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The Pre-1914 UK Productivity Slowdown: A Reappraisal

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Abstract

This paper re-examines UK productivity growth in the decades before World War I using a new dataset compiled by Thomas and Dimsdale (2017). We find that the productivity slowdown of the early 20th century was quite modest and does not deserve to be called a climacteric. A more serious slowdown in labour productivity growth occurred in the 1870s. Neither of these episodes should be regarded as a precedent for the current severe deterioration in UK productivity performance. Nor should a late-Victorian productivity slowdown be attributed to the end of the steam age despite the popularity of this belief.

Keywords: climacteric; growth accounting; Hodrick-Prescott filter; productivity slowdown

JEL Classification: N13; O47

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1. Introduction

The weakness of UK productivity growth since the start of the financial crisis has been remarkable and is still not fully understood. The so-called 'productivity puzzle' is captured by the observation that in 2018 quarter 4, real GDP per hour worked was actually only 2.0 per cent above the pre-crisis peak level seen in 2007 quarter 4 and was 18.3 per cent lower than if pre-crisis trend growth had been sustained (ONS, 2019).

This productivity slowdown has prompted renewed interest in an earlier slowdown, namely, that in Edwardian Britain. Goodridge et al. (2014) suggest that 1900 to World War I may be the only previous period when total factor productivity (TFP) growth was equally dismal and comment that this makes these years highly unusual. TFP growth averaged zero per cent per year between 1899 and 1913 according to Feinstein et al. (1982), who used the term 'climacteric' to describe these years. The Deputy Governor of the Bank of England, in an interview with the Daily Telegraph in 2018 which attracted great deal of attention, compared the current state of the economy with the 'climacteric', the sharp fall in productivity growth during the pause between the age of steam and the age of electricity at the end of the Victorian era. In doing so, he repeated the argument famously made by Phelps-Brown and Handfield-Jones (1952).

It is fair to say that more recent papers by quantitative economic historians have been sceptical of these claims. Crafts et al. (1989), using a time series approach, found that the decrease in trend growth after 1899 was only about 0.15 percentage points per year, while Crafts and Mills (2004) pointed out that, on a growth accounting basis, the contribution of steam power to industrial productivity growth actually strengthened in the late 19th century. Interestingly, before the very influential paper by Feinstein et al. (1982) many economic historians, notably including Coppock (1956), thought that the Victorian climacteric occurred in the 1870s rather than at the turn of the century.

This paper re-examines UK productivity growth in the decades prior to World War I using a new dataset compiled by Thomas and Dimsdale (2017). This has two key differences compared with the vintage of data used by Feinstein et al. (1982). First, the series for real GDP is based on the 'balanced estimates' made by Solomou and Weale (1991) rather than the 'compromise estimate' of GDP favoured by Feinstein (1972). Second, the data include an annual series for hours worked per year, which means labour productivity growth can be analysed per hour rather than per worker. We provide descriptive averages for relevant periods and analyse trend productivity growth using a Hodrick-Prescott (1997) filter methodology.

Our main results are as follows. First, the slowdown in average annual productivity growth after 1899 was about half as bad as Feinstein et al. (1982) thought. Comparing 1873-99 with 1899-1913, we find that labour productivity growth fell from 1.18 per cent per year to 0.84 per cent while TFP growth fell from 0.81 to 0.42 per cent. Second, the decline in trend labour productivity growth after 1899 was only slight, falling from 0.91% in the late 1890s to a minimum of 0.75% in 1913. Third, the productivity slowdown in the 1870s was more impressive and more worthy of the climacteric label. There was a sustained fall in trend labour productivity growth from 2.15 per cent per year in 1869 to 0.84 per cent in 1890. This is reflected in a substantial fall in the period average from 2.06 per cent per year in 1856-73 to 1.18 in 1873-99. Fourth, the Edwardian climacteric is not really a good

precedent for the current productivity slowdown. Both labour productivity growth and TFP growth at 0.07 and -0.29 per cent per year, respectively, are much weaker now than then. Moreover, the gap between the actual level of labour productivity and that which would have been expected on the basis of the trend prior to the downturn is now much bigger: we estimate that ten years after 2008 this gap was 19.7 per cent whereas ten years on from 1899 it was 5.5 per cent (Crafts and Mills, 2019).

