

**Manuscript version: Working paper (or pre-print)**

The version presented here is a Working Paper (or 'pre-print') that may be later published elsewhere.

**Persistent WRAP URL:**

<http://wrap.warwick.ac.uk/122638>

**How to cite:**

Please refer to the repository item page, detailed above, for the most recent bibliographic citation information. If a published version is known of, the repository item page linked to above, will contain details on accessing it.

**Copyright and reuse:**

The Warwick Research Archive Portal (WRAP) makes this work by researchers of the University of Warwick available open access under the following conditions.

Copyright © and all moral rights to the version of the paper presented here belong to the individual author(s) and/or other copyright owners. To the extent reasonable and practicable the material made available in WRAP has been checked for eligibility before being made available.

Copies of full items can be used for personal research or study, educational, or not-for-profit purposes without prior permission or charge. Provided that the authors, title and full bibliographic details are credited, a hyperlink and/or URL is given for the original metadata page and the content is not changed in any way.

**Publisher's statement:**

Please refer to the repository item page, publisher's statement section, for further information.

For more information, please contact the WRAP Team at: [wrap@warwick.ac.uk](mailto:wrap@warwick.ac.uk).

Is the UK Productivity Slowdown Unprecedented?

Nicholas Crafts and Terence C. Mills

[\(This paper also appears as CAGE Discussion paper 429\)](#)

July 2019

No: 1215

Warwick Economics Research Papers

ISSN 2059-4283 (online)

ISSN 0083-7350 (print)

# Is the UK Productivity Slowdown Unprecedented?

**Nicholas Crafts**

University of Warwick

and

**Terence C. Mills**

Loughborough University

July 2019

## Abstract

We estimate trend UK labour productivity growth using a Hodrick-Prescott filter method. We use the results to compare downturns where the economy fell below its pre-existing trend. We find that the current productivity slowdown has resulted in productivity being 19.7% below the pre-2008 trend path in 2018. This is nearly double the previous worst productivity shortfall ten years after the start of a downturn. On this criterion the slowdown is unprecedented in the last 250 years. We conjecture that this reflects a combination of adverse circumstances, namely, a financial crisis, a weakening impact of ICT and impending Brexit.

Keywords: Brexit; financial crisis; Hodrick-Prescott filter; ICT; productivity slowdown.

JEL Classification: C22; N13; N14; O47.

Acknowledgement: we are grateful to Ryland Thomas for advance access to data from the updated version of the Thomas and Dimsdale dataset. The usual disclaimer applies.

## 1. Introduction

The weakness of UK productivity growth after 2007 has been much discussed. 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). The pre-crisis peak level of labour productivity was only surpassed in 2016 quarter 2.

Not surprisingly, people have looked for a precedent for such a decline in productivity performance. This is interesting per se but if a similar episode can be identified this might provide useful insights into the current malaise. Clearly, there have been significant productivity slowdowns in the past – for example, at the end of the mid-Victorian boom in the early 1870s, in the Edwardian ‘climacteric’ at the turn of the 20<sup>th</sup> century, during the ‘great depression’ of the early 1930s, and at the end of the European ‘golden age’ in the early 1970s. At least two of these episodes might be thought to have some relevance for today – the Edwardian era, which is sometimes seen as a hiatus between general purpose technologies, and the 1930s as a period of severe recession.<sup>1</sup>

The obvious prior question is whether these previous slowdowns are comparable in terms of the shortfall in performance relative to previous expectations. In this paper we investigate this issue by looking at the measure given prominence by ONS: namely, to estimate how much the level of labour productivity had fallen below what would have been expected if the previous trend had been sustained for the next 10 years. This analysis is facilitated by the recent publication of a dataset (Thomas and Dimsdale, 2017) which provides estimates of labour productivity over the long run on a GDP per hour worked basis. We estimate trend productivity growth by using the Hodrick-Prescott (1997) filter technique to analyse these data.

Our main results are as follows. First, we find that during the last 150 years trend labour productivity growth has varied between 0.9 and 3.3 per cent per year. In the context of this long run performance, pre-crisis trend productivity growth was very respectable at around 2.3 per cent per year, higher than at any time except the golden age. Second, our estimate of the shortfall between the actual level of labour productivity in 2018 and what would have been expected on the basis of the pre-crisis trend is similar to that of ONS at 19.7 per cent. Third, this shortfall at the 10-year interval far exceeds that of any previous productivity slowdown. The two previous largest negative deviations from previous trend are 10.9 per cent ten years after 1971 and 10 per cent ten years after 1883. Fourth, in the case of both the Edwardian climacteric (1898) and the great depression (1929) the shortfall at the 10-year mark is much smaller at 5.5 and 5.3 per cent respectively. Fifth, labour productivity was lower in the late 18<sup>th</sup> century when it averaged -0.13 per cent per year between 1760 and 1800 than it has been post 2008 but this did not entail a downward turn from a previous strong trend growth performance.

