Analysis

Long-term growth from a productivity and employment perspective

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In developed economies, the recovery from the financial crisis has been exceptionally arduous and productivity development in particular has been very subdued. Speculation has abounded as to whether economic growth will stay low on a more permanent basis. At the same time, global trends in international trade and technological development are reshaping production and employment structures. Accelerated automation and a decline in labour income share have raised concerns about decreasing employment, contracting wages and increasing inequality in the long term.



What do we know about preconditions for economic growth in the long term? Long-term productivity growth is created by technological development, but anticipating new ideas and assessing their benefits are inevitably largely guesswork. Development of employment can be estimated more precisely with respect to ageing, for example, but the impact of technological development on labour markets is harder to predict.

Improved living standards dependent on productivity growth

Development of productivity and employment can be analysed through so-called growth accounting, which examines the impact on economic growth of production factors used in the economy and the development of production technology. In the short term, the rate of return in the economy may increase in line with raised labour input, accumulated production capital and larger commodity volumes. In the long term, however, economic growth is underpinned by technological development. Production technology refers to the way different production factors can be combined to produce goods and services. Technological development means that new ways of combining production factors are created in the economy in order to achieve gains.

Economic growth can also be achieved by moving resources to more productive activities, without increasing total input. Such growth can arise when, for example, the labour input structure in terms of industry, education or age changes towards supporting growth.

Technological development can be measured by productivity. Increased productivity means that commodities of increased quantity and quality can be produced using the given production factors. Increased productivity also means learning to produce the same quantity of commodities with smaller input.

Either labour productivity or total factor productivity is often used as a measure of productivity development. In sectoral analyses, labour productivity refers to value added per hours worked. As regards the economy as a whole, GDP per hours worked can also be measured. Total factor productivity, in turn, refers to productivity that is not explicable by development of labour or capital input.

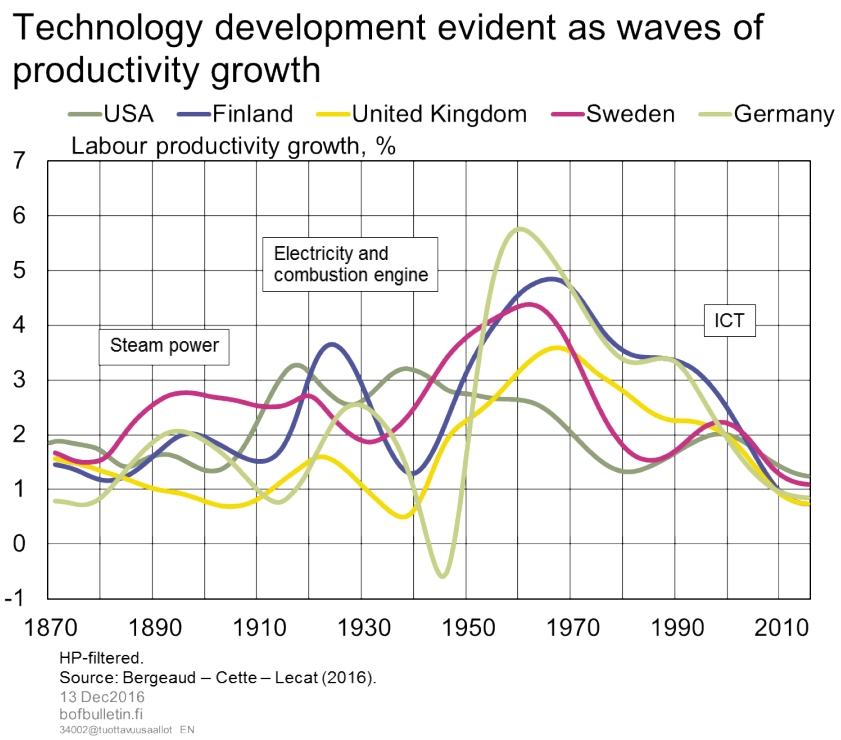
In economics, improvements in the standard of living, in turn, are generally measured by GDP calculated per capita. The standard of living can also be measured by different measures related to, among other things, health, mortality and education. An improved standard of living means that more and better goods and services are available for people to consume.

The significance of technological development is emphasised over time, because growth in the standard of living cannot deviate for long from growth in labour productivity. This is due to the fact that an indefinitely raised labour input per capita is not possible and not even desirable. The standard of living and labour productivity have developed more or less hand in hand, with a few occasional exceptions (Chart 1).