1. Data

Our data are taken from Thomas and Dimsdale (2017). This source is superior to earlier datasets in two ways which matter for our analysis. First, it embodies several important revisions that have recently been made to historical estimates of real GDP. For the period prior to 1855, these are based on the study by Broadberry et al. (2015), which provides annual estimates where previously only benchmark years were available. For the period from 1870 to 1913, the 'balanced estimates' made by Solomou and Weale (1991) are used rather than the 'compromise estimate' of GDP favoured by Feinstein (1972).[1]

Second, the Thomas and Dimsdale (2017) dataset contains estimates for total hours worked on an annual basis from 1856 onwards. This is an important improvement which permits time-series analysis of labour productivity growth in terms of output per hour worked rather than per worker during the pre-World War I period. Given the considerable changes to hours worked after the mid-19th century this is much preferred and, in particular, it makes a notable difference at the end of the mid-Victorian boom. Prior to 1856 the estimates of hours worked, which provide the basis for an interpolated series, are available only for a few benchmark years at wide intervals between which there are substantial differences. We do analyse the pre-1856 data, which has the advantage that the years around 1870 are not near the beginning of the sample period, but note that they have to be treated with caution. Fortunately, for the years after 1870 the estimated trend rate of labour productivity growth is essentially the same whether estimation starts in 1761 or 1856. Our analysis is based on Table A56 column O of Thomas and Dimsdale (2017).

2. A Growth Accounting Perspective

Before turning to time-series analysis it is helpful to set out the implications of the new data in a growth accounting format. This was the method used by Feinstein et al. (1982) to validate their view that the climacteric occurred after 1899, so repeating the analysis with the new data gives a clear insight into the difference that they make as well as a check on whether the claim of an Edwardian climacteric is convincing.

Feinstein et al. (1982) used a conventional (neoclassical) growth accounting methodology which is based on treating the economy as if it can be characterized by a Cobb-Douglas production function with constant returns to scale

$$Y = AK^{\alpha}L^{1-\alpha} \quad (1)$$

[1] As is well-known, there is a significant discrepancy between the expenditure, income and output estimates of GDP notably for the post-1899 period. 'Compromise' and 'balanced' estimates are alternative ways to make a weighted average of the three series.

where Y is output, K is capital, L is labour and A is total factor productivity (TFP), while α and $1-\alpha$ are the elasticities of output with respect to capital and labour, respectively. The basic growth accounting formula is

$$\Delta Y/Y = \alpha\,\Delta K/K + \Delta L/L + \Delta A/A \qquad (2)$$

This can be re-written in terms of the rate of growth of labour productivity as

$$\Delta log(Y/L) = \alpha \Delta log(K/L) + \Delta logA \qquad (3)$$

where the first term represents the contribution of capital deepening. The output elasticity, α, is assumed to equal the share of profits in national income.

In this formulation the contribution to growth of labour quality is not quantified but will accrue as part of A, a residual which can be thought of as 'crude TFP'. Feinstein et al. (1982) followed a periodization based on business cycle peaks which precluded taking explicit account of labour quality.

In Table 1 we report growth-accounting estimates using data from Thomas and Dimsdale (2017) and juxtapose them with the original. The central features of the Edwardian climacteric according to Feinstein et al. (1982) were a fall in real GDP growth from 2.1 per cent per year in 1873-1899 to 1.4 per cent per year in 1899-1913 together with a decline in labour productivity growth from 1.2 to 0.5 per cent per year and in TFP growth from 0.7 to 0.0 per cent per year. The new estimates based on hours worked rather than employment and on balanced rather than compromise GDP reported in Table 1 alter this picture quite considerably. The slowdown is relatively mild with GDP growth, labour productivity growth, and TFP growth falling by 0.33, 0.34 and 0.39 per cent per year, respectively. A key point to note is that the major fall in labour productivity growth occurs after 1873 (rather than after 1899) in the new estimates, from 2.06 per cent in 1856-1873 to 1.18 per cent per year in 1873-1899, which compares with 1.3 to 1.2 per cent per year in Feinstein et al. (1982). This is almost entirely because they examined the climacteric in terms of output per worker rather than output per hour worked.[2]