---

<sup>1</sup> In a notorious interview with the Daily Telegraph in 2018 Ben Broadbent, Deputy Governor of the Bank of England, 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 which was first highlighted by Phelps-Brown and Handfield-Jones (1952).

We conclude that the present productivity slowdown can indeed be described as unprecedented and this adds to the sense that it is a ‘puzzle’. We conjecture that it may be the outcome of a novel combination of circumstances – a financial crisis plus a hiatus between general purpose technologies plus uncertainty associated with a major change in trading arrangements.

## 2. Data

Our data are taken from Thomas and Dimsdale (2017).<sup>2</sup> 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 1948, in line with modern ONS methods, the ‘balanced estimates’ made by Sefton and Weale (1995) and Solomou and Weale (1991) are used rather than the ‘compromise’ estimate of GDP favoured by Feinstein (1972). Finally, for the period since 1948, current ONS estimates are available which incorporate recent methodological innovations affecting the construction of the GDP deflator and the treatment of R and D expenditure. These changes are conveniently summarized in Bank of England (2011); their effect is to raise the growth rate of real GDP compared with previous estimates.

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-19<sup>th</sup> century this is much preferred and, in particular, it makes a notable difference at the end of the mid-Victorian boom. Prior to 1856 estimates of hours worked are available only for a few benchmark years at wide intervals between which there are substantial differences. Thomas and Dimsdale construct an interpolated series which provides the basis for their real GDP per hour worked series for earlier years. We do analyse the pre-1856 data but note that it has 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).

## 3. Computing trends in productivity

Figure 1 shows the logarithm of labour productivity from 1856 to 2018 with a ‘smooth’ trend superimposed. This trend is obtained using a Hodrick-Prescott (HP) filter computed over the period 1856 to 2007 with the trend then being extrapolated to 2018 using the 2007 trend growth rate of 2.30%. The smoothing parameter for the HP filter was set at 10,000. This is a larger value than is typically used (often with annual data a value of 100 is suggested), but it is employed here to produce a trend that is sufficiently smooth for the purposes of this study. The resulting trend may be interpreted as being that produced by the ‘smooth trend’ structural model  $x_t = x_{t-1} + \mu_{t-1} + a_t$ ,

---

<sup>2</sup> Ryland Thomas kindly supplied an updated version of page A56 of the spreadsheet which allowed us to extend the analysis to 2018.

$\mu_t = \mu_{t-1} + \beta_t$ ,  $\beta_t = \beta_{t-1} + b_t$ , where  $x_t$  is the logarithm of labour productivity,  $\mu_t$  and  $\beta_t$  are the trend level and trend growth components, and  $a_t$  and  $b_t$  are white noise errors. Thus trend growth follows a driftless random walk, whose shock is then transmitted to the trend level; this single shock produces the smooth trend that is shown in Figure 1. Mills (2019, chapter 8) provides a discussion of these issues.

It is clear that labour productivity from 2008 has diverged substantially from this extrapolated growth path and this is also seen in Figure 2, where the growth rates (in % per annum) of actual and trend labour productivity are shown. These range from just over 0.9% during the first decade of the 20<sup>th</sup> century to just above 3.3% during the 1960s. Trend labour productivity growth just prior to the great recession was 2.3%. Figure 3 shows the cumulative divergence from trend growth in year  $t$  over the next 10 years. The behaviour of labour productivity since the financial crisis is unprecedented, with the divergence in the decade from 2007 being -20.8% and -19.7% from 2008. As we remark in the introduction, these declines are twice that of the next steepest decline, -10.9% in the decade from 1971, and almost four times the declines seen during the Victorian climacteric and the depression of the 1930s.

