Analysis

Manufacturing is not fostering labour productivity growth as it did before

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Finnish labour productivity growth faded during the global financial crisis and recession that followed. Productivity growth picked up again amid the economy's recovery and subsequent boom, but only momentarily. The economy's low levels of productivity growth are in part explained by structural change, as output has shifted from high-productivity manufacturing industries to services. On the other hand, labour productivity developments in the manufacturing sector have in recent years remained historically weak in almost all industries. Declining labour productivity growth is a widespread phenomenon that not only affects Finland but many other advanced economies as well. Causes may include challenges in measuring productivity growth but also the increasing cost and difficulty associated with innovation and the adoption of new technologies, with easy applications of technology having already been exhausted.



Structural change is slowing down productivity growth

Labour productivity growth slowed during and after the global financial crisis, both in Finland and internationally. In particular, Finland's weak productivity developments over 2008–2009 are largely attributable to cyclical factors. Gross domestic product (GDP) fell exceptionally sharply in Finland in 2009; however, the contraction in output only had a relatively minor impact on employment levels, particularly in many of the manufacturing industries. Because labour productivity is calculated as value added per worker or hour worked, productivity growth, by its very definition, declined. In the years following the crisis, Finnish productivity growth was also weakened by turbulence in individual industries, such as the decline of the mobile phone industry spearheaded by Nokia and domestic capacity reductions by the pulp and paper industry in Finland. On the one hand, productivity growth was being dampened by diminishing productivity gains within these industries themselves, and on the other hand, by their declining share of value added created within the economy.

Finnish labour productivity growth began to recover alongside the broader economy in 2015. This time around, however, productivity growth began to pick up in a different order of industries than in previous upswings, where manufacturing has, as a rule, served as the locomotive for labour productivity growth (Chart 1). When the aggregate economy began gathering momentum in 2015, labour productivity first picked up in services, with manufacturing productivity lagging behind slightly and not growing until early 2016. Productivity growth eventually topped out in 2016, increasing 2.3% on the previous year.

The return of productivity growth turned out to be short-lived. In 2018 economic growth rested

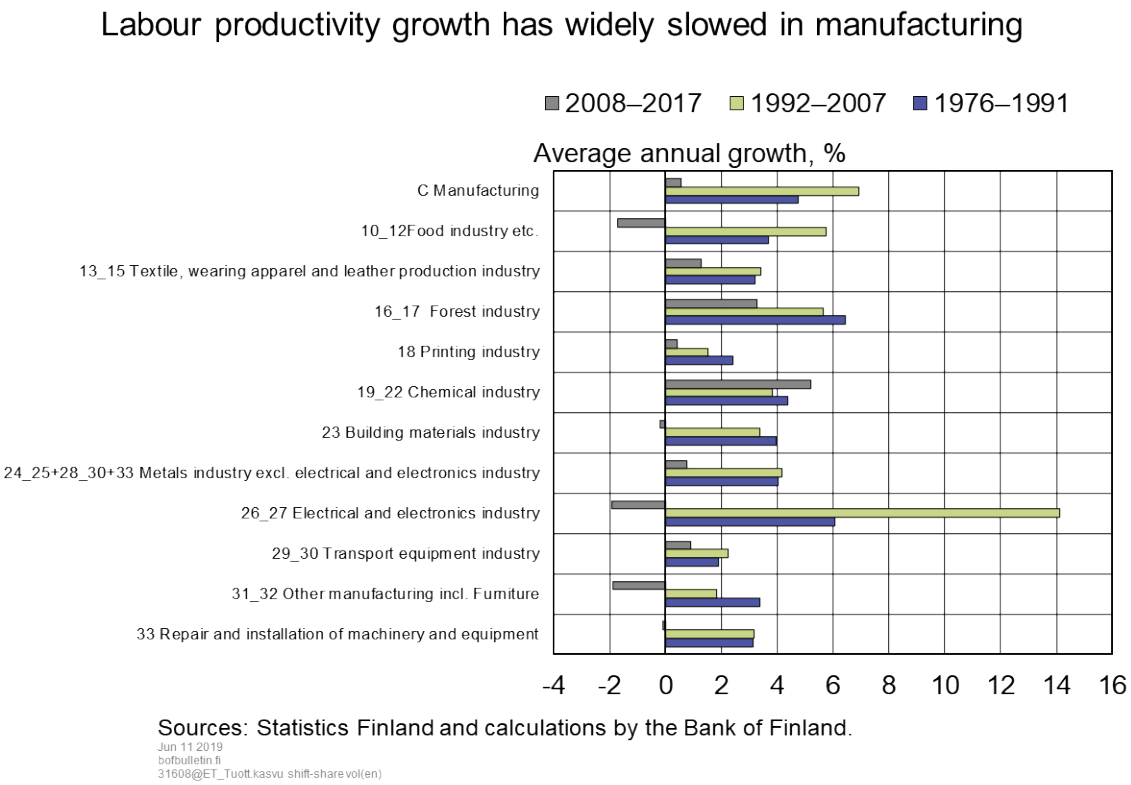
entirely on favourable developments in employment, as labour productivity growth once again sputtered to a halt. Instead of temporary factors, weakness in productivity growth is increasingly being driven by structural developments, many of which are shared across the advanced economies.