The implication of employing the new data is that using the label 'climacteric' to describe the slowdown in UK productivity growth in the early 20th century seems inappropriate. This was a modest decline compared with nowadays. It also serves to detract from the more serious fall in productivity growth in the 1870s. Indeed, if anything, it would seem to vindicate the basic position taken by Coppock (1956) before Feinstein et al. (1982) became conventional wisdom, namely, that the term climacteric was better used to describe the 1870s rather than the 1900s.[3]

3. Time Series Analysis of Trend Growth in UK Productivity

[2] This was apparently because they only had available estimates for hours worked for the benchmark years of 1856, 1873 and 1913, so their discussion of sub-periods within 1873-1913 had to be conducted in terms of employment. A reader of the parent study by Matthews et al. (1982), whose estimates used output per hour worked, would have seen that productivity growth fell sharply after 1873.

[3] Coppock's justification for a climacteric in the 1870s was based on output growth calculated from the old Hoffmann index of industrial production to derive industrial productivity growth. This is not an appropriate methodology.

The underlying model for obtaining trend growth rates is that of an additive decomposition of the series x_t, the logarithm of the variable under consideration and which is observed over the years $t = 1,2,\dots,T$, into a trend, μ_t, and a cycle, ψ_t, typically assumed to be independent of each other, i.e.,

$$x_t = \mu_t + \psi_t \qquad E(\mu_t \psi_s) = 0 \text{ for all } t \text{ and } s \tag{4}$$t

Various models may be assumed for the trend component.[4] The model used here is one in which the trend follows a random walk

$$\mu_t = \mu_{t-1} + \beta_{t-1} + a_t \tag{5}$$

In which the drift, which is the trend growth rate here, also follows a random walk

$$\beta_t = \beta_{t-1} + b_t \tag{6}$$

The errors a_t and b_t are assumed to be independent zero mean white noises with variances σ_a^2 and σ_b^2. The cycle ψ_t is also assumed to be white noise with variance σ_ψ^2 and, from the assumption made in (4), will be independent of both a_t and b_t. The choice of structural model was made to ensure that the trend component could be both smooth and slowly evolving and, as we discuss below, is able to have a ready interpretation as a popularly used trend filter.

When this model was fitted to the labour productivity series discussed in section 2, it was found that the variance of the error to the trend equation (5), σ_a^2, was estimated to be very small and insignificantly different from zero. Setting this variance to zero produces what is known as a 'smooth trend' structural model and is equivalent to obtaining the trend using a Hodrick-Prescott (HP) filter with the smoothing parameter, say λ, set to a very large value (see, for example, Mills, 2019, chapter 8). The labour productivity trend and trend growth rate shown superimposed on the actual (log) level and growth rate in Figures 1 and 2, respectively, for 1856 to 1913 were, in fact, computed using the HP filter with $\lambda = 1{,}000$. This setting does indeed produce a satisfactorily smooth, albeit slowly evolving, trend component and readily interpretable trend growth rates, defined as $100\Delta\mu_t$, which gives the growth rate in percentages per annum.[5] Figures 3 and 4 show the results of repeating the analysis for the longer sample period of 1760 to 1913.

Trend labour productivity growth peaks in 1869 at 2.15% for the sample beginning in 1856, and in 1870 at 2.11% for the longer sample beginning in 1760. Trend growth then declines to 0.84% (0.85%) in 1890 before recovering slightly to 0.91% by 1897. There is then a slow and small decline

[4] For example, μ_t may be defined as a deterministic segmented trend, typically linear in t but Mills and Crafts (1996) have used a cubic polynomial. A non-linear trend, such as a smooth transition function, may also be used, but parametric models of this type are not as flexible as the approach taken here. Mills (2009, 2016, 2019) provides detailed historical and technical development of these various approaches, none of which were found to fit particularly satisfactorily to the labour productivity series being studied here.

[5] The use of a higher value for λ than is often employed in much macroeconomic modelling (for example, setting the smoothing parameter to 100 is common practice when using annual data) may also be justified from the theoretical and simulation analyses of Harvey and Trimbur (2008) and Flaig (2015).

to 0.75% by 1913. It is thus clear that extending the sample period back to 1760 makes little difference to the behaviour of trend labour productivity growth during the period of interest.[6]

Of course, the data that we have analysed are imperfect and may yet be subject to further revisions. In particular, further research may yet resolve the discrepancy between the expenditure, income and output series for GDP and, if so, the dimensions of the post-1899 slowdown could look somewhat different.[7]

4. Discussion

In the context of the current productivity slowdown, the most striking result of our analysis is that it does not support the claim that there was a climacteric in the Edwardian period. We find that there was only a modest decrease (0.16 percentage points) in trend labour productivity growth between 1897 and 1913. This is superficially very similar to the estimate by Crafts et al. (1989) but is derived from a much better dataset and is based on real GDP per hour worked rather than real GDP.