This exercise was also carried out for the longer period from 1760 although, as noted above, some caution should be exercised as the pre-1856 data on labour productivity has been interpolated. Thus Figures 4-6 reproduce Figures 1-3 for the extended period. For the post-1870 period the results are essentially the same. For the years prior to 1856 we observe very low productivity growth, both actual and trend, at the outset followed by a gradual rise to a peak in trend growth at 1.7% in the 1860s. Actual productivity growth between 1760 and 1800 averaged -0.13% compared with 0.25% from 2008 to 2018. However, Figure 6 shows that the downturn in recent productivity performance continues to be unprecedented when the period from the mid-18<sup>th</sup> to mid-19<sup>th</sup> century is also included in the analysis; since 1760 there is no previous episode where 10 years on productivity was anywhere near 20 percent below what would have been expected from its previous trend growth.

#### 4. Discussion

Our analysis has been carried out using conventional estimates of real GDP as the basis for measuring labour productivity. It has been widely remarked that the rise of the digital economy presents a serious challenge to national accounting and thus to traditional labour productivity measurement. The issue partly concerns some economic activity moving across the boundary between GDP and home production and partly because of new business models in which digital services are not fully charged for directly (Coyle, 2017). Bean (2016) suggests that real GDP growth could have been as much as 0.7% per year larger over the period 2005 to 2014 had the impact of the digital economy been captured fully. Even so, the increase in this digital contribution post 2008 was presumably quite a lot less than 0.7% since it was already in evidence previously. There is widespread agreement among economists who have examined the issue for the United States, where the literature is much richer, that measurement problems account at most for a small proportion of the productivity slowdown.<sup>3</sup>

If the productivity slowdown is not primarily a statistical artefact and is unprecedented, what might be the explanation for such a dramatic turn of events? It is fair to say that the answer to this question

---

<sup>3</sup> Crafts (2018) provides a review of the slowdown literature.

has proved elusive but we can offer a conjecture that a combination of adverse circumstances, itself unprecedented, may be responsible for a large part of the evaporation of productivity growth since 2008. The unfavourable conditions include the ebbing away of the ICT boom, the implications of the financial crisis and, in the recent past, impending Brexit.

ICT is an important general-purpose technology (GPT) which had a substantial impact on UK productivity growth around the turn of the century. Using conventional growth accounting methods, the contribution of ICT capital to labour productivity growth averaged 0.82 percentage points per year during 1996 to 2007 compared with only 0.19 percentage points during 2008 to 2018 (The Conference Board, 2019). Similarly, the contribution of TFP growth in ICT production fell from 0.23 to 0.04 percentage points (EU KLEMS, 2017).<sup>4</sup> Cumulated over the 10 years from 2008, this implies labour productivity in 2018 was about 8.5% lower than if the earlier ICT contribution had been sustained. Although a new GPT may be on the horizon in the form of artificial intelligence, this has yet to have a significant impact on productivity.

Banking crises can be expected to have an adverse impact on productive capacity such that the level of potential output is permanently reduced compared with a business-as-usual counterfactual. Thinking in terms of a production function or growth accounting, there may be direct adverse effects on capital inputs as investment is interrupted, on human capital if skills are lost or restructuring makes them redundant, on labour inputs through increases in equilibrium unemployment, and on TFP if R & D is cut back or innovative firms cannot get finance. The impact of the UK financial crisis on potential output has variously been estimated to be between 3.8 and 7.5 per cent.<sup>5</sup> In addition, productivity growth in the financial sector itself has been markedly reduced with the implication that its contribution to overall labour productivity growth fell by 0.6 per cent per year pre- and post-crisis (Riley et al., 2018). Thus, the financial crisis may have reduced the level of labour productivity relative to the counterfactual of staying on the pre-2008 trend by 10 per cent or more.<sup>6</sup>

Brexit is the third unusual shock to have materialised. Here the relevant aspect is, of course, the short run impact since mid-2016 working through channels such as its effect on investment through uncertainty. An estimate of the Brexit effect is provided by Born et al. (2019a) using a synthetic control group methodology which creates a 'doppelganger' economy which is not subjected to the Brexit shock.<sup>7</sup> The result is that GDP (and presumably labour productivity) was about 2 per cent lower in 2018 than it would have been without the vote for Brexit.

Obviously, this discussion does not provide a precise accounting for the productivity puzzle. It does, however, highlight a marked contrast with previous episodes when downturns from an earlier trend productivity growth were observed which some might expect to have been similar but which were, in fact, relatively mild. In neither the Great Depression nor the Edwardian climacteric were the three ingredients of a rapidly ebbing GPT, a banking crisis and prolonged uncertainty over trading arrangements all present.

---

<sup>4</sup> This comparison is between 1996 to 2007 and 2008 to 2015.

<sup>5</sup> For sources and discussion of these estimates, see Crafts (2019).