Services increasingly important for productivity growth

The decline in labour productivity growth is in part due to the economy's transition towards services. Productivity growth has historically been most rapid in manufacturing; however, the manufacturing sector's share of value added has contracted significantly over the past decade. Manufacturing[1] accounted for 25% of the economy's total value added in 2007, but only 18% in 2017. How different industries contribute to aggregate, economy-wide labour productivity growth can be decomposed into productivity developments within industries themselves and changes in the flow of labour across industries (Chart 1). If labour is reallocated from industries with high rates of productivity growth to industries with lower productivity growth, it follows that the average rate of productivity growth in the aggregate economy will decline. This dynamics can be referred to as the impact of structural change. To a lesser degree, changes in the relative prices between different industries also have an impact on measured productivity growth: raising the price of one industry's output relative to others' increases its share of value added in the economy. Boxes 1 and 2 at the end of this article go into further detail on how labour productivity growth can be decomposed into industry-level factors.

In the early 2000s, aggregate labour productivity growth was mainly driven by productivity improvements in the manufacturing sector (Chart 1). After the 2008–2009 recession, however, labour productivity growth in manufacturing has performed poorly by historical standards. Instead, productivity growth has been eked out of other areas of the economy in recent years, mostly from services. In 2011–2012, in the period of weak economic growth following the recession, employment and output both contracted rapidly in the manufacturing sector. As a result, the economy's total output shifted towards the service sector, where productivity growth has been slower than in manufacturing, significantly dampening the rate of economy-wide labour productivity growth. This shift in the employment structure is denoted as structural change in Chart 1.

Chart 1.



Productivity growth in manufacturing now dependent on basic industry

Chart 2 illustrates how average labour productivity growth rates have evolved in different manufacturing industries in 2008–2017, after the financial crisis. For comparison's sake, two reference periods flanking both sides of the 1990s recession, 1976–1991 and 1992–2007, are also included in the chart. In the 1990s and early 2000s, labour productivity in manufacturing grew at an average annual rate of 6.9%. This figure collapsed during the recession in 2008–2009. Manufacturing productivity growth was slow to recover from the recession, increasing at an average annual pace of just 0.1% between 2008 and 2017 (Chart 2). Productivity growth declined in all manufacturing industries except the chemical industry.

Chart 3 depicts each manufacturing industry's contribution to aggregate labour productivity growth from 1976 to 2017. From the late 1990s all the way up to financial crisis, the lion's share of economy-wide labour productivity growth was driven by manufacturing industries. After 2008, however, productivity growth has largely been created in other industries, since productivity growth in manufacturing has remained weak on average.

Labour productivity growth has historically been robust in Finland's traditional manufacturing industries—in the forest and metals industries. However, from the early 1990s all the way up to 2007, productivity growth was fastest in the electrical and electronics industry, which underwent rapid expansion after the 1990s recession, spearheaded by Nokia. Accordingly, the industry's average annual growth rate for labour productivity was as much as 14% during this time period (Chart 2). Further compounding the industry's influence on aggregate productivity growth was its large share of total output, on average slightly over 6% of GDP. As the mobile phone industry started to falter, productivity growth began declining sharply across the electrical and electronics industry after 2008.

In the early 2000s especially, the electrical and electronics industry played a key role in spurring economy-wide productivity growth. With aggregate labour productivity growing at an average rate of 1.8% a year in 1992–2007, the electrical and electronics industry alone accounted for about half of this growth (Chart 3). Consequently, when the industry's own labour productivity growth fell sharply after the 2008–2009 recession, this had the effect of dragging down the rate of productivity growth for the entire economy.