Capital accumulation, moreover, cannot explain long-term growth if production technology does not develop. Increased use of tools in production improves labour productivity, but the benefit achieved from an increased number of the same old machines and devices decreases, when equipment is sufficiently available. For example, an additional computer increases the productivity of an IT employee less than the first one.

In the short term, living standards are affected by changes related to labour supply, capital accumulation and economic structures, and these can have a major impact. For example, women's increased employment rate, increased life expectancy, higher retirement age, industrialisation and service domination as well as longer vacation and shortened working hours have significantly affected living standards.

Chart 1.

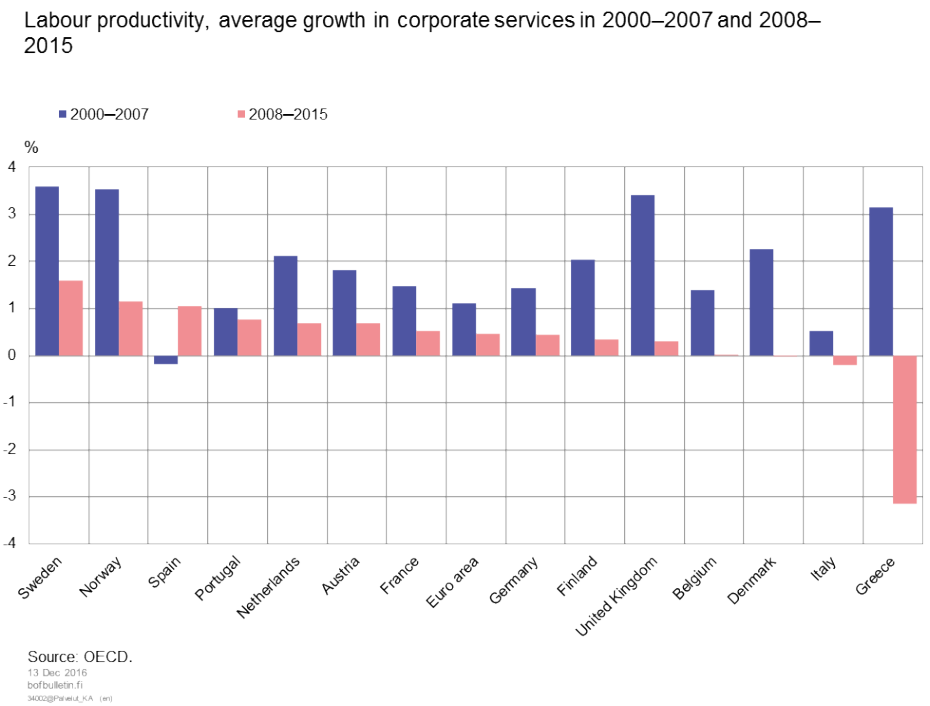


Digitalisation, the fourth technological revolution?

Economists largely agree that if a sufficiently long period is analysed, the most important factor for economic growth, and rising living standards in particular, is technological development, which improves labour productivity. As regards the whole national economy, the most important impact on productivity growth arises from so-called general purpose technologies. The steam engine, electricity and computers are inventions that society has been able to utilise very widely across different sectors of the economy. They have enabled a reorganisation of production and accelerated the growth rate of productivity.

In history, introduction of new general purpose technologies has been evident as waves of productivity growth. Broad-based introduction of technology takes time, and faster productivity growth has often followed inventions after a considerable delay. Productivity growth picks up as useful usages for the technology are found in different sectors of the economy. When the most significant benefits of new technology have been harnessed, productivity growth fades. Once again, something new must be invented.

Chart 2.



Many have predicted that digitalisation will give rise to the next technological revolution, which will bring a new wave of productivity growth (Brynjolfsson – McAfee 2011, 2014, Pohjola 2014). Digitalisation as a term refers to a process of economic and social change resulting from the development of the information and communications technology (ICT). Computers and telecommunication networks are general purpose technologies whose impact is evident in all sectors of the economy.

In recent years, only a few major upheavals have occurred in the development of basic digital technology, but many digital commodity components have gradually become more affordable, their performance has improved and their size has decreased. Combining components into new devices and services has become technically feasible and economically profitable.