<sup>6</sup> Reduced productivity growth in financial services no doubt partly reflected a lower ICT capital contribution so is not entirely additional to the ICT impact already discussed.

<sup>7</sup> The technicalities of the approach are explained in Born et al. (2019b).

As we noted earlier, the 10-year difference after 1929 was 5.3% (Figure 3). The ‘great depression’ years look quite different from post-2008 in that there was no banking crisis and the impacts of GPTs of the time (electricity and the internal combustion engine) were gathering pace rather than weakening. The move from fixed exchange rate and free trade to cheap money, dirty floating and the general tariff on manufactures was completed in less than a year, after which recovery soon followed (Crafts and Fearon, 2013).

In the case of the Edwardian climacteric, the 10-year difference after 1898 was 5.5% (Figure 3). The steam age was coming to an end and electricity had yet to make a significant impact on productivity (Ristuccia and Solomou, 2014). Growth accounting suggests, however, that 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 (Crafts, 2004), with the implication that its waning weighed less heavily at the start of the 20<sup>th</sup> century than that of ICT in the early 21<sup>st</sup> century. There was no banking crisis during the Edwardian climacteric. There was, however, a lengthy and bitter controversy over moving away from free trade, with Joseph Chamberlain as the leading advocate of tariff reform, which culminated in a landslide victory for the (pro-free-trade) Liberal Party in the General Election of 1906.

## **5. Conclusions**

Our main conclusion is that the answer to the question posed at the outset is ‘yes’ – the current UK productivity slowdown is unprecedented. We base this finding on the criterion of how far the level of productivity is below the path implied by the continuation of earlier trend productivity growth, a measure of performance highlighted by ONS in recent times. We focus on the level reached ten years after a slowdown began. We estimate the shortfall in 2018 to have been 19.7 per cent. This compares with 10.9 per cent ten years after 1971 and 10 per cent ten years after 1883, these being the next worst episodes in the 250 years.

We do not have a fully satisfactory explanation for the productivity slowdown. Nevertheless, we think it is important to recognise that it has occurred in the context of a novel combination of adverse circumstances. These are the coincidence of a banking crisis, the waning impact of a general purpose technology (ICT) and uncertainty about international trading relations (Brexit). It is plausible that together they have comprised a major shock to productivity outcomes.



## References

- Bank of England (2011), *Inflation Report November 2011*.
- Bean, C. (2016), *Independent Review of UK Economic Statistics*. London: HMSO.
- Born, B., Mueller, G., Schularick, M. and Sedlacek, P. (2019a), “£350 Million a Week: the Output Cost of the Brexit Vote”, VoxEU. <https://voxeu.org/article/300-million-week-output-cost-brexit-vote>
- Born, B., Mueller, G., Schularick, M. and Sedlacek, P. (2019b), “The Costs of Economic Nationalism: Evidence from the Brexit Experiment”, *Economic Journal*, forthcoming.
- Broadberry, S., Campbell, B., Klein, A., Overton, M. and van Leeuwen, B. (2015), *British Economic Growth, 1270-1870*. Cambridge: Cambridge University Press.
- Coyle, D. (2017), “Do-It-Yourself Digital: the Production Boundary and the Productivity Puzzle”, ESCoE Discussion Paper No. 2017-01.
- Crafts, N. (2004), “Steam as a General Purpose Technology: a Growth Accounting Perspective”, *Economic Journal*, 114, 338-351.
- Crafts, N. (2018), “The Productivity Slowdown: Is It the ‘New Normal’?”, *Oxford Review of Economic Policy*, 34, 443-460.
- Crafts, N. (2019), The Fall in Potential Output due to the Financial Crisis: a Much Bigger Estimate for the UK”, *Comparative Economic Studies*, forthcoming.
- Crafts, N. and Fearon, P. (2013), “Depression and Recovery in the 1930s: an Overview”, in N. Crafts and P. Fearon (eds.), *The Great Depression of the 1930s: Lessons for Today*. Oxford: Oxford University Press, 1-44.
- EU KLEMS (2017), *Growth and Productivity Accounts*. [www.euklems.net](http://www.euklems.net)
- Feinstein, C. H. (1972), *National Income, Expenditure and Output of the United Kingdom, 1855-1965*. Cambridge: Cambridge University Press.
- Hodrick, R.J. and Prescott, E.C. (1997), “Postwar US Business Cycles: an Empirical Investigation”, *Journal of Money, Credit and Banking*, 29, 1-16.
- Office for National Statistics (2019), *Labour Productivity UK: October to December 2018*.
- Mills, T.C. (2019), *Applied Time Series Analysis: a Practical Guide to Modelling and Forecasting*. London: Academic Press.
- Phelps-Brown, E. H. and Handfield-Jones, S.J. (1952), “The Climacteric of the 1890s: a Study in the Expanding Economy”, *Oxford Economic Papers*, 4, 266-307.
- Riley, R., Rincon-Aznar, A. and Samek, L. (2018), “Below the Aggregate: a Detailed Account of the UK Productivity Puzzle”, ESCoE Discussion Paper No. 2018-06.

