP(I) data**	Memo: Solomou and Weale's (1991) Balanced measure
1882	57.1	56.7	56.7	57.0	57.4
1883	57.5	57.3	57.3	57.7	59.3
1884	57.6	57.6	57.6	58.2	58.8
1885	57.3	57.2	57.2	58.0	58.2
1886	58.2	58.2	58.1	59.1	58.7
1887	60.5	60.3	60.3	61.0	61.1
1888	63.2	62.8	62.8	63.2	63.0
1889	66.6	66.5	66.5	66.4	65.1
1890	66.9	66.9	66.9	66.7	65.6
1891	66.9	66.5	66.5	66.5	67.1
1892	65.3	64.9	64.9	65.1	65.7
1893	65.3	64.8	64.8	64.9	65.2
1894	69.7	69.9	69.9	70.0	68.5
1895	71.9	72.0	71.9	71.9	70.7
1896	74.9	74.5	74.5	74.4	73.8
1897	75.9	75.0	75.0	75.0	74.5
1898	79.6	79.0	79.0	78.8	78.0
1899	82.9	82.6	82.6	82.4	81.0
1900	82.3	81.4	81.4	81.0	80.4
1901	82.3	82.3	82.3	82.0	82.4
1902	84.4	83.8	83.7	83.7	83.6
1903	83.5	82.5	82.5	82.4	82.8
1904	84.0	83.4	83.4	83.5	83.9
1905	86.5	86.6	86.6	86.7	86.4
1906	89.4	88.7	88.6	88.6	88.6
1907	91.1	90.6	90.6	90.1	90.2
1908	87.4	87.1	87.1	87.1	86.8
1909	89.4	89.5	89.4	89.3	89.2
1910	92.2	91.7	91.6	91.4	91.5
1911	94.9	94.9	94.8	94.5	94.6
1912	96.3	96.1	96.1	95.8	95.9
1913	100.0	100.0	100.0	100.0	100.0
1914	101.0	102.3	102.3	102.4	
1915	109.1	108.8	108.8	109.1	
1916	111.5	110.9	110.9	111.2	
1917	112.5	111.7	111.7	112.1	
1918	113.2	114.1	114.1	114.5	
1919	100.9	102.8	102.8	103.1	
1920	94.8	94.8	94.8	95.0	

2.5 Towards a new balanced measure of Victorian and Edwardian GDP

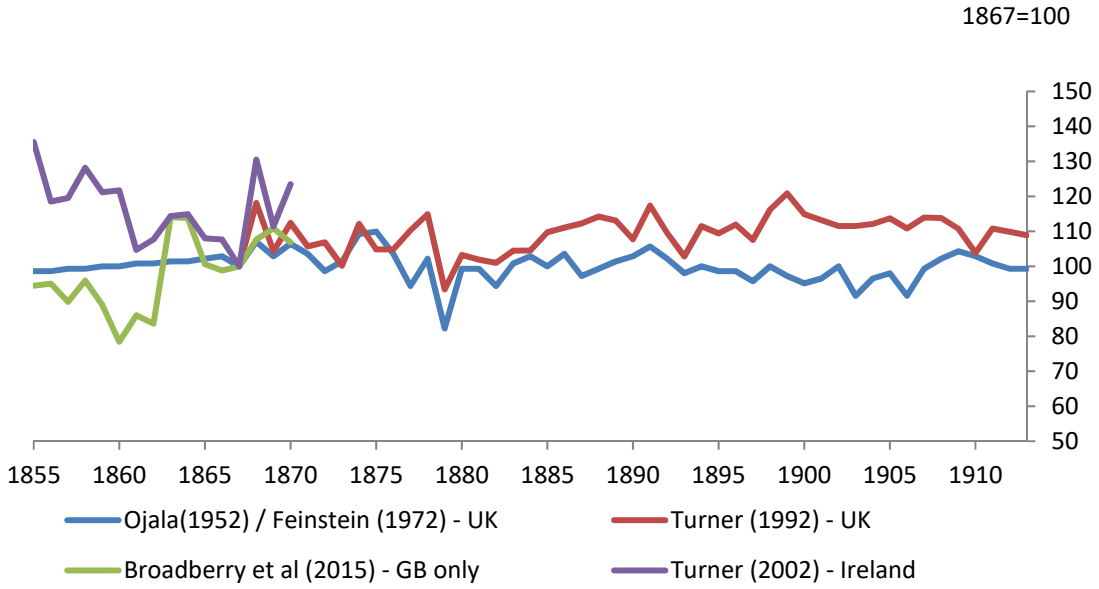
The income estimates compiled in this paper represent an initial step towards bringing together the improvements and revisions to the various components of GDP that Charles Feinstein made in the 20 years following the publication of his 1972 NIEOUK volume. There are several further potential improvements on the output and expenditure sides that need similar consideration which in turn offers the prospect of not only a completely revised compromise estimate but also a new balanced measure using the methods of Solomou and Weale (1991).

2.5.1 Future improvements to the output measure of GDP

The output measure of GDP in Feinstein's 1972 index relies heavily on the work of Ojala (1952) for agriculture and Lewis (1967, 1978) for industrial production.

