Statistical bulletin

Growth accounting: multi-factor productivity estimates, UK: October to December 2019

Growth accounting estimates for the UK market sector and 10 industry groups. Experimental estimates.

Notice

7 July 2020

Subsequent releases of this productivity release were combined with other productivity measures into a single article. The latest figures from the combined article are published in the Productivity economic commentary page.

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1 . Main points

- Multi-factor productivity (MFP) in the UK in Quarter 4 (Oct to Dec) 2019 is estimated to have decreased by 0.3% compared with the same quarter a year ago; this contrasts with trend growth in MFP of around 1.5% per year prior to the 2008 economic downturn.

- Capital services per hour worked (capital deepening) has also been exceptionally weak by historical standards, reflecting sluggish growth in investment and buoyant growth in hours worked, delivering a negative contribution to market sector labour productivity growth since 2012.

- The largest positive contributor to growth in market sector hours worked has been workers with degrees, as opposed to workers with lower qualifications; in Quarter 4 2019, workers with degrees accounted for 32.5% of total hours worked in the market sector, compared with 21% in 2008.

- Since the 2008 downturn, non-financial services have made a positive contribution to MFP growth, while all other industries have made negative contributions.

2 . Contributions to growth in output and labour productivity

Productivity is a measure of the relationship between inputs and outputs in the economy. The fewer inputs needed to produce the same output, the more productive the economy is. Productivity is a main driver of economic growth and is an indicator of the economic health of a nation.

Estimates of multi-factor productivity (MFP) attempt to control for the changes in the various inputs used to create the economic output and how these inputs are combined to deliver output. These inputs include changes to capital services (such as machinery and software), changes to the composition of the labour market (for example, the number of workers with university degrees) and changes to labour input in terms of hours.

The difference between changes in these inputs and changes in output in a given period is MFP, which reflects how the inputs are organised and used in order to generate output.

All percentage changes in this release are expressed as changes in (natural) logarithms, which can differ slightly from the discrete percentage changes typically used in our other statistical releases. The use of log changes allows our productivity decompositions to be exactly additive across components. For more information, see our simple guide to MFP.

Figure 1 shows that yearly growth of 1.2% in market sector gross value added (GVA) in 2019 was mainly driven by labour input, while MFP made a negative contribution to GVA growth. The upward trend in market sector GVA seen in earlier years has been roughly matched by increases in hours worked.

Labour composition growth has been relatively flat since the economic downturn. In 2019, labour composition increased by 0.2% when compared with 2018. Capital input (as measured by capital services) has increased in 2019 by 1.3%, still a slow pace by historical standards. Further information is available in the dataset published alongside this release.

Figure 1: Multi-factor productivity made a negative contribution to output growth

Decomposition of cumulative quarterly output growth, Quarter 1 (Jan to Mar) 2008 to Quarter 4 (Oct to Dec) 2019, UK, market sector
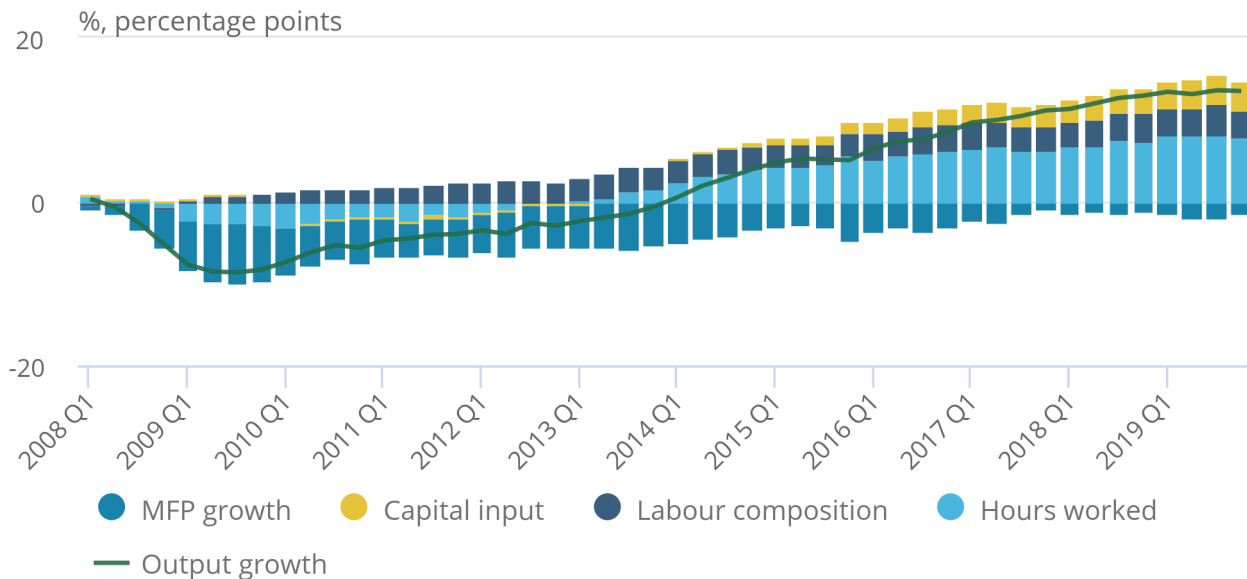
Source: Office for National Statistics