It follows that it is quite misleading to claim that the productivity slowdown just prior to World War I is a precedent for today's productivity puzzle. One way to establish that is to compare the extent to which real GDP per hour worked is below the previous trend growth path ten years after the start of the downturn. Ten years on from 2008 we estimate the shortfall was 19.7 per cent whereas ten years on from 1899 it was 5.5 per cent (Crafts and Mills, 2019). A second way to make the point is by comparing growth accounting estimates for the current slowdown with those reported in Table 1 relating to 1899-1913. The estimates reported in Table 2 show a fall of about 2 percentage points per year in labour productivity growth and about 1.5 percentage points in TFP growth compared with the 40-plus years prior to the financial crisis. In the period 2007-2016, labour productivity growth was only 0.07% per year and TFP growth was -0.29% per year compared with 0.84% and 0.42% per year, respectively, in 1899-1913.

The productivity slowdown of the early 20th century also seems quite modest relative to that which occurred in the 1870s and continued through the 1880s. Trend labour productivity growth peaked at 2.15 per cent per year in 1869 and fell steadily to 0.84 per cent in 1890. The label of climacteric seems more apt for this period, as claimed by Coppock (1956), given that labour productivity is measured on a per hour worked basis. Average hours worked per year fell by about 10 per cent between the mid-1850s and the mid-1870s but then by only a further 1 per cent to the end of the century (Thomas and Dimsdale, 2017, Table A54).

It should be noted, however, that Coppock's chief explanation for this slowdown, that it was driven by the ending of the general application of steam power and iron machinery in the staple industries, is not convincing. Evaluated by growth accounting, the contribution of steam power to labour

[6] If the exercise is repeated using data from 1760 into the 21st century then during the 1856-1913 period trend labour productivity growth peaks at 1.67% in 1868 before declining to 0.93% in 1903 before slightly increasing to 1.03% by 1913.

[7] Solomou and Thomas are currently engaged on a project to improve the GDP estimates. They have already made improved income estimates and used them to make a provisional re-calculation of Feinstein's compromise estimate (Solomou and Thomas, 2019). Repeating our analysis using this series to estimate labour productivity gives results which are essentially unchanged from those that we obtained for the post-1856 sample as reported in the main text.

productivity growth in industry rose from 0.41 per cent per year in 1850-1870 to 0.51 per cent per year in 1870-1910 (Crafts and Mills, 2004). The two sectors which contributed most to the slowdown in labour productivity growth were agriculture and mining and Coppock's hypothesis does not obtain in either of these sectors.[8] More generally, as Musson pointed out a long time ago, "steam-powered mechanization … [was] still proceeding at a tremendous pace … the 1870s did not witness the end of the 'massive application' of steam power" (1963, p. 530).

Even though there was a significant productivity slowdown after 1870, in historical perspective this should not be seen as too disappointing. Notably, growth performance still exceeded that of the classic industrial revolution period at the end of the 18th and beginning of the 19th centuries, as is clear from Figure 4: trend labour productivity growth only reached 0.75 per cent per year in 1825. There are, in fact, good reasons to think that growth potential had improved by the late 19th century as institutions were better suited to modern economic growth and investments in human capital increased substantially (Crafts, 2018).