For agriculture, Ojala – who had worked as part of Bellerby's group at the Oxford Agricultural Economics Research Institute – only published estimates for multi-year periods and so interpolation was required to create annual estimates. Lewis (1967) interpolated these estimates with annual estimates by Drescher (1955) which were constrained to match Ojala's multi- year estimates[23]. Feinstein took these interpolated estimates for NIEOUK. Turner (1992) however has managed to construct improved annual estimates based on recovering some of Bellerby's unpublished work. Broadberry et al (2015)'s estimates to 1870 for Great Britain and Turner's (2002) estimates for Ireland also show considerable fluctuation in the period prior to 1870 which are not reflected in the Lewis/Feinstein UK index. These should be incorporated into a future UK output-based index given the differences shown in **Chart 2.10.**

Chart 2.10: Agricultural output



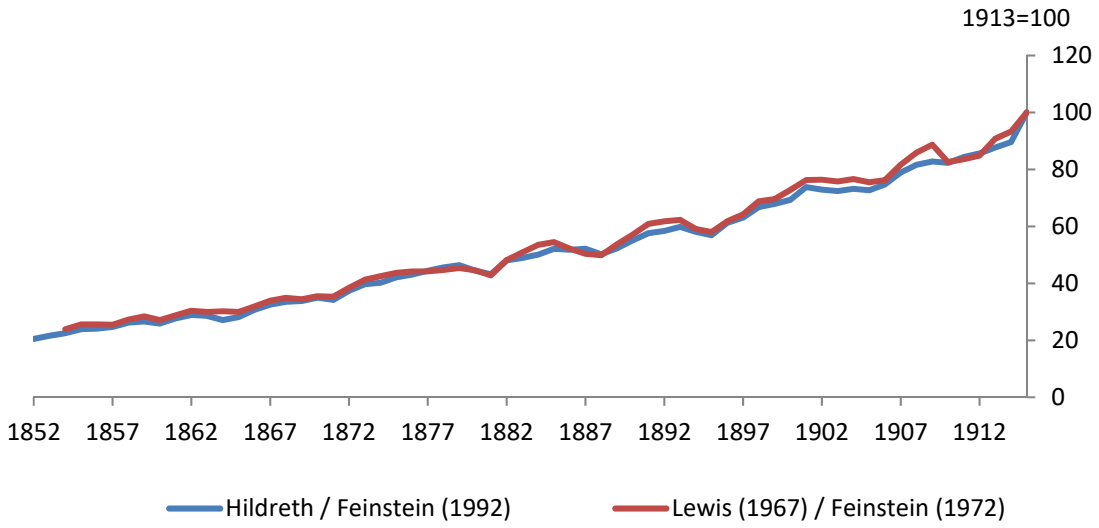
For industrial production Feinstein used the index of Lewis (1967) in NIEOUK. Lewis based his index on earlier work by Hoffman (1955) but made various improvements to the following sectors: iron and steel, iron and steel products, shipbuilding, building materials and construction, clothing, textile finishing,

[23] See Lewis (1967) Appendix III page 123.

printing, chemicals, electricity, food manufacture, gas, and meat. Importantly in assembling his index Lewis (1978) gave an artificial cyclical fluctuation to a number of important indices for individual industries where the annual fluctuations had been based on interpolation between benchmarks (eg chemicals) or where the annual fluctuations could not be trusted (eg printing). Lewis (1978) method involved smoothing the raw data using a nine year moving average and applying a different series of cyclical fluctuations, either based on the cycle of a related industry or the cyclical deviation from trend for the index of marriages in England and Wales which Lewis argued was highly correlated with production. The industries that were given an imposed cyclical movement were: iron and steel products, building materials for commercial property, clothing, printing, and chemicals. In total, these elements represent just over a quarter of the weight of Lewis (1978) index for industrial production.

Feinstein revisited Lewis' index in later work with Andrew Hildreth as part of an ESRC funded project[24]. The improved index appears in an unpublished paper by Hildreth (1992). Feinstein and Hildreth went back to Lewis's index and removed the artificial cyclical components that had been added in. They also made further improvements to certain industries but details of the revisions were not given in the paper except to note certain quality and productivity adjustments[25]. The series in Hildreth (1992) is shown in **Chart 2.11** and is compared to the Lewis index. The chart shows that the cyclical properties of the series are different. In particular the amplitude of the cycle of the Hildreth and Feinstein index is somewhat smaller and so is an indicator of the artificial cycles introduced into the Lewis index.