Notes:

1. Output growth is the cumulative quarter-on-quarter log change in market sector gross value added (GVA).

2. Columns show contributions of components, calculated by weighting log changes in each component by its factor income share.

3. MFP is calculated by residual.

The growth accounting framework can be re-arranged to provide a decomposition of movements in labour productivity measured by output per hour, as shown in Figure 2. In this presentation, the capital contribution reflects changes in capital services per hour worked (known as capital deepening, which differs from the broader concept of capital input used in Figure 1). The contributions of labour composition and of MFP are identical between Figures 1 and 2.

Figure 2: Market sector output per hour has barely increased in the last 12 years

Decomposition of cumulative quarterly growth of output per hour worked, Quarter 1 (Jan to Mar) 2008 to Quarter 4 (Oct to Dec) 2019, UK, market sector

Figure 2: Market sector output per hour has barely increased in the last 12 years

Decomposition of cumulative quarterly growth of output per hour worked, Quarter 1 (Jan to Mar) 2008 to Quarter 4 (Oct to Dec) 2019, UK, market sector

Source: Office for National Statistics

Notes:

1. Labour productivity growth is the cumulative quarter-on-quarter log change in market sector gross value added (GVA) per hour worked.

2. Columns show contributions of components, calculated by weighting log changes in each component by its factor income share.

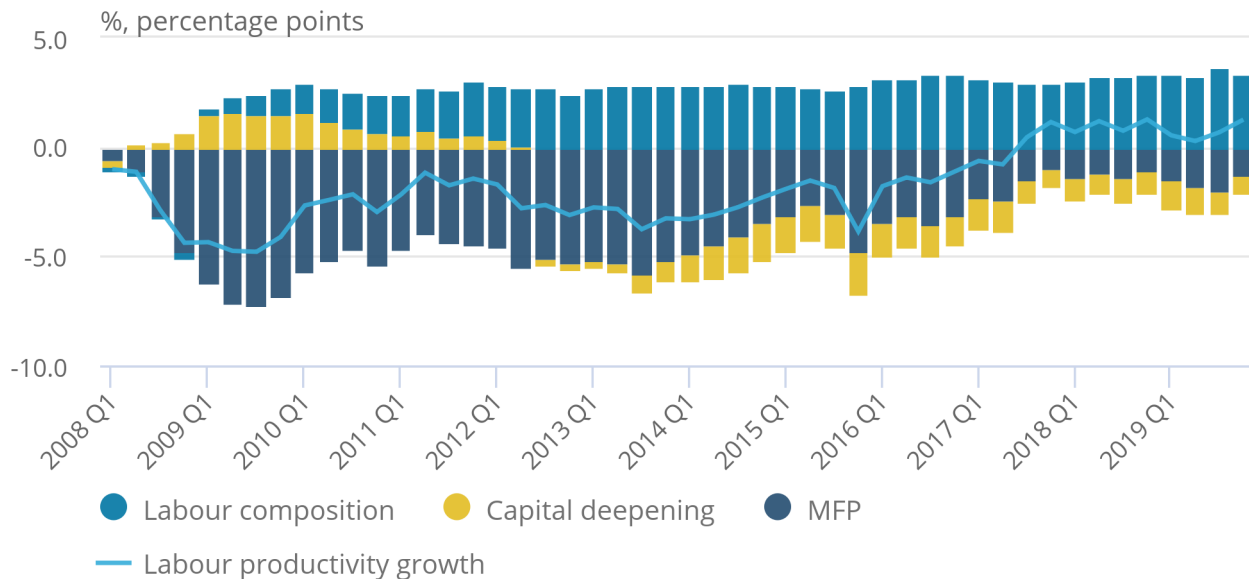3. MFP is calculated by residual.

Figure 2 highlights the prolonged weakness of market sector labour productivity since the 2008 economic downturn. More than 10 years on, labour productivity per hour worked is just 1.2% above of its level at the end of 2007. Quarter 4 (Oct to Dec) 2019 is the second quarter in a row of higher quarter-on-quarter labour productivity growth.