Even if we use the term 'climacteric' to describe the post-1870 slowdown, it is clearly not of a similar magnitude to the current episode and cannot be seen as a precedent. In part, this is because the marked decline in the ICT contribution to labour productivity growth after 2007 has been much more pronounced than anything that could have resulted from a weakening in that of steam in the late 19th century. The impact of steam power on productivity growth extended over a long period of time but never reaching the intensity of the peak associated with ICT. Growth accounting estimates show that the ICT contribution fell from 1.04 per cent per year during 1996 to 2007 to 0.23 per cent per year in 2008 to 2018 (Crafts and Mills, 2019), while steam's contribution fell from 0.41 to 0.31 per cent per year comparing 1850-1870 with 1870-1910 (Crafts, 2004).[9]

If we follow the widespread practice of calibrating the current productivity slowdown by the extent to which the level of labour productivity has fallen below the previous trend path, as noted above, we estimate this to have been 19.7 per cent in 2018. This is much more than can be attributed to a reduced ICT contribution to growth, as well as being way ahead of the 5.5 per cent shortfall ten years after 1899. All this suggests that the idea of a late Victorian precedent for today's slowdown based on the end of the steam age is misconceived.

5. Conclusions

Our reappraisal of UK productivity performance in the decades leading up to World War I indicates that the analysis put forward by Feinstein et al. (1982) should be revised in view of more recent data. In particular, the availability in Thomas and Dimsdale (2017) of an annual series for labour productivity based on hours worked rather than headcount permits a new view of both the timing and the extent of productivity slowdown.

We find that the use of the term 'climacteric' to describe slower productivity growth from 1899 to 1913 is inappropriate. There was a slowdown but it was quite modest. Contrary to some recent

[8] Based on output per worker, these two sectors contributed almost 95 percent of the total decrease in labour productivity growth between 1856-1873 and 1873-1899 according to the estimates in Feinstein (1972).

[9] These estimates for the steam contribution relate to GDP rather than the industrial sector. Unfortunately, data limitations make it impossible to estimate the productivity growth contribution of steam for sub-periods within 1870-1910.

suggestions, this period is not a precedent for the much larger deterioration in productivity growth experienced by the UK in recent years. Neither is the productivity slowdown that characterized the 1870s and 1880s although this was both more pronounced and of a longer duration than that of the early 20th century. Nevertheless, we believe that if the label 'climacteric' is to be used in the context of 19th century productivity growth it should be used for the 1870s.

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Table 1. Growth Accounting Estimates for the Early 20th Century Productivity Slowdown (% per year)

a) Based on Early 1980s' Data

	ΔY/Y	*ΔK/K*	*ΔL/L*	*Δ(Y/L)/ (Y/L)*	*Capital Deepening*	*TFP*
1856-73	2.2	2.0	0.9	1.3	0.5	0.8
1873-82	1.9	2.4	0.6	1.3	0.7	0.6
1882-89	2.2	1.6	1.1	1.2	0.3	0.9
1889-99	2.2	1.8	1.1	1.1	0.3	0.8
1899-1907	1.2	2.4	0.7	0.5	0.8	-0.3
1907-13	1.6	1.4	1.1	0.4	0.1	0.3
1873-99	2.1	2.0	0.9	1.2	0.5	0.7
1899-1913	1.4	2.0	0.9	0.5	0.5	0.0
1924-37	2.2	1.8	1.5	0.7	0.1	0.6

Notes: *K* is gross capital and *L* is employment.

Source: Feinstein et al. (1982).

b) Based on Modern Data

	ΔY/Y	*ΔK/K*	*ΔL/L*	*Δ(Y/L)/ (Y/L)*	*Capital Deepening*	*TFP*
1856-73	2.38	2.38	0.32	2.06	0.72	1.34
1873-82	1.85	2.28	0.35	1.50	0.68	0.82
1882-89	1.76	1.24	1.11	0.65	0.04	0.61
1889-99	2.27	1.89	0.98	1.29	0.32	0.97
1899-1907	1.50	2.81	0.82	0.68	0.69	-0.01
1907-13	1.85	0.94	0.81	1.04	0.05	0.99
1873-99	1.98	1.85	0.80	1.18	0.37	0.81
1899-1913	1.65	2.00	0.81	0.84	0.42	0.42
1924-37	2.13	0.63	1.43	0.70	-0.20	0.90

Notes: *K* is net capital and *L* is hours worked.

Source: Thomas and Dimsdale (2017)

Table 2. Growth Accounting Estimates for the Early 21st Century Productivity Slowdown (% per year)

	ΔY/Y	*ΔK/K*	*ΔL/L*	*Δ(Y/L)/ (Y/L)*	*Capital Deepening*	*TFP*
1973-1995	1.98	3.43	-0.20	2.18	0.91	1.27
1995-2007	2.88	4.27	0.80	2.08	0.87	1.21
2007-2016	0.95	2.34	0.88	0.07	0.36	-0.29

Notes: K is net capital, L is hours worked.