Chart 2.11– Lewis (1967) industrial production index and revised version in Hildreth (1992)



[24] ESRC project: 'Reconciliation and Revision of the U.K. National Accounts 1850-1990.
https://www.researchcatalogue.esrc.ac.uk/grants/R000231814/read/outputs

[25] The authors were able to contact Andrew Hildreth with the help of Nicholas Dimsdale but unfortunately none of the detailed data used in the project are still available. The relevant section of the paper says '*In brief changes made to individual sectors in the index for industrial production were carried out in terms of alterations made and justified by using results from research on individual industry sectors. As the raw data used to construct the indices was broadly the same as Hoffmann (1955) or Lewis (1978), any differences between the Lewis (1978) and revised indices were the result of changes made in terms of a change in quality of output produced, or a change in the technology of the production process'*. Hildreth (1992)

One other change that Lewis made to Hoffmann's original index is that he restricted his use of value-added weights to those from 1907. Hoffmann had sourced the 1907 weighs from the first census of production but he had used two earlier sets of weights, based on 1850 and 1881. However he did not specify where those weights came from so Lewis stuck to using just those of 1907. Investigation into the possibility of using an earlier set of weights is surely warranted in this regard although Lewis claimed using Hoffmann's weights made little difference to the overall indices. Feinstein himself started a piece of work that would have provided earlier weights – the construction of an input-output table for 1851. This project was started with Mark Thomas who carried on the work and which is now close to completion.

2.5.2 Future improvements to the expenditure measure of GDP

As discussed earlier, on the expenditure side of GDP many of Feinstein's revisions to investment and net trade from the work in Feinstein and Pollard (1988) appeared in Mitchell (1988)'s *British Historical Statistics*[26]. However these estimates are not the final word for the expenditure-based estimate of GDP.

One issue with the estimates is that the net trade figures were not split into separate export and import categories, unlike Feinstein (1972). This reflects the fact that in Feinstein and Pollard (1988), Feinstein had included estimates of net non-monetary gold and silver exports in order to create a more appropriate measure of the accumulation of net external assets. This was to differentiate the monetary role of precious metals from their industrial use as is still done in today's accounts. The necessity of this adjustment for non-monetary gold was also the subject of a paper by Jones and Obstfeld (1997) who carried through Feinstein's adjustments for non-monetary gold to 1945[27]. Because this adjustment was calculated on a net basis, the presentation in Mitchell (1988) understandably did not split out total exports and imports for the expenditure estimates of GDP. However, later tables in Mitchell[28] for the balance of payments shows the separate totals for exports and imports of goods and services from Feinstein (1972) for the post-1870 period (and Imlah (1958) prior to that) but does not contain the later adjustment for non-monetary gold and silver. This is at first somewhat confusing for those who try and compare the two sets of figures and are unaware of the non-monetary gold adjustments in Feinstein and Pollard (1988). No direct mention of this issue is made in Mitchell (1988). So an expansion and reconciliation of the different components in current and constant prices is required for transparency and to allow future research to improve these elements.

However when this reconciliation analysis is attempted a further issue emerges. **Table A.6** shows that the net trade figures ('Exports less imports') in current prices in Mitchell (1988) page 831, appear to also include net overseas transfers as well as total exports and imports of goods and services (from Feinstein (1972) and Imlah (1958)) and net non-monetary gold exports (from Feinstein and Pollard (1988)). Overseas transfers should not form part of GDP but part of Gross National Disposable Income. So the total for net trade and GDP measured from the expenditure side in Mitchell (1988) needs adjustment. Furthermore it is not clear how this issue then affects the deflated constant price estimates, as we need to uncover the implicit deflators used to create the constant price estimates of the net trade components. We know Feinstein used Imlah's (1958) export, import and re-export deflators for NIEOUK (1972) but some unpicking

[26] See pages 831 to 841.
[27] From 1946 the official UK trade data treats non-monetary gold exports and imports as one of the adjustments required to go from Overseas Trade Statistics (OTS) basis to a Balance of Payments basis.
[28] Table 15B National Accounts, Page 871.

of the constant price estimates and a removal of the overseas transfers from the constant price net trade figures in Mitchell (1988) is required for a full reconciliation. A full breakdown of the necessary annual figures is not directly available in Feinstein and Pollard (1988) so this will take some further work to unravel.

Small improvements could also be made to Feinstein's estimates of non-monetary gold exports themselves. These were based on taking net exports of bullion and adding in back in net monetary gold imports which are equivalent to increases in the monetary gold stock (Jones and Obstfeld (1997)). For the monetary gold stock Feinstein used Capie and Webber's (1985) estimates of gold coin in circulation outside the Bank of England plus Issue Department's holdings of bullion and specie from the Statistical Abstracts of the United Kingdom. However more refined estimates derived from the recently published daily account books of the Bank of England might now be constructed which would allow end period stocks of coin and bullion to be calculated more accurately.

There is also scope for revising other expenditure components given the recent work of Broadberry et al. (2015). The consumer expenditure estimates shown in Mitchell (1988) for the pre-1870 period are largely based on earlier work by Deane (1968). Feinstein had chosen not to include these in his 1972 estimates for expenditure (which only start in 1870) because he felt they were not sufficiently independent from other components of the accounts. For example, Deane had typically used a combination of production data and trade data to construct many of the categories of consumption. Broadberry et al (2015)'s newer estimates of production could be incorporated into the estimates for consumption expenditure. But this would require a full replication of Deane's estimates as a starting point. Although the sources and procedures are outlined in her 1968 paper, our attempts to match her series accurately have not yet succeeded. It may also be possible to bring the insights from the analysis of household budgets to bear on the Deane's pre-1870 estimates as well. For example, Horrell (1996) examines some of the reconciliation issues of household budgets with national estimates of consumption.