In Quarter 4 2019, MFP decreased by 0.3% compared with the same quarter a year ago, bringing MFP 1.3% under its 2008 level. This contrasts with trend growth in MFP of around 1.5% per year prior to the downturn.

Since the downturn, firms in the UK have expanded their production capacity by mainly increasing the labour input, while investment in capital has been weak. Capital deepening (capital services per hour worked) has been weak by historical standards and since 2012, the UK market sector has actually been faced with capital shallowing: the growth of capital services has been slower than the growth in hours worked.

The average growth rate for capital deepening for the 2009 to 2019 period has been negative 0.3% while the average growth rate for the pre-downturn period 1998 to 2008 was 1.8%. This means that the amount of capital services available for each hour worked has been declining in the UK since the financial downturn. This might be partly explained by uncertainties in the economy where firms may have been holding back from costly long-term investments such as new machinery and equipment, and instead employed labour, which can be seen as the more flexible input of production.

Further information is available in the MFP01 dataset published alongside this release.

Figure 3: Sustained labour composition growth has propped up productivity

Decomposition of cumulative quarterly growth of output per hour worked, Quarter 1 (Jan to Mar) 1994 to Quarter 4 (Oct to Dec) 2019, UK, market sector

Figure 3: Sustained labour composition growth has propped up productivity

Decomposition of cumulative quarterly growth of output per hour worked, Quarter 1 (Jan to Mar) 1994 to Quarter 4 (Oct to Dec) 2019, UK, market sector

● MFP ● Labour composition ● Capital deepening
— Labour productivity growth
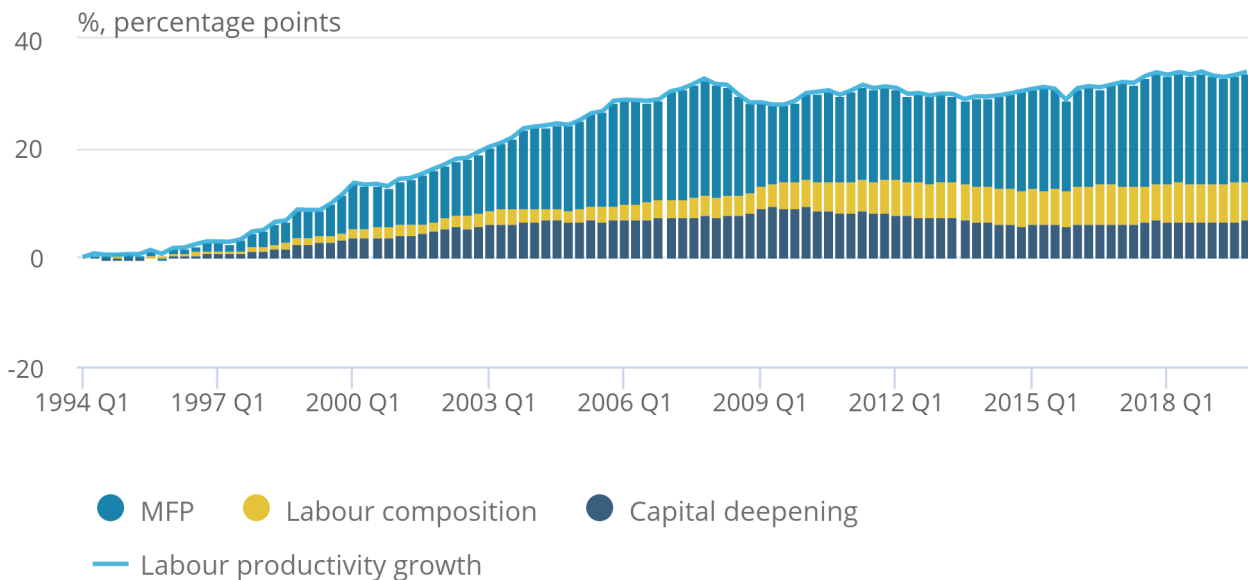
Source: Office for National Statistics

Figure 3 highlights the structural break at the time of the 2008 economic downturn, where capital deepening ceased growing and MFP demonstrated a level-shift downwards. The MFP growth has so far failed to exceed the pre-downturn growth rate. Labour composition, however, has been growing slightly faster post-downturn. There are several possible reasons for the weak post-downturn MFP growth and it is an area that we continue to investigate. For more information, see Section 7.

3 . Quality-adjusted labour input

In Quarter 4 (Oct to Dec) 2019, labour composition has not grown compared with the same quarter a year ago. The share of hours worked by workers with degrees or postgraduate degrees has been increasing since the downturn. In 2019, workers with degrees accounted for 32.5% of the total hours worked in the market sector, compared with 21% in 2008. With respect to 2008, labour composition in 2019 has grown by 3.3%.