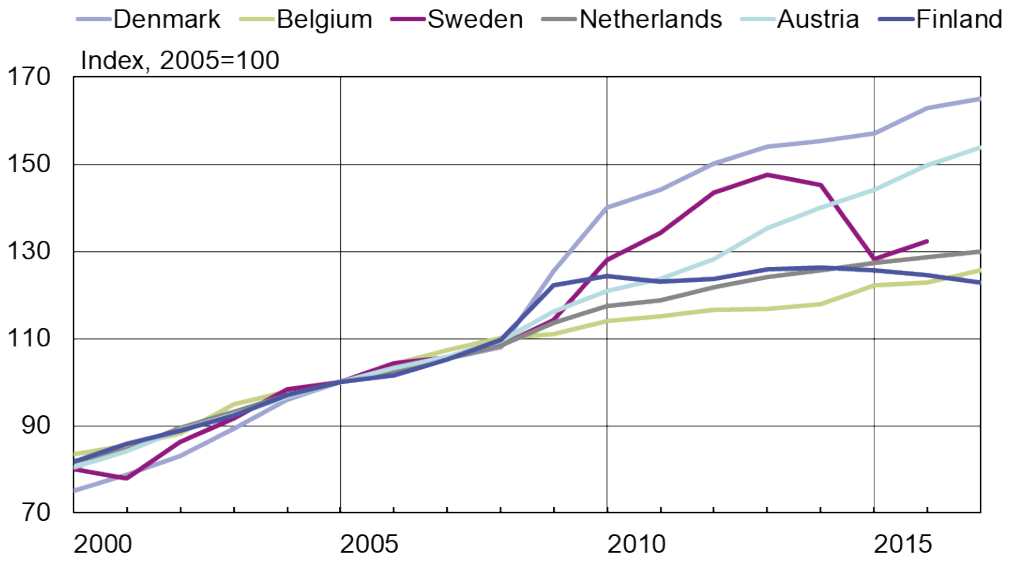
In the years following the recession, productivity growth also declined in other export-intensive manufacturing industries. Labour productivity in the metal industry grew by almost 4% per annum in the 15 years leading up to the recession (Chart 2) and contributed an average of 0.3 percentage points a year to aggregate productivity growth. Yet after 2007 the industry has barely contributed to productivity growth in the broader economy (Chart 3).

Labour productivity in the forest industry has grown at an average annual rate of 3% even after the recession. However, the industry's contribution to aggregate productivity growth has diminished as its share of GDP has contracted. In 1992–2007 the forest industry accounted for more than 5% of the value added created in the economy; in the years following the financial crisis, the industry's share of GDP has remained at approximately half of this. At the same time, its contribution to aggregate labour productivity growth has contracted from an average of 0.3 percentage points to 0.1 percentage points (Chart 3).

Only the chemical industry has seen markedly steady labour productivity growth all the way from the mid-1970s, even averaging over 5% a year in the 2008–2017 post-crisis period (Chart 2). The chemical industry includes the oil industry, the manufacture of chemicals and chemical products, the manufacture of rubber and plastic products, and the pharmaceutical industry, among others. In the years after the financial crisis, the chemical industry has contributed an average of 0.2 percentage points a year to aggregate labour productivity growth (Chart 3).

Chart 2.