Finally, annual chain-linking of the expenditure components is now relatively straightforward to do with current technology. Applying this to a set of improved expenditure components may reveal certain changes in the pattern of growth over the Victorian period. The cost of annual chain-linking would be the lack of additivity in the volume components which is a feature of the current estimates. But forced additivity is not a virtue if it stands in the way of improved volume estimates and an improved deflator to apply to the nominal GDP(I) data.

3 Conclusion

This paper has attempted to bring together some of the improvements to C19th national income estimates since the publication of Charles Feinstein's 1972 volume *National Income, Expenditure and Output of the United Kingdom, 1855-1965.* Most of the improvements and refinements were made by Feinstein himself and this paper makes a start in bringing the different elements together focusing chiefly on reconstructing the income-based estimates, but also outlining where improvements might be made on the output and expenditure sides. We have also incorporated the improvements of other scholars and provided a new set of benchmark compromise estimates. We have also compared the productivity slowdown in the late C19th and early C20th with that of the recent financial crisis and shown that similar measurement issues are prevalent in both periods particularly with regard to deflators.

We hope this stock take and the discussion of the various measurement issues that remain encourages future work to be done on the national accounts components over this period. Once improvements and extensions are made there would then be scope for constructing new balanced estimates of GDP for the C19th and early C20th, using modern techniques which would allow existing puzzles and issues in the data to be re-explored and new insights to be gained.

Appendices

Table A1: Employment estimates 1841-1920, 000s

	Total UK workforce	o/w Armed forces	o/w Civilian wage earners	**Unemployment rate**	**Employment incl. Armed forces**
1841	12061	135	9693	8.32	9021
1842	12142	139	9698	8.39	9023
1843	12247	140	9705	7.55	9112
1844	12359	136	9714	5.96	9271
1845	12463	140	9726	4.39	9439
1846	12555	149	9740	6.61	9245
1847	12529	150	9755	7.66	9158
1848	12382	157	9773	10.64	8890
1849	12312	143	9793	8.34	9119
1850	12243	138	9815	6.40	9325
1851	12180	138	9838	4.92	9493
1852	12220	148	9890	5.26	9517
1853	12279	148	9943	3.35	9758
1854	12348	192	9998	4.45	9745
1855	12460	250	9958	5.81	9630
1856	12560	280	10015	3.32	9963
1857	12660	230	10137	4.52	9910
1858	12770	250	10211	6.91	9755
1859	12880	270	10284	4.50	10091
1860	12980	300	10341	2.84	10347
1861	13090	300	10430	4.53	10258
1862	13180	290	10508	6.71	10093
1863	13280	280	10595	5.56	10286
1864	13370	270	10673	4.50	10463
1865	13470	270	10752	3.92	10601
1866	13560	250	10838	3.25	10736
1867	13660	250	10916	5.35	10582
1868	13760	250	10994	5.08	10686
1869	13850	240	11072	5.07	10751
1870	13950	240	11150	4.40	10900
1871	14050	250	11220	3.60	11066
1872	14150	250	11296	2.70	11241
1873	14250	240	11380	2.80	11301
1874	14350	240	11455	3.30	11317
1875	14450	240	11531	4.00	11310
1876	14550	240	11606	4.80	11289
1877	14650	250	11673	6.60	11153
1878	14750	260	11741	7.90	11073
1879	14850	250	11824	9.10	10998
1880	14960	240	11915	6.60	11369

1881	15060	240	11990	5.70	11547
1882	15210	240	12100	5.00	11735
1883	15370	240	12218	4.90	11860
1884	15520	240	12328	6.30	11791
1885	15680	250	12438	8.00	11693
1886	15840	260	12547	7.90	11816
1887	16000	270	12656	7.10	12027
1888	16160	270	12773	5.80	12302
1889	16330	270	12897	4.30	12613
1890	16490	270	13014	4.00	12763
1891	16660	280	13130	4.90	12767
1892	16850	280	13262	6.10	12733
1893	17050	290	13394	7.30	12706
1894	17240	290	13526	7.00	12869
1895	17440	300	13657	7.30	12960
1896	17640	310	13787	6.10	13256
1897	17840	310	13925	5.90	13413
1898	18050	320	14063	4.90	13693
1899	18260	340	14192	4.30	13921
1900	18470	490	14217	4.30	14096
1901	18680	530	14330	5.70	14043
1902	18840	500	14453	6.00	14086
1903	19010	420	14623	6.50	14092
1904	19180	410	14737	8.00	13968
1905	19350	400	14851	7.50	14137
1906	19520	390	14964	6.00	14456
1907	19690	380	15076	5.10	14687
1908	19860	380	15180	8.20	14316
1909	20040	390	15284	8.70	14344
1910	20210	390	15387	6.70	14746
1911	20390	400	15490	5.50	15038
1912	20560	400	15663	4.60	15343
1913	20740	400	15845	4.20	15580
1914	20910	810	15700	3.74	15923
1915	21090	2490	14566	1.21	16880
1916	21270	3500	13953	0.44	17391
1917	21450	4250	13541	0.65	17702
1918	21630	4430	13576	0.91	17883
1919	21820	2130	15582	3.74	17129
1920	22000	760	16853	2.25	17233

* There are some small discrepancies between Feinstein's working population figures at some of the census dates in his 1972 and 1989/90 estimates. Feinstein's 1989/90 estimates show 15100 for 1881 and 20380 for 1911. The armed forces estimates are also slightly different (370 instead of 400 for 1911). The annual time series of Feinstein (1972) however have been retained here and the series has not been re-interpolated for the slight differences in his later census benchmarks. The effect on the estimates is not significant.