Individual basic technologies in themselves are not yet capable of achieving productivity growth at a national level; they must first be linked to other existing production. Technology development can be analysed using, for example, the recombinant growth model (Weitzmann 1998), where innovations are created by combining old ideas in new ways. Innovations in turn enable combinations of new types of ideas. Some of the combinations succeed in improving productivity efficiency, some do not.

New useful ideas accumulate intellectual capital in the economy, enable productivity growth and

recreate space for innovations. In the industrial internet, for example, traditional production equipment is combined with new micro sensors, mobile devices, IT networks and cloud services. Correspondingly, the smart phone is an innovation in which numerous smaller innovations are combined. Each smart phone component is the result of numerous earlier innovations. The smart phone in turn serves as an essential part of many future innovations.

Digital commodities have characteristics that influence the nature and productivity development of the markets surrounding those commodities. Firstly, it is typical of digital commodities that they are easily duplicatable and distributable, so that the best products can rapidly capture a large share of global markets. Secondly, digital commodities are typically part of a larger ecosystem, i.e. an infrastructure of compatible devices, programs and services, which complicates consumers' switch to competing products due to compatibility issues. Thirdly, the attraction of digital commodities is based on so-called network effects, i.e. their usefulness to consumers and producers grows in line with the number of users. For example, consumers benefit more from social media in which all their friends participate, and from digital marketplaces that have a lot of vendors.

The duplicatability, complementarity and network effects of digital commodities easily lead to a final result where the winner takes it all. Success in such markets is evident as strong productivity growth, but success may be fragile. In a small open economy, rapid changes in market position may lead to increased volatility of productivity development.

Assessment of long-term economic prospects is probably most challenging precisely with respect to technological development, as predicting new ideas and assessing their usefulness are inevitably a matter of guesswork. We cannot with certainty say what impact, for example, self-driven cars, drones, 3D printers or the industrial internet will have on the development of productivity in future decades.

Recession only partly explains weak productivity

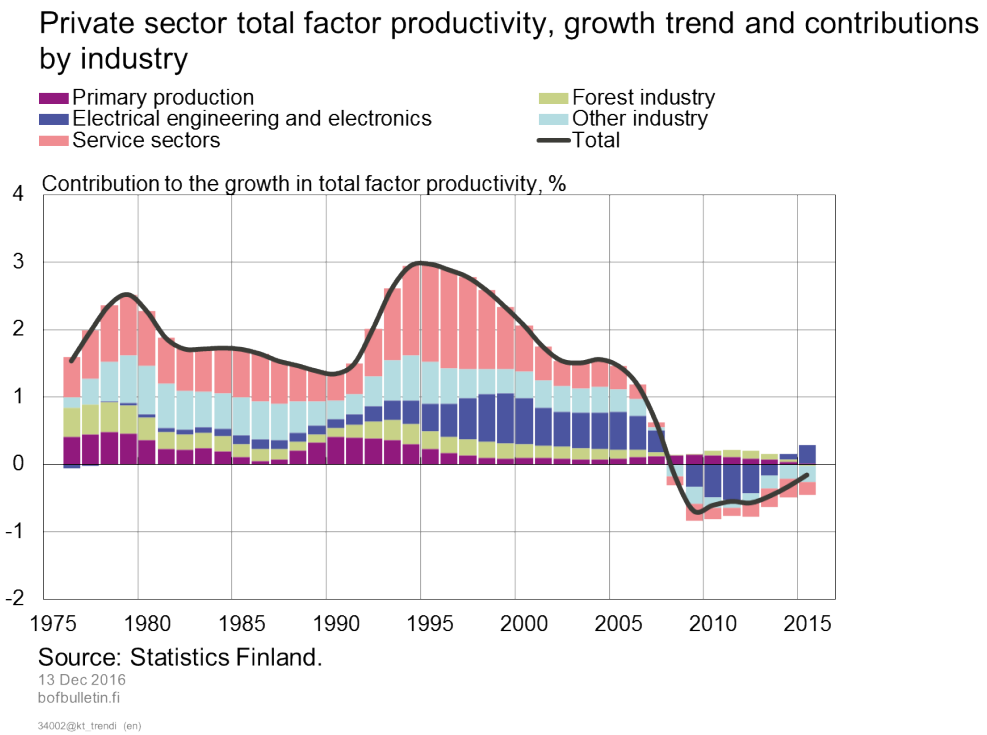
Despite the tremendous development of digital technology, productivity growth in most Western countries has slowed down significantly in recent decades and particularly after the financial crisis. In Finland, the slowdown of productivity growth has been particularly sharp.