Ristuccia, C. A and Solomou, S. (2014), "Can General Purpose Technology Theory Explain Economic Growth? Electrical Power as a Case Study", *European Review of Economic History*, 18, 227-247.

Sefton, J. and Weale, M. (1995), *Reconciliation of National Income and Expenditure: Balanced Estimates of National Income for the United Kingdom, 1920-1990*. Cambridge: Cambridge University Press.

Solomou, S. and Weale, M. (1991), "Balanced Estimates of UK GDP, 1870-1913", *Explorations in Economic History*, 28, 54-63.

The Conference Board (2019), Total Economy Database: Growth Accounting and Total Factor Productivity, 1990-2018. <https://www.conference-board.org/data/economydatabase/>

Thomas, R. and Dimsdale, N. (2017), "A Millennium of UK Data", Bank of England OBRA Dataset. <http://www.bankofengland.co.uk/research/Pages/onebank/threecenturies.aspx>

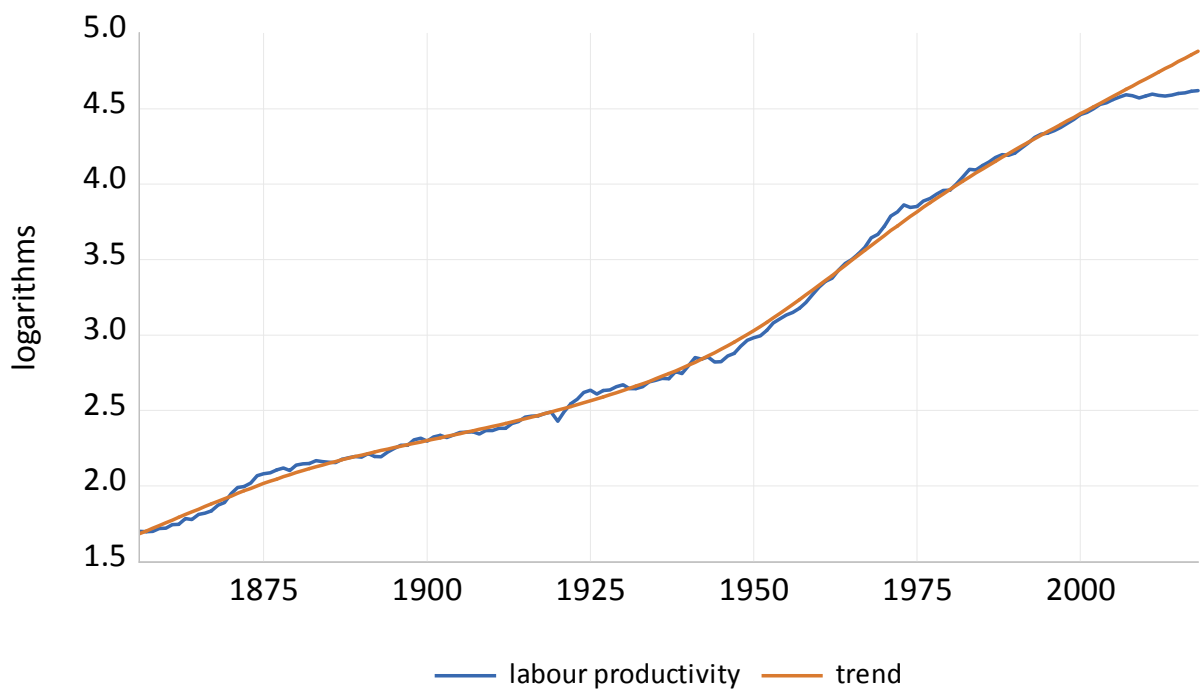


Figure 1 Logarithms of labour productivity, 1856 – 2008, with trend superimposed.