This means that the labour composition or "labour quality" in the UK has been higher for the post-downturn period, and therefore labour composition is estimated to have not contributed to the productivity puzzle. More information on the UK labour composition post-downturn can be found in our analysis of compositional changes in hours worked in the UK .

Figure 4: Since the 2008 financial downturn, growth in market sector hours worked has been driven by workers holding degrees or higher qualifications

Cumulative contributions to changes in hours worked by highest level of education, Quarter 1 (Jan to Mar) 2008 to Quarter 4 (Oct to Dec) 2019, UK, market sector

Figure 4: Since the 2008 financial downturn, growth in market sector hours worked has been driven by workers holding degrees or higher qualifications

Cumulative contributions to changes in hours worked by highest level of education, Quarter 1 (Jan to Mar) 2008 to Quarter 4 (Oct to Dec) 2019, UK, market sector
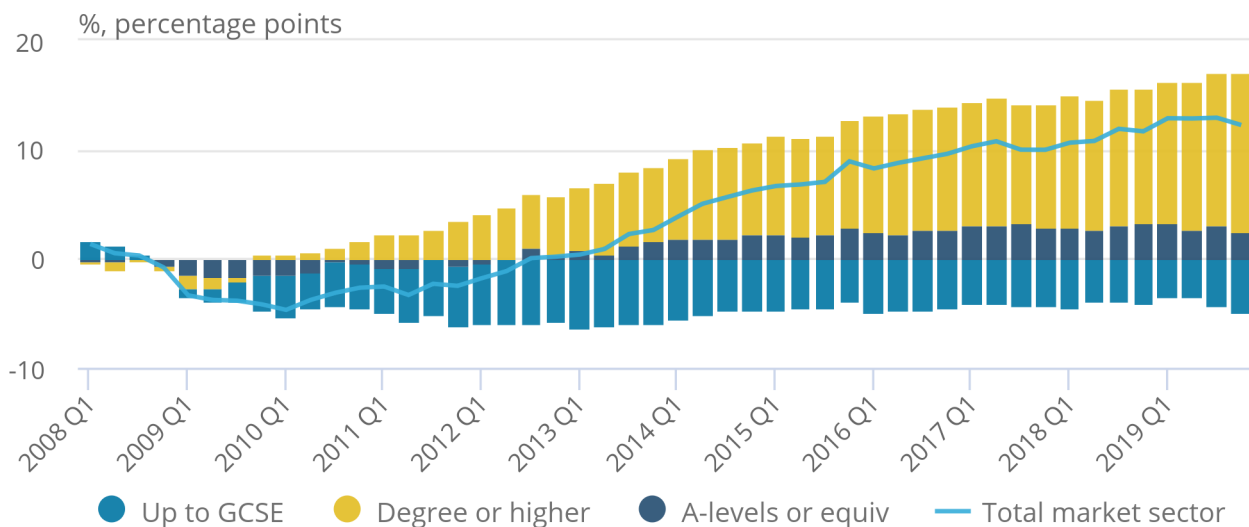
Source: Office for National Statistics

Figure 4 shows quarterly changes in hours worked broken down by highest education qualification. In general, there is a strong positive correlation between level of education and hourly earnings, so a shift in hours worked towards workers with higher qualifications will typically materialise as an increase in labour quality.

In Quarter 4 2019, the share of hours worked by workers with no education attainment or with only GCSEs decreased by 11.1% compared with the previous quarter. This represents the largest quarter-on-quarter fall for this worker category currently available in our datasets. On the other hand, in Quarter 4 2019, the share of hours worked by workers with an undergraduate degree increased by 3.3%.