Source: Thomas and Dimsdale (2017)

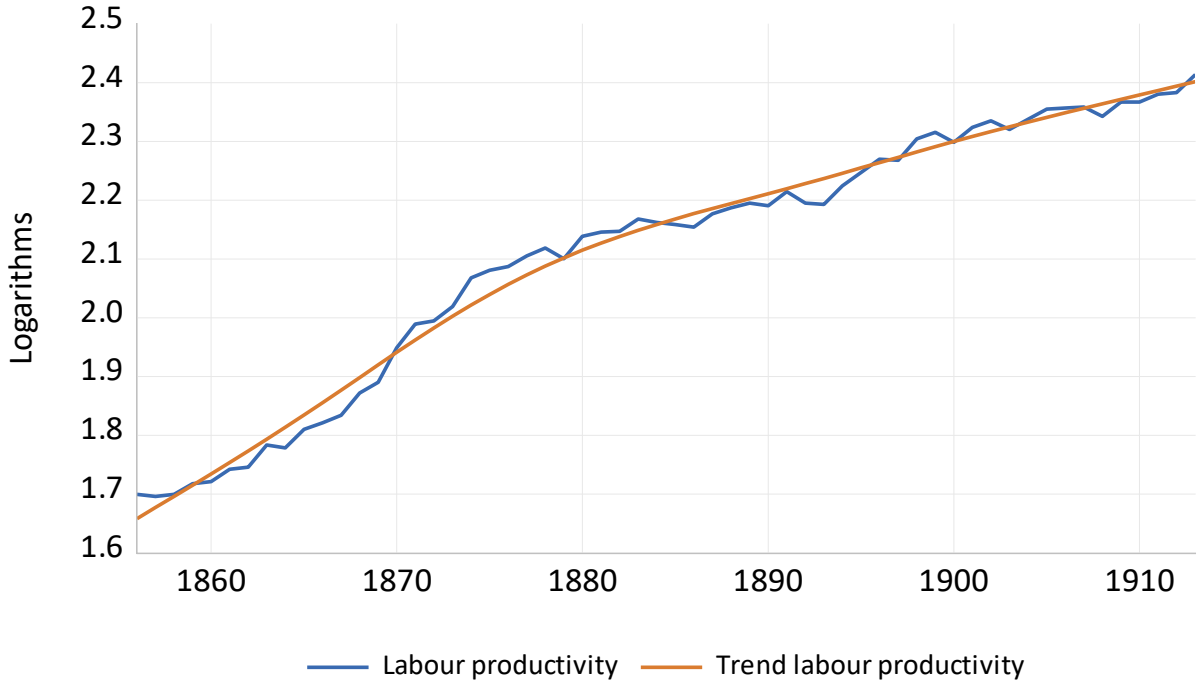

Figure 1 Labour productivity and trend labour productivity, 1856 – 1913.

Figure 2 Labour productivity growth and trend labour productivity growth: 1857 – 1913.