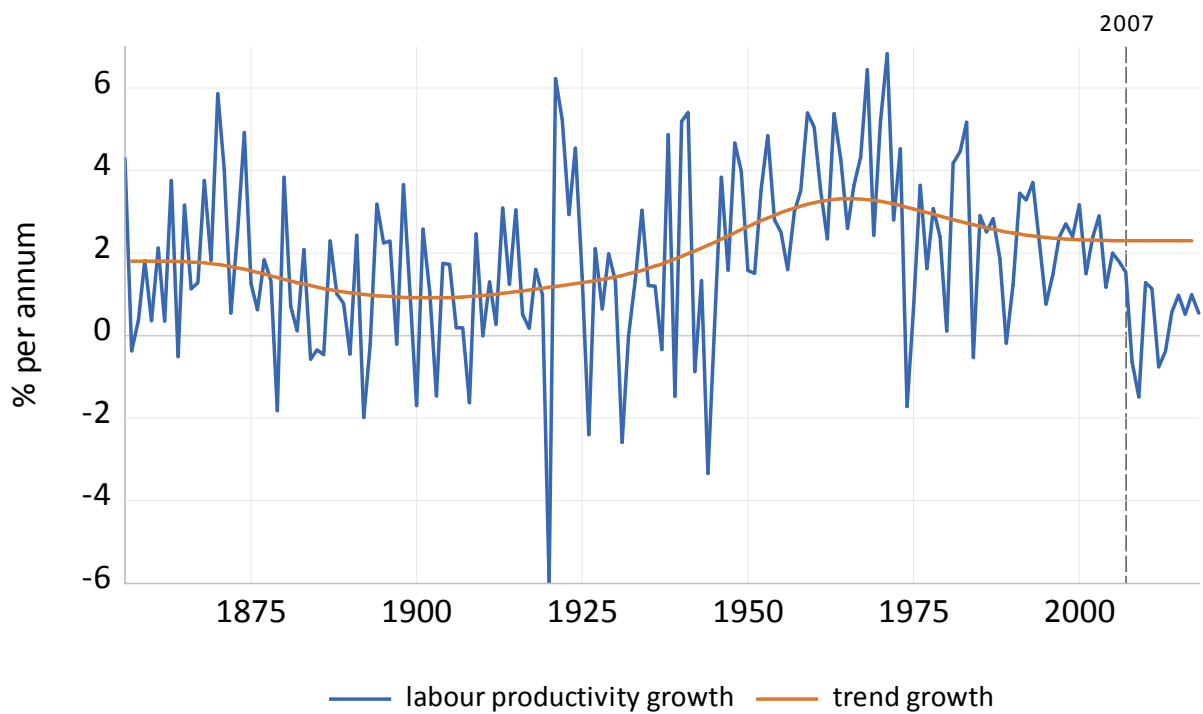


Figure 2 Labour productivity growth, 1857 – 2018, with trend growth superimposed.