Further information on hours worked and labour composition, including industry components, is available in the QALI00, QALI01 and QALI02 datasets published alongside this release.
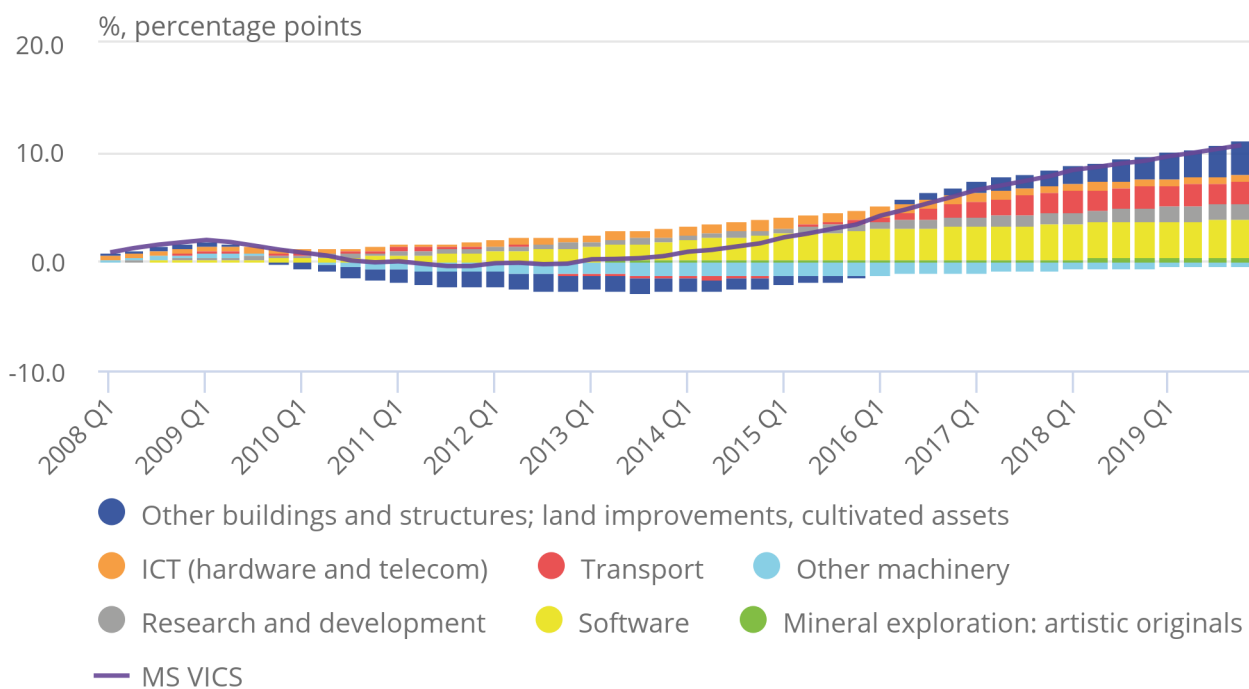
4 . Volume index of capital services

Figure 5: Capital services growth has been dominated by software

Cumulative contributions to changes in capital services, Quarter 1 (Jan to Mar) 2008 to Quarter 4 (Oct to Dec) 2019, UK, market sector, by broad asset category

Figure 5: Capital services growth has been dominated by software

Cumulative contributions to changes in capital services, Quarter 1 (Jan to Mar) 2008 to Quarter 4 (Oct to Dec) 2019, UK, market sector, by broad asset category

- Other buildings and structures; land improvements, cultivated assets
- ICT (hardware and telecom)
- Transport
- Other machinery
- Research and development
- Software
- Mineral exploration: artistic originals
- MS VICS

Source: Office for National Statistics

Capital services measure the flow of services that different types of assets provide to the production process. These different types of assets are adjusted for deterioration and weighted by a set of user cost weights. These weights reflect how intensively different types of assets are used in the production process .

In capital services, short-lived assets such as software are given a proportionately higher weight than long-lived assets such as buildings. This differs from the weights these assets have in capital stocks. Shorter-lived assets in the volume index of capital services (VICS) have proportionately higher weights than they do in capital stocks. This reflects the more intensive way the short-lived assets are used in the production process.

Software is making the largest cumulative contribution to capital services growth since Quarter 4 (Oct to Dec) 2007, accounting for 3.5 percentage points out of the total growth, while the positive contribution by other buildings has been growing steadily since Quarter 1 (Jan to Mar) 2016, now accounting for 3 percentage points.

The coverage of capital in the multi-factor productivity (MFP) system is similar to that of business investment. Business investment growth was 1.8% in Quarter 4 2019 when compared with Quarter 4 2018. Similarly, capital services are estimated to have increased by 1.3% in Quarter 4 2019 compared with the same quarter a year ago. This suggests that the lower levels of new investment were sufficient to offset declines in the stock of productive capital caused by wear and tear, and retirements. This growth is weak by historical standards, with capital services growing 2.3% a year on average between 1998 and 2008.

5 . Contributions to growth in multi-factor productivity

Figure 6 shows the cumulative contributions to growth in multi-factor productivity (MFP) by five broad industry groups. Non-financial services is the only industry group that has made a positive contribution to post-downturn growth in MFP. The positive contributions to MFP growth reflect the ability of these industries to harness new technologies or use their inputs in a more efficient way in the production process.

There is variation in MFP growth within the industry groups. For example, manufacturing overall has made a negative contribution to post-downturn MFP growth. However, some of the sub-sectors of manufacturing had a positive MFP growth during the same period. Manufacturing of computer, electronic and optical products has seen strong MFP growth since 2016 while the MFP growth in manufacturing of textiles, wearing apparel and leather products was mostly unaffected by the downturn but since 2011 the growth has trended downwards. See the MFP02 dataset for more granular MFP data.