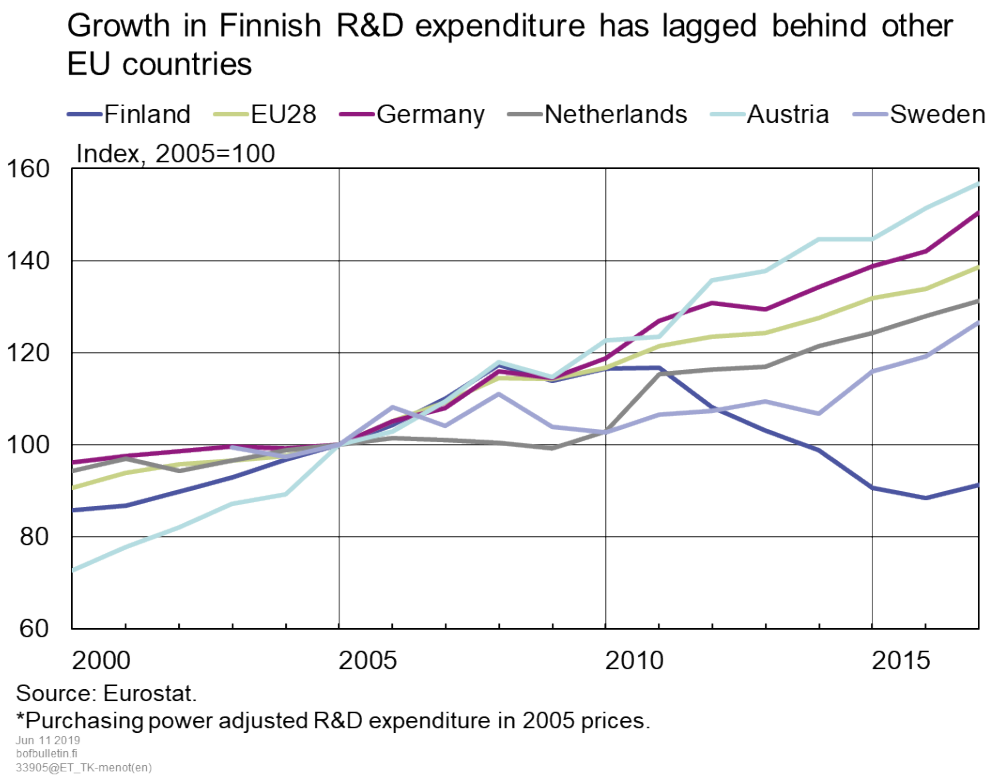
Capital deepening in Finnish manufacturing has been slow after the financial crisis*



Source: Eurostat.
*Capital intensity is calculated as the amount of capital per worker in manufacturing (industry C in the TOL 2008 standard classification of industries).

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Chart 3.



Sparse investment holding back productivity growth in manufacturing

Since the financial crisis, labour productivity growth in manufacturing has remained weak not only in Finland but in other advanced economies as well. According to the OECD (2016), the weakness in labour productivity growth observed in many OECD countries in recent years may be attributable to lower levels of capital intensity, among other causes. A decrease in capital intensity means that the stock of productive capital per worker has declined.

Due to the weak growth prospects faced by firms during the recession, non-residential investment remained sparse also in Finland, and gross investment was not always sufficient to cover the rate of capital depreciation. The investment rate has since recovered on the back of the boom, but not sufficiently enough for the capital stock to keep pace with the rapid rise in employment.

Chart 4.