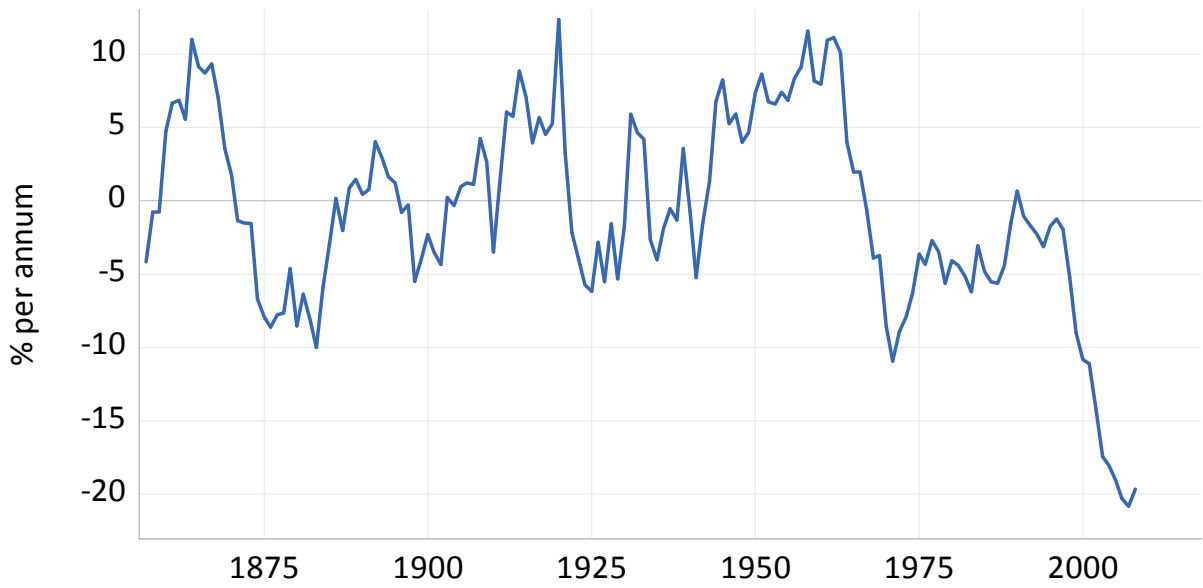


Figure 3 Cumulative 10-year ahead difference from trend growth, 1857 – 2008.

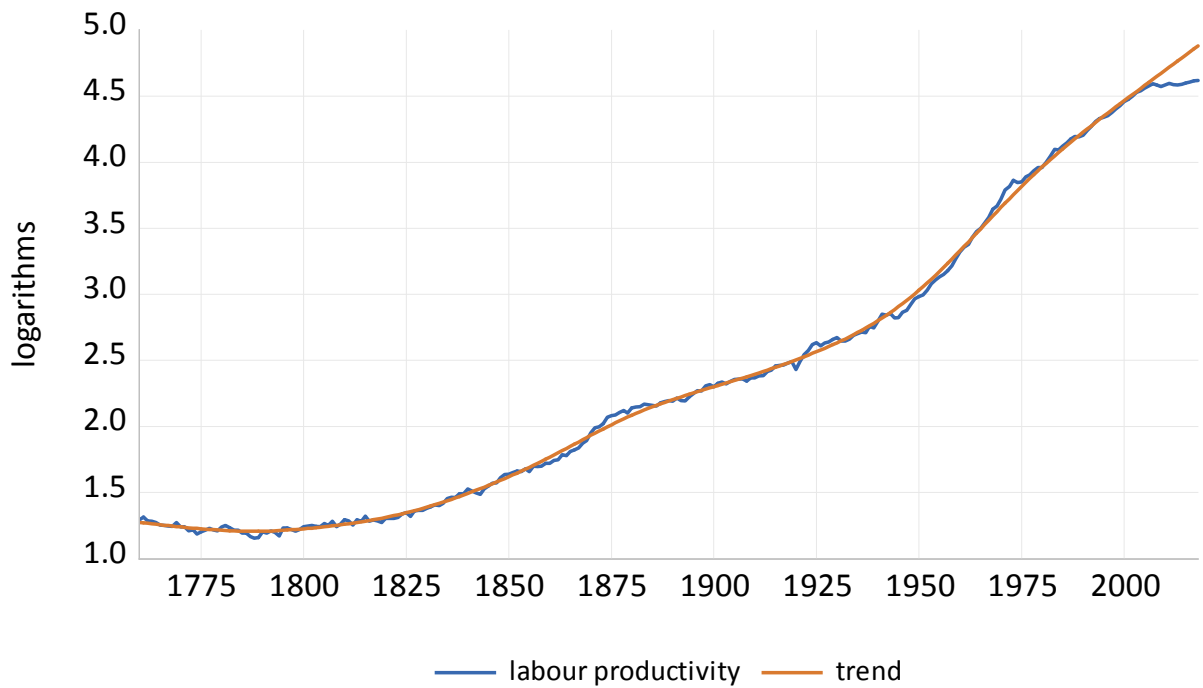


Figure 4 Logarithms of labour productivity, 1760 – 2008, with trend superimposed.