The MFP01 dataset published alongside this release includes breakdowns of aggregate market sector MFP into contributions from individual industries, following the methodology set out by Diewert (2015) in Decompositions of productivity growth into sectoral effects. This is an extension and generalisation of the Tang and Wang (2004) methodology used in our labour productivity release.

Figure 6: Multi-factor productivity is lower in all industries since 2008 downturn except non-financial services

Industry contributions to cumulative multi-factor productivity growth, Quarter 1 (Jan to Mar) 2008 to Quarter 4 (Oct to Dec) 2019, UK, market sector

Figure 6: Multi-factor productivity is lower in all industries since 2008 downturn except non-financial services

Industry contributions to cumulative multi-factor productivity growth, Quarter 1 (Jan to Mar) 2008 to Quarter 4 (Oct to Dec) 2019, UK, market sector
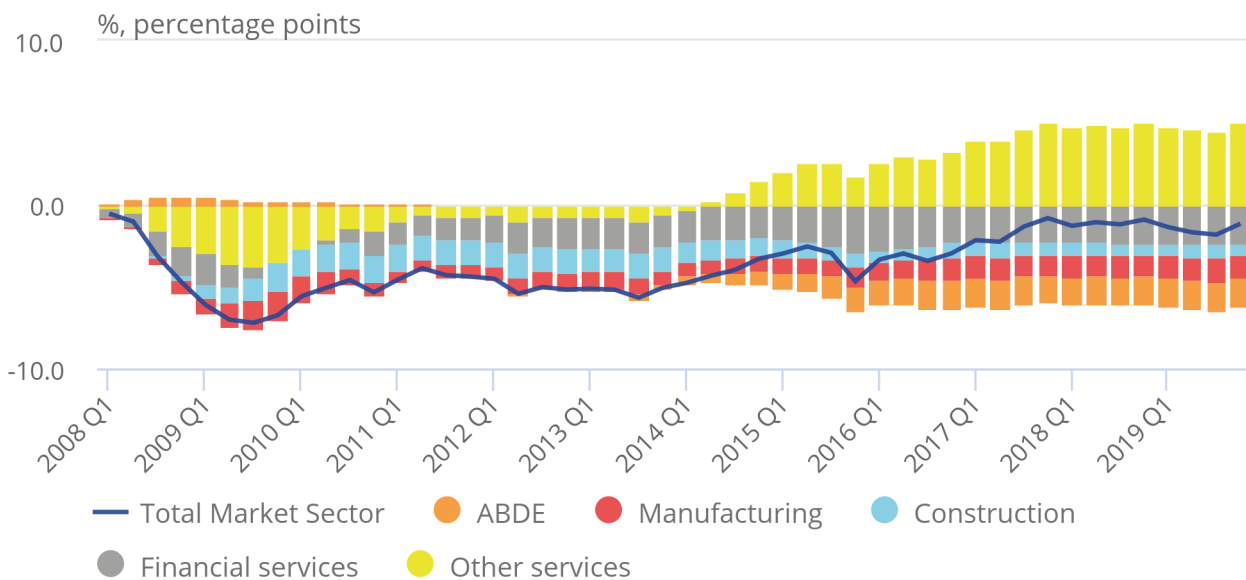
Source: Office for National Statistics

Notes:

1. ABDE is: agriculture, forestry and fishing; mining and quarrying; electricity, gas, steam and air conditioning supply and water supply; and sewerage, waste management and remediation activities.

2. Total MS is the MFP for the whole market sector.

6 . Non-financial services

Figure 7 builds on the previous section, drilling down into non-financial services. Non-financial services comprise 14 industries out of the 21 within the one-digit Standard Industrial Classification (SIC). The chart shows the quarterly cumulative growth of multi-factor productivity (MFP) in all industries constituting non-financial services, their aggregate (the solid line) and total MFP growth (the dotted line).

Non-financial services faced negative growth after the downturn. In non-financial services, MFP growth started to recover in 2014. Since 2014, MFP in non-financial services has been growing on average 0.2% per quarter. If we subtract the MFP growth of non-financial services from the market sector, since 2014, MFP quarterly growth would have been negative 0.1% on average.

Drawing attention to the two lines in the chart, we can see how the gap between total MFP cumulative growth and non-financial service MFP growth has been increasing since 2008. When considering the productivity puzzle the UK economy is confronting, one can notice that non-financial services is the only industry-aggregate where cumulative growth in MFP is above its pre-downturn level and growing at a faster rate than for the whole market sector.