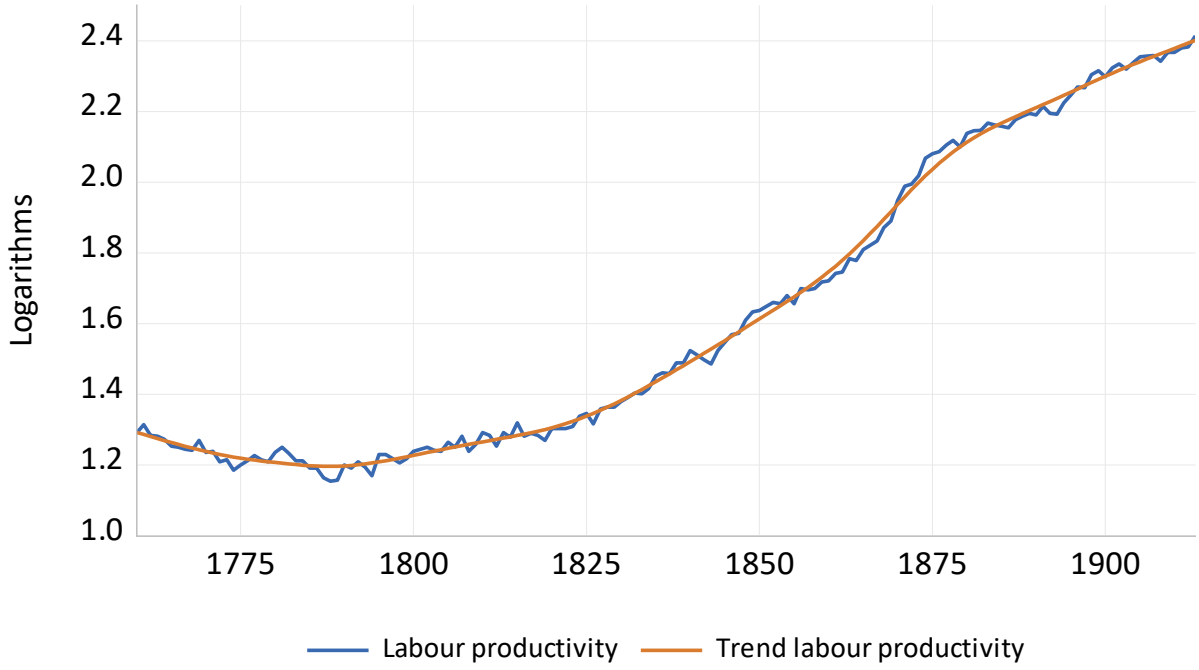

Figure 3 Labour productivity and trend labour productivity, 1760 – 1913.

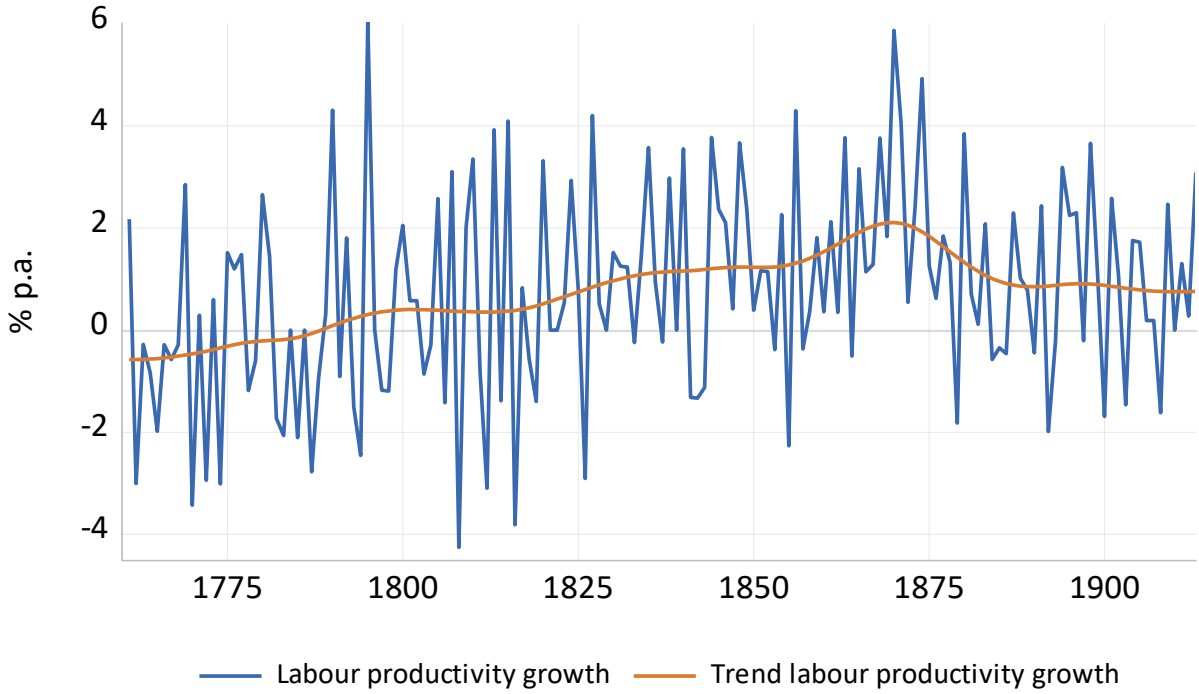

Figure 4 Labour productivity growth and trend labour productivity growth: 1761 – 1913.