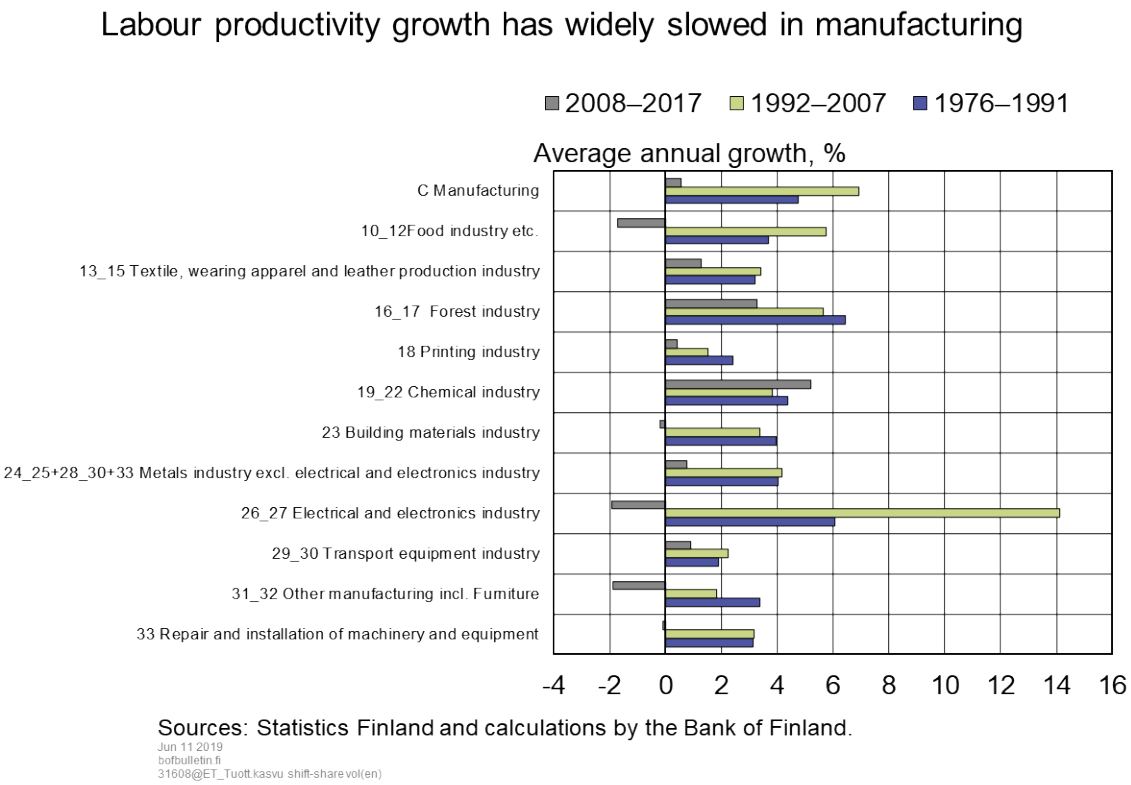


Chart 4 illustrates how capital intensity in manufacturing has evolved in Finland and a selection of other small open economies during 2000–2017. From the early 2000s all the way up to the financial crisis, capital intensity, i.e. the amount of capital per worker, grew at a near-even pace in all of the countries surveyed. Capital deepening continued in other countries even after the financial crisis, but in Finland it has remained anaemic in manufacturing ever since 2009, even entering a decline in 2015. In 2017, the level of capital stock per worker in the Finnish manufacturing sector was about the same as during the recession in 2009. The deterioration of the capital base during the recession was largely a consequence of the collapse of the mobile phone industry and the forest industry's capacity reductions. However, the majority of other important manufacturing industries saw weak developments in their levels of capital stock as well.

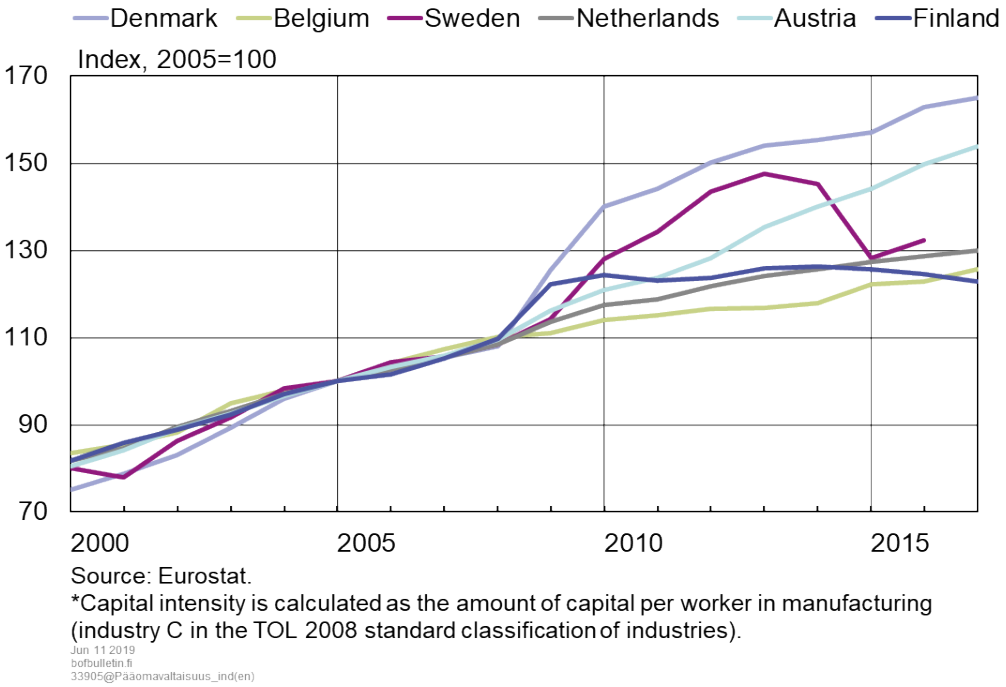
The survey presented in Chart 4 may, however, paint an excessively grim picture of the Finnish manufacturing sector's production capacity. The survey only looks at relative change in the capital stock—not its actual volume. According to Pohjola (2017), Finland's total level of capital stock relative to GDP remains quite large by international standards even in spite of its weak growth in recent years, as the Finnish economy managed to expand its capital base exceptionally quickly from the 1950s to the early 1990s. In addition, calculations by Maliranta (2019) suggest that the

effect of capital deepening on labour productivity growth in Finland has remained broadly the same since after the financial crisis.