Table A2: Total Salaries, £mn

	Schedule E	Salaries in Schedule D	Salaries below £160	**Total salaries**	*Memo: Feinstein estimate*	*Revision*
1841	9	6	26	35		
1842	9	6	25	34		
1843	11	7	30	41		
1844	11	7	29	39		
1845	11	7	30	41		
1846	11	7	30	42		
1847	11	7	31	43		
1848	12	7	32	43		
1849	11	7	30	42		
1850	11	7	30	41		
1851	11	7	30	41		
1852	11	7	30	41		
1853	11	7	31	42		
1854	12	8	33	44		
1855	13	8	36	57	43	14
1856	14	9	37	60	46	14
1857	14	9	38	61	46	15
1858	15	10	40	64	48	16
1859	14	9	39	63	47	16
1860	15	10	40	65	50	15
1861	15	10	41	66	50	16
1862	16	10	42	68	52	16
1863	17	11	43	70	54	16
1864	18	11	43	72	56	16
1865	19	12	44	75	58	17
1866	19	12	45	76	59	17
1867	19	12	46	77	59	18
1868	19	13	46	78	60	18
1869	21	14	47	82	64	18
1870	22	14	48	84	66	18
1871	22	14	49	85	67	18
1872	24	16	50	90	72	18
1873	25	16	51	92	74	18
1874	26	17	51	94	77	17
1875	27	17	52	97	79	18
1876	28	18	53	99	82	17
1877	29	19	54	102	85	17
1878	29	19	55	104	86	18
1879	30	19	56	105	88	17
1880	30	20	57	107	90	17
1881	32	21	58	110	94	16
1882	33	21	59	113	96	17

1883	35	23	60	117	101	16
1884	35	23	61	119	102	17
1885	35	23	63	121	103	18
1886	36	23	64	123	105	18
1887	38	24	65	126	108	18
1888	39	23	66	129	110	19
1889	43	24	67	134	116	18
1890	44	23	69	135	117	18
1891	45	22	70	137	120	17
1892	47	22	71	141	125	16
1893	48	22	73	143	129	14
1894	52	24	75	151	138	13
1895	51	23	77	151	139	12
1896	55	22	78	156	145	11
1897	58	22	80	160	151	9
1898	62	21	82	165	157	8
1899	66	20	84	170	163	7
1900	72	21	86	179	173	6
1901	75	21	88	184	179	5
1902	78	21	89	189	184	5
1903	82	22	91	194	191	3
1904	85	22	92	199	196	3
1905	89	22	93	204	202	2
1906	93	23	95	210	208	2
1907	98	24	96	218	217	1
1908	104	26	98	228	227	1
1909	108	25	99	233	232	1
1910	114	26	100	240	240	0
1911	121	26	102	249	249	0
1912	129	28	106	263	263	0
1913	138	30	111	279	279	0
1914	148*	32*	116	296	296	0

*There is a discrepancy in Feinstein (1972) for the 1914 estimates for Salaries under Schedules E and D. Summary Table 2.3 provides figures of 145 and 35 respectively. Inspection of Table 7.16 however suggests the figure under Schedule E should be 148 implying a figure 32 for salaries in Schedule D is consistent with the total. An inspection of Feinstein's underlying working sheets shows numbers of 148 and 32 and so we have used these here and so the numbers in summary Table 2.3 appear to be typos.

Table A3: Derivation of gross trading profits of companies, public corporations, local authority trading enterprises and non-farm self-employed income*