The growth in MFP has been driven by real estate activities, administrative and support service activities and the combination of other industries with smaller weights (please see the note attached to Figure 7). We are planning to publish a more detailed analysis on non-financial services in the future to look more into detail at these industries and the possible reasons behind their better performance in terms of MFP growth in recent times.

Figure 7: Multi-factor productivity growth in non-financial services has constantly higher growth than the overall average, at an increasing rate

Cumulative growth of MFP in different industries compared to total market-sector average from 2008, UK

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Cumulative growth of MFP in different industries compared to total market-sector average from 2008, UK
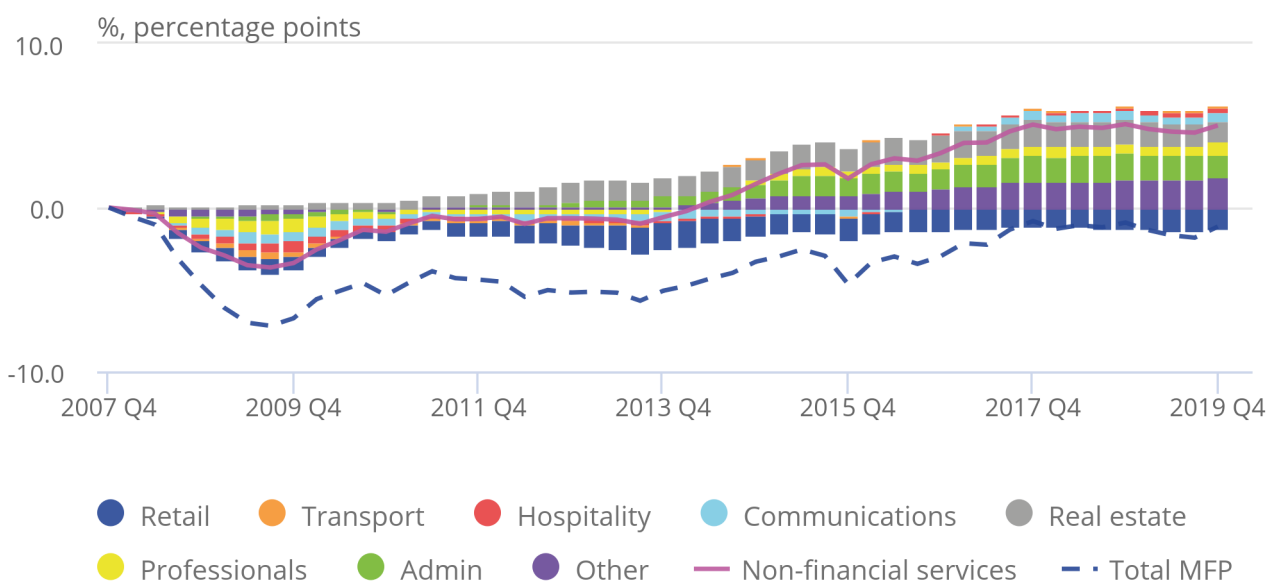
Source: Office for National Statistics

Notes:

1. The label admin refers to the industry of administrative and support service activities.

2. Others is the aggregate of the market-sector part of industries O, P, Q (that correspond to public administration and defence, compulsory social security; education; human health and social work activities) together with industries R, S, T and U (arts, entertainment and recreation; activities of households as employers, undifferentiated goods and services producing activities of household for own use; activities of extraterritorial organisations and bodies).

7 . Multi-factor productivity data

[Multi-factor productivity estimates](#)
Dataset MFP01 | Released 7 April 2020
Indices and log changes for gross value added (GVA), multi-factor productivity, implied factor prices, hours worked, labour composition, capital services and GVA per hour worked.

[Multi-factor productivity estimates for sub-sections for industries C, G and M](#)
Dataset MFP02 | Released 7 April 2020
Annual experimental estimates, 1970 to 2018, for sub-sections for industries C, G and M.

[Capital services estimates](#)
Dataset VICS01| Released 7 April 2020
Industry and asset data for volume index of capital services, user cost, gross fixed capital formation, productive capital stock, implied deflator for gross fixed capital formation and market sector rate of return.

[Quality adjusted labour input, descriptive statistics](#)
Dataset QALI00 | Released 7 April 2020
Annual data on relative hourly remuneration and shares of hours worked by industry, age, sex and education for market sector and whole economy.

[Quality adjusted labour input, summary data](#)
Dataset QALI01| Released 7 April 2020
Quarterly and annual data on quality-adjusted labour input log changes by industry, age, sex and education.

[Quality adjusted labour input, underlying data](#)
Dataset QALI02| Released 7 April 2020
Underlying quarterly quality-adjusted labour input data on hours worked, jobs and income weights.