Non-residential investment has picked up again on the back of Finland's strong economic expansion in recent years. Capital stock in the chemical industry already began to grow in 2015. The forest industry, for its part, has put in place several large-scale investments that are yet to be fully accounted for in statistical data.

Chart 5.

Capital deepening in Finnish manufacturing has been slow after the financial crisis*



Source: Eurostat.
*Capital intensity is calculated as the amount of capital per worker in manufacturing (industry C in the TOL 2008 standard classification of industries).

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The scarcity of research and development (R&D) expenditure after and during the recession may in part explain the weakness in labour productivity growth. Growth in Finnish R&D spending remained notably behind the EU average in the 2010s (Chart 5). In 2017, Finland's total research and development expenditure stood at some EUR 6.2 billion, which, in real terms, is about 18% lower than in 2007. Meanwhile, the cumulative R&D spending of all the countries in the EU increased by about 27% during the same period.

However, lacklustre growth in R&D expenditure cannot in and of itself fully account for the weakness in productivity growth in manufacturing. The decline in R&D spending can largely be attributed to the contraction of the electrical and electronics industry. R&D expenditure did not materially decline in other industries, and total R&D spending even began to grow again in 2016.

Yet manufacturing productivity growth has remained weak across almost all industries.

Focusing solely on the nominal sums of R&D expenditure may misrepresent the innovation activity of Finnish firms. In the European Union's Community Innovation Survey, enterprise innovation activity is measured not only in terms of R&D expenditure but also by broader metrics focusing on the development and adoption of innovations. In the most recent survey, carried out in 2019, enterprises operating in Finland reported even broader innovation activity in 2014–2016 than during the previous two-year period. Innovation activity in Finnish firms was also far more common than the EU average.[2]

Total factor productivity began to decline as well

More than the volume of productive capital, labour productivity growth is determined by the rate of technological progress and the ability of organisations to implement technology as a means of saving on work. The share of labour productivity growth that cannot be explained by changes in the level of capital intensity is often referred to as total factor productivity. According to Maliranta (2019) and Pohjola (2017), the decline in Finnish labour productivity growth from levels in 2001–2007 to much lower 2008–2015 levels is primarily explained by weak growth in total factor productivity, seeing as the impact of capital deepening on productivity growth has remained more or less the same. According to Pohjola (2017), total factor productivity even contributed to economic growth negatively in the period 2008–2015.

Weak total factor productivity growth is hardly a uniquely Finnish phenomenon. According to Syverson (2016), total factor productivity increased at an average annual pace of about 0.4% in the US manufacturing sector during the years 2005–2013, compared with an average pace of 2.2% between 1995–2004.

Measuring total factor productivity is not without challenge, however. Since total factor productivity is in itself unobservable, it must be estimated with the help of growth accounting. Accordingly, total factor productivity is defined as the share of labour productivity growth that is not explained by changes in capital intensity. The calculation is based on the assumption of perfectively competitive markets. Especially in industries where research and development and product differentiation are important, markets are not perfectly competitive. Instead, firms may have varying degrees of market power, which allows them to put high mark-ups on their products. Mobile phone manufacturing typically represents one such industry.

In this event, the part of labour productivity growth that is not explained by capital deepening not only reflects change in total factor productivity but also developments in firms' market power and mark-ups. The shift in manufacturing from high-value added industries, such as the electrical and

electronics industry to lower value added industries, such as the forest industry, is seen as a decline in measured total factor productivity due to lower mark-ups. Hence the significant contraction of Finland's electrical and electronics industry is also a factor in the observed weakness in total factor productivity growth.

Productivity growth may be slowing because innovation is becoming more difficult

Alternative explanations have been put forward to explain the broad slowdown in labour productivity growth and apparent weakness in technological innovation. According to Goldin et al. (2018), mismeasurement issues may partly explain the decline in labour productivity growth. Technological advancements may improve well-being in areas of the economy that are not fully represented in national accounts and productivity figures. The digitalisation of the economy has provided consumers and firms with access to free goods and services that are not accounted for in GDP statistics. In addition, quality improvements in products are not always fully represented in price indices. This results in the overestimation of inflation and, correspondingly, the underestimation of real output growth. However, according to Goldin et al. (2018), mismeasurements only account for a small portion of the slowdown in labour productivity growth.