	+ Schedule C Taxable income	+ Schedule D Taxable income	- Taxable income adjustment	- Interest paid in the UK	- Salaries assessed under schedule D	+ Small incomes exempt from tax	+ Total Evasion	+ Co-ops and charities	- Net property income from abroad	+ Depreci-ation	= Gross trading profits + non-farm self-employment income
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	
1841	28	59	2	23	6	34	33	0	6	9	124
1842	28	62	2	23	6	36	35	0	6	9	131
1843	27	57	2	23	7	33	32	0	7	9	119
1844	26	69	3	24	7	40	39	0	8	9	142
1845	26	66	2	22	7	38	37	0	10	9	134
1846	26	59	2	22	7	34	33	0	10	9	118
1847	26	64	2	22	7	37	36	0	11	9	128
1848	26	67	2	22	7	38	38	0	9	9	136
1849	26	62	2	22	7	36	35	0	8	9	127
1850	26	71	3	22	7	41	40	0	9	9	145
1851	26	75	3	22	7	43	43	0	10	8	154
1852	26	80	3	22	7	46	45	0	11	9	164
1853	28	71	3	22	7	41	40	0	12	11	147
1854	27	76	3	21	8	44	43	0	13	12	158
1855	26	86	3	22	8	49	48	0	13	13	176
1856	27	94	3	22	9	54	53	0	15	13	192
1857	29	90	3	22	9	52	50	0	17	13	184
1858	29	97	4	23	10	56	54	0	16	13	198
1859	29	95	4	21	9	55	52	0	17	13	194
1860	28	103	4	21	10	60	56	0	19	14	207
1861	29	114	4	21	10	61	61	0	20	14	224
1862	30	125	5	21	10	63	66	0	21	14	242
1863	31	133	5	21	11	64	70	0	22	15	255
1864	32	146	5	21	11	67	76	0	23	17	276
1865	33	147	5	21	12	65	76	1	24	18	276
1866	33	151	6	22	12	63	77	1	27	19	277
1867	34	143	5	22	12	57	72	1	29	19	257
1868	34	153	6	22	13	57	77	1	32	19	269
1869	35	171	6	23	14	60	85	1	34	19	295
1870	37	192	7	23	14	62	94	1	36	21	328
1871	38	221	8	23	14	67	103	1	40	22	367
1872	40	235	9	23	16	67	103	2	45	26	379
1873	41	248	9	23	16	68	102	2	53	30	390
1874	42	248	9	23	17	66	95	2	58	32	378
1875	42	245	9	24	17	65	87	2	59	31	362
1876	40	238	9	24	18	63	79	3	59	29	342
1877	39	238	9	24	19	62	72	3	56	28	335

1878	39	235	9	25	19	60	65	3	56	28	322
1879	39	241	9	25	19	61	61	3	57	28	323
1880	39	266	10	25	20	66	60	3	59	29	350
1881	39	279	10	25	21	70	61	3	60	29	365
1882	39	279	10	25	21	70	60	4	64	30	361
1883	39	270	10	25	23	68	56	4	66	31	345
1884	40	259	10	25	23	66	53	4	68	30	326
1885	40	259	10	25	23	66	52	5	71	29	322
1886	42	277	10	26	23	70	54	5	75	28	340
1887	44	292	11	26	24	73	55	5	81	28	356
1888	44	321	12	24	23	79	59	5	86	28	391
1889	42	345	13	23	24	85	62	6	90	30	420
1890	40	340	13	23	23	85	59	6	96	31	408
1891	37	325	12	23	22	80	55	7	96	31	381
1892	36	304	11	22	22	76	50	7	96	32	352
1893	37	305	11	22	22	77	48	7	96	31	354
1894	37	357	13	21	24	90	55	7	94	31	424
1895	37	366	14	21	23	91	54	7	95	32	434
1896	37	369	14	21	22	88	53	9	98	33	433
1897	37	392	15	22	22	90	54	9	99	34	459
1898	38	426	16	22	21	98	56	9	103	36	503
1899	38	465	17	23	20	106	59	11	105	40	552
1900	39	459	17	25	21	106	56	11	105	44	547
1901	42	434	16	27	21	101	51	12	108	45	511
1902	44	446	16	27	21	104	50	13	111	46	526
1903	43	423	16	28	22	98	45	14	114	47	491
1904	43	422	16	29	22	97	43	14	115	49	486
1905	44	462	17	27	22	106	44	14	126	52	530
1906	44	508	19	29	23	116	46	15	136	55	578
1907	45	539	20	28	24	120	46	16	146	59	607
1908	45	493	18	27	26	104	39	16	154	59	531
1909	45	512	19	27	25	107	38	17	161	60	548
1910	46	551	20	27	26	110	38	17	173	63	579
1911	46	573	21	28	26	117	37	18	180	66	602
1912	47	624	23	26	28	125	38	19	190	71	656
1913	48	656	25	26	30	130	37	20	203	75	682

*Note Central Government Trading Surplus is derived separately and shown in Table A5.

Table A.4: Farmers' incomes

	Total factor incomes	Wages	Rent	Farmers' income	*Memo: Agricultural prices (1700=100)*	*Memo: Agricultural output (1700=100)*
1841				28	185.82	289.70
1842				29	173.09	315.59
1843				26	159.63	315.78
1844				30	164.41	346.01
1845				29	168.95	326.09
1846				29	173.46	319.09
1847				36	203.93	339.22
1848				28	168.76	319.21
1849				28	155.25	337.18
1850				23	140.27	309.69
1851				24	139.22	323.22
1852				27	146.21	344.76
1853				29	172.83	297.48
1854				41	193.79	370.04
1855	146	61	45	40	199.12	339.09
1856	149	60	47	42	198.53	341.15
1857	155	57	49	49	190.69	322.47
1858	146	56	49	41	169.37	344.26
1859	143	57	49	37	171.59	319.35
1860	142	56	49	37	189.42	281.60
1861	154	56	50	48	191.74	308.78
1862	155	56	50	49	185.94	300.16
1863	158	55	50	53	181.49	409.40
1864	148	55	50	43	172.67	408.52
1865	151	56	49	46	188.72	361.29
1866	156	56	50	50	198.81	354.66
1867	160	55	51	54	207.32	359.02
1868	156	55	52	49	203.37	386.47
1869	140	53	53	34	197.73	398.12
1870	156	57	53	46	195.61	383.66
1871	159	56	54	49		
1872	161	62	55	44		
1873	172	61	56	55		
1874	164	61	56	47		
1875	163	62	57	44		
1876	161	61	57	43		
1877	154	61	58	35		