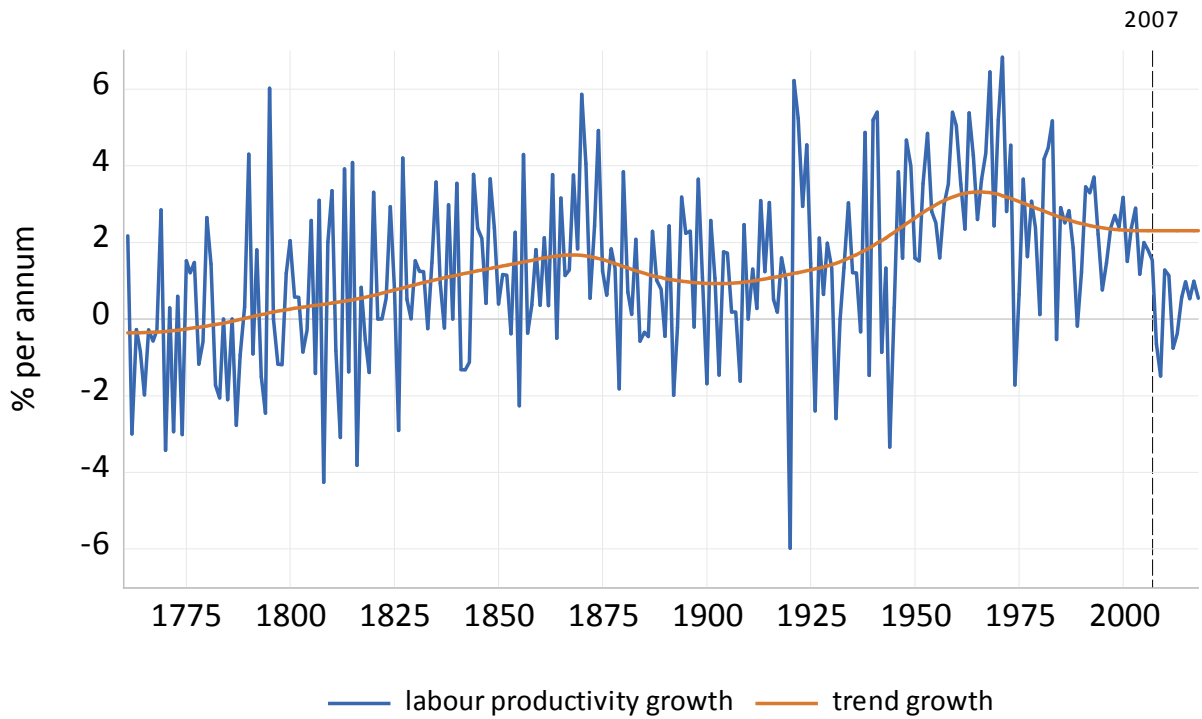


Figure 5 Labour productivity growth, 1761 – 2018, with trend growth superimposed.

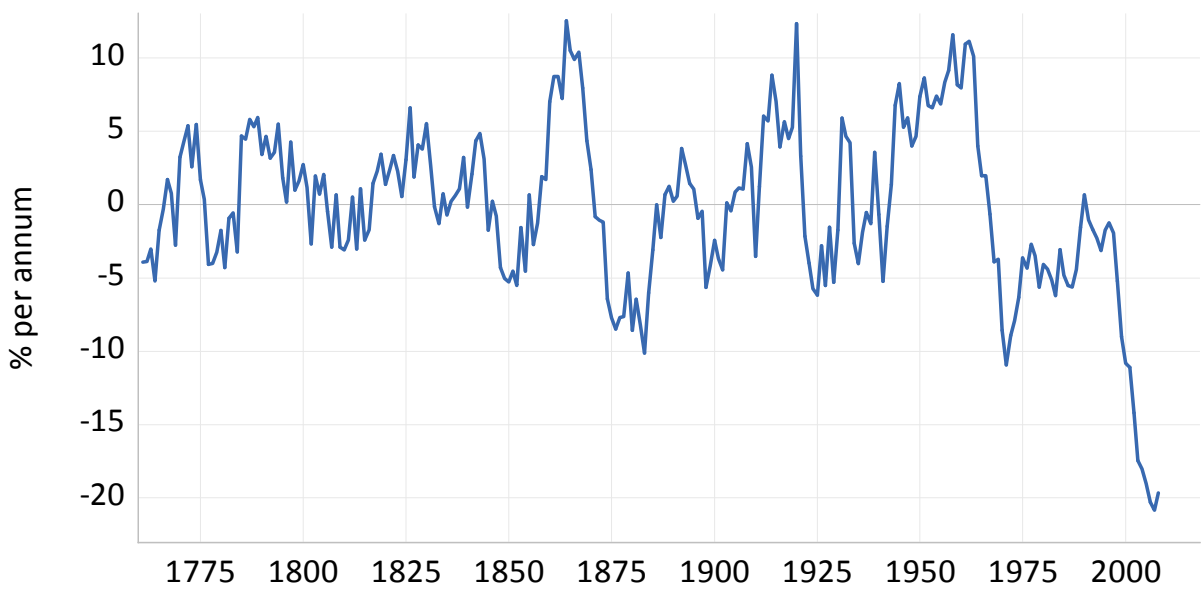


Figure 6 Cumulative 10-year ahead difference from trend growth, 1761 – 2008.