One possible explanation for the slowdown in labour productivity growth may lie in diminishing returns on ICT investments and research and development activities. The adoption of information and communication technology across firms was enough to boost labour productivity levels in the 1990s and early 2000s. Yet as ICT has become increasingly commonplace, its marginal benefits in production have declined. Contrary to common expectation, new innovations in ICT have yet to provide a general purpose technology that would transform production methods across the economy. However, some researchers, such as Brynjolfsson and McAfee (2014), are keen to point out that it often takes decades for an innovation to transform into a general purpose technology. Accordingly, it may be that the greatest productivity gains from recent ICT innovations will be reaped in the future.

Innovation activity is mostly centred around coming up with new ways of combining existing ideas. As the amount of knowledge in the world increases, so can it be combined in a growing multitude of different ways. However, this bulk of knowledge also becomes increasingly unwieldy, demanding ever-increasing specialisation from researchers and product developers, which not only slows down innovation activity but makes it more expensive. Bloom et al. (2017) look at the connection between research inputs and productivity in the aggregate economy. The paper's conclusions find that through time an increasing amount of research and development is needed

to generate the same number of innovations.

Explanations for the decline in productivity growth can also be sought on the industry level. Studies based on international firm-level data have found that the gap between the very most and least productive firms in different industries increased both during and after the financial crisis. Labour productivity growth has come to depend on the biggest and most successful firms in any given industry, and at the same time the least productive firms have depressed average productivity growth. Vanhala and Virén (2018) document similar divergences in Finland, especially in manufacturing and ICT. Widening gaps in productivity levels interfere with the flow of innovation and technology between firms and are thus detrimental to productivity growth as a whole. There are substantial differences among firms in how they are able to leverage new innovations, such as digital technology.[3] According to Vanhala and Virén (2018), Finland has an abundance of weakly productive firms in almost all industries, and many industries do not see particularly robust productivity growth even in their most successful firms.

Conclusions

Labour productivity growth has remained subdued in Finland even in spite of the booming economy. The recovery of output from the aftermath of the recession has rested more heavily on employment growth than before. Productivity growth has remained historically slow even in manufacturing, where productivity has traditionally increased quickly. In addition to cyclical factors, structural developments in the economy, such as the transition towards services, are responsible for the weakness in productivity growth. Output and employment levels in high-productivity manufacturing industries have declined and been replaced, in part, with service jobs with slower productivity growth. In manufacturing itself, output has shifted away from industries with high rates of productivity growth, such as the mobile phone industry, towards industries with slower productivity growth. In addition, industry-level productivity growth has broadly slowed down across the manufacturing industries.

Investment, including investment in research and development, has gradually recovered during the upswing and boom in recent years, and the erosion of the capital base that began after the recession has stopped. Investment may pick up in the coming years also because of more rapid technological innovation, as the digitalisation of the economy advances and forces firms to overhaul their means of production.

In an ageing economy, it will nevertheless prove increasingly difficult to match the productivity growth of past decades. Population ageing will accelerate the economy's transition towards services, as the demand for age-related caregiving and health care services will rise sharply by the

2020s and 2030s. An increasingly large share of the economy's labour input will be diverted towards low productivity growth service industries. Indeed, important questions for productivity growth are the extent to which new technologies will be utilised in firms and how digitalisation will be able to raise productivity growth across industries. In future, developing and adopting new technologies may demand ever increasing amounts of resources before meaningful productivity gains are found.

Going forward, it will become increasingly difficult to predicate economic growth on the labour input alone. The working-age population is shrinking, and structural unemployment remains high. In the coming years, Finland will have to look much harder into raising labour productivity growth as a means of fuelling the expansion of its economy.