	Total factor incomes	Wages	Rent	Farmers' income
1878	146	60	56	30
1879	126	58	55	13
1880	132	58	53	21
1881	135	58	53	24
1882	141	57	55	29
1883	136	57	55	24
1884	133	56	53	24
1885	127	55	51	21
1886	127	54	49	24
1887	124	54	48	22
1888	125	54	48	23
1889	126	54	48	24
1890	133	55	48	30
1891	139	54	48	37
1892	130	54	47	29
1893	125	54	46	25
1894	121	54	45	22
1895	122	54	44	24
1896	124	54	43	27
1897	127	54	42	31
1898	123	54	41	28
1899	130	55	41	34
1900	130	56	41	33
1901	130	56	41	33
1902	138	56	42	40
1903	127	56	41	30
1904	127	56	41	30
1905	131	56	41	34
1906	139	57	42	40
1907	140	57	42	41
1908	145	56	43	46
1909	136	56	43	37
1910	135	57	43	35
1911	152	58	43	51
1912	148	59	43	46
1913	142	60	43	39
1914	173	62	44	67
1915	188	65	44	79
1916	236	64	45	127
1917	279	78	46	155
1918	306	87	46	173
1919	345	122	47	176
1920	395	150	48	197

Table A5: Breakdown of Gross Trading Profits and Self Employment income

	Non-farm self-employment income	Gross trading profits of companies	Gross trading surplus of local authority trading enterprises	Total from Table A.3	+ Farm incomes	+ Central Government Trading Surplus	= Gross trading profits + self-employment income
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
1841	*86*	*38*		124	28		153
1842	*91*	*40*		131	29		160
1843	*83*	*37*		119	26		146
1844	*98*	*44*		142	30		172
1845	*93*	*41*		134	29		163
1846	*82*	*36*		118	29		147
1847	*89*	*39*		128	36		164
1848	*94*	*42*		136	28		164
1849	*88*	*39*		127	28		154
1850	*100*	*44*		145	23		168
1851	*107*	*47*		154	24		177
1852	*114*	*50*		164	27		191
1853	*102*	*45*		147	29		176
1854	*110*	*49*		158	41		200
1855	*122*	*54*		176	40		216
1856	*133*	*59*		192	42		234
1857	*128*	*56*		184	49		233
1858	*137*	*61*		198	41		239
1859	*135*	*60*		194	37		231
1860	*144*	*64*		207	37		244
1861	*155*	*69*		224	48		272
1862	*168*	*74*		242	49		291
1863	*177*	*78*		255	53		308
1864	*191*	*85*		276	43		319
1865	*191*	*85*		276	46		322
1866	*192*	*85*		277	50		327
1867	*178*	*79*		257	54		311
1868	*187*	*83*		269	49		318
1869	*204*	*90*		295	34		329
1870	*227*	*101*		328	46		374
1871	*254*	*113*		367	49		416
1872	*263*	*116*		379	44		423
1873	*270*	*120*		390	55		445
1874	*262*	*116*		378	47		425
1875	*251*	*111*		362	44		406
1876	*237*	*105*		342	43		385
1877	*233*	*103*		335	35		370

1878	*223*	*99*		322	30		352
1879	*224*	*99*		323	13		336
1880	*243*	*107*		350	21		371
1881	*253*	*112*		365	24		389
1882	*250*	*111*		361	29		390
1883	*239*	*106*		345	24		369
1884	*226*	*100*		326	24		350
1885	*223*	*99*		322	21		343
1886	*236*	*104*		340	24		364
1887	*246*	*109*		356	22		378
1888	*271*	*120*		391	23		414
1889	291	125	4	420	24		444
1890	280	122	5	408	30		438
1891	262	115	5	381	37		418
1892	240	107	5	352	29		381
1893	234	114	6	354	25		379
1894	277	141	6	424	22		446
1895	277	151	6	434	24		458
1896	270	157	6	433	27		460
1897	278	176	6	459	31		490
1898	295	201	7	503	28		531
1899	319	226	7	552	34		586
1900	310	229	7	547	33	1	581
1901	289	216	7	511	33	1	545
1902	293	224	9	526	40	1	567
1903	272	209	10	491	30	1	522
1904	268	205	13	486	30	1	517
1905	289	229	12	530	34	1	565
1906	306	259	13	578	40	1	619
1907	320	274	14	607	41	1	649
1908	273	244	14	531	46	1	578
1909	284	248	16	548	37	1	586
1910	298	265	16	579	35	1	615
1911	307	278	17	602	51	1	654
1912	325	313	18	656	46	3	705
1913	333	332	17	682	39	3	724