8 . Glossary

Capital deepening and capital shallowing

Capital deepening measures the amount of capital services available per hour worked. If the amount of capital services per hour worked is increasing it is referred to as capital deepening and when the amount of capital services per hour worked is reducing it is referred to as capital shallowing.

Capital services

Measures the flows of services that different types of assets provide to the production process. The capital services measure used in multi-factor productivity is volume index of capital services (VICS).

Gross value added

Gross value added (GVA) is an estimate of the volume of goods and services produced by an industry, and in aggregate for the UK.

Labour composition

Labour composition measures the characteristics of the labour used in the production process. The labour measure used in multi-factor productivity is quality-adjusted labour input (QALI), which splits the hours worked data using four categories: industry, age, sex and education.

Market sector

Market sector is that part of the economy where economically meaningful prices for goods and services can be measured. Market sector excludes general government and non-profit institutions serving households.

User cost

User cost, sometimes referred to as the rental price, reflects the cost of using a capital asset for the period in question. User costs are used in the volume index of capital services to weight the contributions by different types of assets in the production process.

9 . Measuring the data

More quality and methodology information on strengths, limitations, appropriate uses, and how the data were created is available in the Multi-factor productivity (MFP) QMI.

Multi-factor productivity (MFP) estimates are compiled within the growth accounting framework, which decomposes changes in economic output, in this case gross value added (GVA) of the UK market sector, into contributions from changes in measured inputs: labour, capital and a residual element known as MFP. For more information, see the QMI and our simple guide to MFP.

The labour measure used for MFP is quality adjusted labour input (QALI), and the capital measure used for MFP is the volume index of capital services (VICS). The weights (and 1-) reflect the factor shares of labour and capital:

$$\Delta \ln MFP \ = \ \Delta \ln GVA - \alpha \Delta \ln QALI - (1 - \alpha)\Delta \ln VICS$$

In the growth accounting framework, the contribution of labour (QALI) to changes in economic output takes account of changes in labour composition or "quality" of the employed labour force, as well as changes in the "volume" of labour measured by hours worked. QALI index is calculated by multiplying log changes in hours worked by income weights. The income weights reflect the shares of different types of labour of the total wage bill. Please refer to the Quality-adjusted labour input (QALI) QMI for a detailed explanation.

Movements in capital inputs (VICS) are captured through capital services, which measures the flow of services that different types of assets provide to the production process. Conceptually, this is analogous to the treatment of labour input insofar as user cost weights are given to different forms of capital (such as machinery and software) to reflect their estimated contribution to the production process. However, unlike labour, where hours worked can be directly observed, there is no equivalent of a standard unit of capital service and so there is no quantifiable distinction between the volume and quality of capital. Please refer to the Volume index of capital services (VICS) QMI for a more detailed analysis of VICS.

$$User \ cost = Net \ capital \ stock * (Depreciation + Rate \ of \ return - Holding \ gains) * Tax \ adjustments$$

Hours worked in the UK market sector are aggregated from estimates of each component industry, as set out in [Developing improved estimates of quality-adjusted labour inputs using the Annual Survey of Hours and Earnings: a progress report](), published in July 2017. These differ slightly from those in our labour productivity release.

10 . Strengths and limitations

We want to inform our users that, from now on, we have switched to bulletins for these releases. Please find our previous release at [Multi-factor productivity estimates, UK: July to September 2019]().

These are [Experimental Statistics](). We are working on strengthening experimental quarterly multi-factor productivity (MFP) estimates for the UK market sector to obtain [National Statistics]() badging. We invite users' feedback on our MFP release to [Productivity@ons.gov.uk]().

11 . Related links

[Labour productivity, UK: October to December 2019]()
Bulletin | Released 7 April 2020
Output per hour, output per job and output per worker for the whole economy and a range of industries.

[Unit labour costs, UK: October to December 2019]()
Bulletin | Released 7 April 2020: October to December 2019
Unit labour costs and sectional unit labour costs estimates for the whole economy and a range of industries.

[Public service productivity, quarterly, UK: October to December 2019]()
Article | Released 7 April 2020
Experimental estimates for UK total public service productivity, inputs and output to provide a short-term, timely indicator of the future path of the annual productivity estimates.

[Business investment in the UK: October to December 2019 revised results]()
Bulletin | Released 31 March 2020
Estimates of short-term indicators of investment in non-financial assets, business investment, and asset and sector breakdowns of total gross fixed capital formation.

[A simple guide to multi-factor productivity]()
Methodology | Released 5 October 2018
Explains the concept and measurement of multi-factor productivity through simple stylised examples.