Annex 1

Compiling and aggregating labour productivity growth in different industries

In this article, labour productivity growth for industry *i* ($\Delta Z_{t,i}$) is compiled by taking the difference in the log transformation of its value-added volume ($Y_{t,i}$) over hours worked ($L_{t,i}$) between the years *t* and *t-1*:

$$\Delta Z_{t,i} = \ln Z_{t,i} - \ln Z_{t-1,i} = \ln\left(\frac{Y_{t,i}}{L_{t,i}}\right) - \ln\left(\frac{Y_{t-1,i}}{L_{t-1,i}}\right)$$

Aggregate labour productivity growth for the whole economy, or for all manufacturing, (ΔZ_t) can be obtained by taking the weighted sum of productivity growth for each industry, where each industry is weighted ($s_{t,i}$) by its share of nominal value added (V_i/V) averaged over two consecutive years *t* and *t-1:*

$$\Delta Z_t = \ln Z_t - \ln Z_{t-1} = \sum_i [s_{t,i}(\ln Z_{t,i} - \ln Z_{t-1,i})],$$

$$s_{t,i} = \frac{1}{2}\left(\frac{V_{t,i}}{V_t} + \frac{V_{t-1,i}}{V_{t-1}}\right)$$

Quarterly year-on-year labour productivity growth can be compiled from quarterly data, between quarters *t* and *t-4.* As chained volume indices are used in national accounts volume data with the

annual overlap method, it is still worth weighting the productivity growth of each industry in each quarter with the aforementioned annual weights $s_{t,i}$.

This method of calculating and aggregating productivity growth is based on the so-called Törnqvist index, developed by Leo Törnqvist at the Bank of Finland in the 1930s (Törnqvist 1936). The Törnqvist index has become the most often cited and popularly used method of measuring productivity growth in the associated literature.

This aggregation takes into account changes in the relative importance of different industries in terms of value added but ignores the impact of labour reallocation driven by structural change. Box 2 provides an overview of how the latter effect may be estimated.

Annex 2

Developments in labour productivity growth are explained by industry-specific factors and economy-wide structural change

Labour productivity growth can be decomposed into three main components, namely within-industry productivity growth, changes in the allocation of labour across different industries, and differences in the relative prices between industries. Each individual industry influences the rate of aggregate productivity growth with a weight coefficient defined as that industry's share of total value added in the economy.

Let labour productivity be

$$Z \equiv Y/L$$

, where *Y* is real value added and *L* hours worked. The following formula decomposes annual labour productivity growth into its industry-specific factors:

$$\Delta Z_t = \sum_i s_t^i [\Delta Z_t^i + \Delta l_t^i (1 + \Delta Z_t^i) + \Delta p_t^i (1 + \Delta Z_t^i + \Delta l_t^i + \Delta Z_t^i \Delta l_t^i)]$$

where

$$\Delta Z_t$$

is the percentage change in aggregate labour productivity over the years *t-1* and *t,* and, respectively,

$$\Delta Z_t^i$$

is the rate of productivity growth in industry *i.*

$$\Delta l_t^i$$

is the percentage change in industry i's labour share

$$\frac{L_t^i}{L_t}$$

and

$$\Delta p_t^i$$

is the percentage change in industry i's relative price

$$\frac{P_t^i}{P_t}$$

. P_t is the deflator for total value added, and

$$p_t^i$$

is the deflator for value added in industry *i.*

$$s_t^i$$

is the nominal value-added weight for each industry (see Annex 1).

Based on the above, the following observations can be made:

First, industries with a high rate of internal productivity growth (

$$\Delta Z_t^i$$

) raise labour productivity growth throughout the economy. Indeed, this effect is generally the most significant factor explaining aggregate labour productivity growth within the economy,

Second, when the reallocation of the labour force is towards industries with high labour

productivity growth, aggregate labour productivity growth increases; increasingly so, the faster the recipient industry's productivity growth is compared to aggregate productivity growth. This dynamic represents the impact of structural change, i.e. the effect that the reallocation of the labour force across industries (

$$\Delta l_t^i$$

) has on aggregate labour productivity growth.

Third, even if an industry's labour productivity and share of the labour force are held constant, it can contribute to aggregate labour productivity growth if its price growth (

$$\Delta p_t^i$$

) . is faster than the economy-wide average. In this event, the industry generates relatively more value added in the economy, which is observed as higher productivity growth.

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Notes

1. Industry C in Statistics Finland's TOL 2008 standard classification of industries. ↑
2. See e.g. Statistics Finland (2019). Datasets from the Community Innovation Survey are released by Eurostat. https://ec.europa.eu/eurostat/web/microdata/community-innovation-survey. ↑
3. See e.g. OECD (2019). ↑

Keywords

investment, labour productivity, research and development expenditure, service economy, total factor productivity