Table A6: Reconciling Net Trade in Feinstein (1972) and Mitchell (1988)

	Net Trade in goods and services excl. all bullion flows Feinstein (1972), /Imlah (1958)	Net-non monetary gold exports	Net overseas transfers	Sum of components	'Exports less Imports' from Mitchell (1988)	**Corrected Total for Net Trade**
	(1)	(2)	(3)	(4)=(1)+(2)+(3)	(5)	(6)=(1)+(2)
1830	1	-3	-1	-3	-3	-2
1831	-4	3	-1	-2	-2	-1
1832	4	-1	-2	2	2	3
1833	2	-2	-1	-1	-1	0
1834	0	2	-1	1	1	2
1835	5	1	-1	5	5	6
1836	-4	2	-1	-3	-3	-2
1837	-3	-2	-1	-6	-6	-5
1838	-3	0	-1	-4	-4	-4
1839	-8	4	-1	-5	-5	-4
1840	-9	1	-1	-9	-9	-8
1841	-2	0	-2	-4	-4	-2
1842	-2	1	-2	-3	-3	-1
1843	7	1	-1	7	7	8
1844	6	1	-1	6	6	7
1845	2	0	-1	1	1	2
1846	1	1	-2	0	0	2
1847	-14	3	-3	-14	-14	-11
1848	-5	1	-3	-7	-7	-4
1849	-2	0	-4	-5	-5	-1
1850	5	0	-3	2	2	5
1851	3	0	-3	0	0	3
1852	8	-4	-4	1	1	5
1853	1	-3	-3	-5	-5	-2
1854	0	-2	-3	-5	-5	-2
1855	11	-4	-2	5	5	7
1856	11	-1	-2	8	8	10
1857	6	4	-2	8	8	10
1858	17	-4	-1	12	12	13
1859	22	-1	-1	20	20	21
1860	4	1	-1	4	4	5
1861	-7	2	-1	-6	-6	-5
1862	-6	-2	-1	-9	-9	-8
1863	11	-3	-2	6	6	8
1864	6	-4	-2	1	1	3
1865	19	-5	-2	12	12	14
1866	21	-10	-2	9	9	11
1867	25	-9	-2	15	15	17
1868	11	-4	-1	6	6	7
1869	20	-4	-2	14	14	16

1870	22	-3	-2	17	17	19
1871	39	6	-2	43	43	45
1872	55	1	-2	54	54	56
1873	36	-4	-2	30	30	32
1874	23	-7	-2	14	14	16
1875	0	-3	-1	-4	-4	-3
1876	-26	-6	0	-32	-32	-32
1877	-45	-2	0	-47	-47	-47
1878	-31	-9	-1	-41	-41	-40
1879	-24	10	-1	-15	-15	-14
1880	-23	-4	-2	-29	-29	-27
1881	3	3	-2	4	4	6
1882	0	-1	-2	-3	-3	-1
1883	-12	-1	-3	-16	-16	-13
1884	5	1	-2	4	4	6
1885	-7	0	-1	-8	-8	-7
1886	5	0	-1	4	4	5
1887	11	-3	-2	6	6	8
1888	9	3	-2	10	10	12
1889	-4	0	-2	-6	-6	-4
1890	14	-4	-1	9	9	10
1891	-21	0	-1	-22	-22	-21
1892	-31	1	-1	-31	-31	-30
1893	-37	-3	-1	-41	-41	-40
1894	-43	-5	0	-48	-48	-48
1895	-38	-1	-1	-40	-40	-39
1896	-45	1	-1	-45	-45	-44
1897	-55	0	-1	-56	-56	-55
1898	-71	-6	-1	-78	-78	-77
1899	-55	1	-1	-55	-55	-54
1900	-68	-8	-2	-78	-78	-76
1901	-82	0	-5	-87	-87	-82
1902	-77	-8	-8	-93	-93	-85
1903	-64	-2	-5	-71	-71	-66
1904	-59	0	-2	-61	-60	-59
1905	-32	-1	-3	-36	-36	-33
1906	-10	-3	-3	-16	-16	-13
1907	22	0	-4	18	18	22
1908	1	10	-2	9	9	11
1909	-13	-3	-3	-19	-19	-16
1910	8	-3	-4	1	1	5
1911	30	5	-3	32	32	35
1912	20	2	-4	18	18	22
1913	39	-2	-4	33	33	37
1914	-55	-31	-1	-87	-87	-86
1915	-220	4	0	-216	-216	-216
1916	-140	9	30	-101	-101	-131

1917	-175	-24	30	-169	-169	-199
1918	-460	28	10	-422	-422	-432
1919	-210	35	0	-175	-175	-175
1920	64	49	-1	112	112	113

Column 1: Derived from Feinstein (1972)/Imlah (1958) excluding all bullion flows, see sheet A36 in Thomas and Dimsdale (2017) and Mitchell pages 869-781.
Column 5: From Mitchell (1988), page 837.

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