The global recession only partly explains the slowdown of productivity growth. Cette et al. (2016) state that the slowdown in productivity already started in the US and Europe prior to the recession following the financial crisis, when the impact of the ICT had faded. In Europe, the productivity growth has, furthermore, been slowed down by structural rigidities in labour and product markets.

Barro (2016) deliberates whether policy choices after or prior to the financial crisis might have contributed to the productivity slowdown. In his view, increasingly ineffective regulation and deteriorating infrastructure as well as increased public debt could be possible explanations. The growth of public sector debt increases uncertainty about future financing of deficits, although accumulation of debt in the present environment of exceptionally low interest rates hardly burdens the short-term management of public debt. This growing uncertainty is likely to lead to lower investment.

In recent years, the possibility of an enduring slowdown in economic growth (secular stagnation) has again been raised in the international economic debate and in economics literature (e.g. Summers 2013, Baldwin – Teulings 2014). One of the models explaining slowing growth is based on total supply and long-term growth factors. The population is ageing and technological development is possibly also slowing down, which is reflected in a fading productivity growth (Gordon 2016).

Chart 3.



Finnish slowdown in productivity growth steeper than in other countries

In Finland, growth in labour productivity has come to a halt after the recession that followed the

global financial crisis, and total factor productivity has even weakened. Except for war-time conditions, the situation is unparalleled in Finnish economic history.

The weaker Finnish productivity growth compared to other countries is predominantly due to poor industrial performance, but productivity growth in the service sectors has also been relatively sluggish. The economic shock in Finland is emphasised by the fact that productivity growth was exceptionally buoyant in the inter-recession period and the slowdown sudden. In 2008–2015, industrial productivity in EU countries has only been weaker in Greece.

Chart 4.

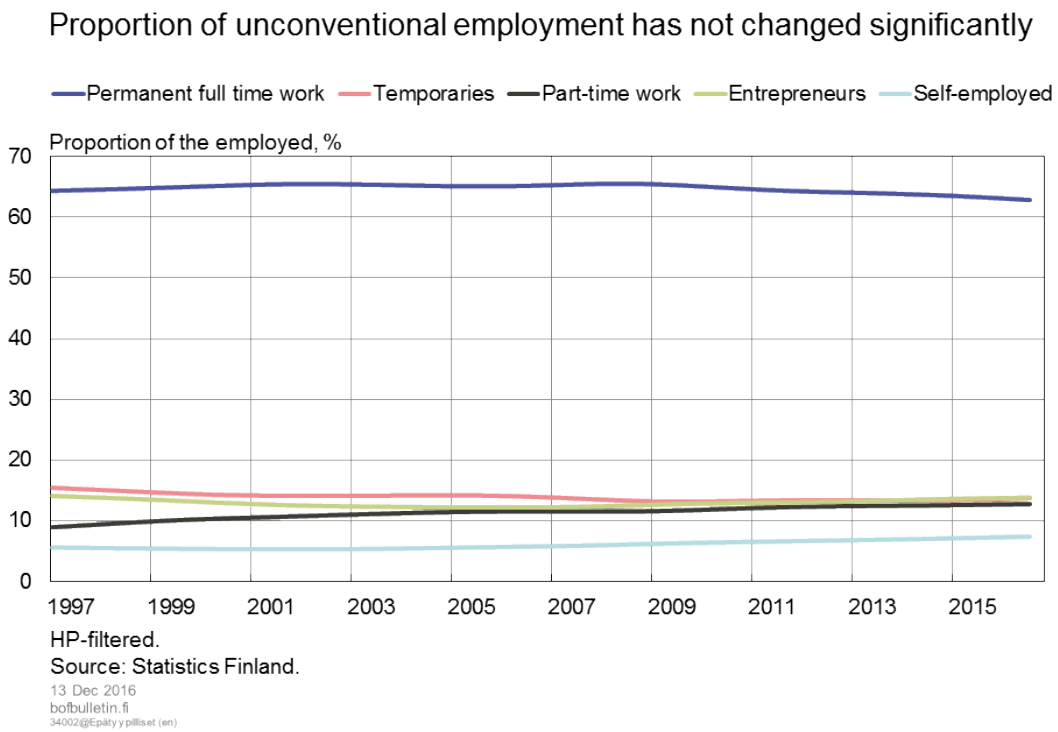
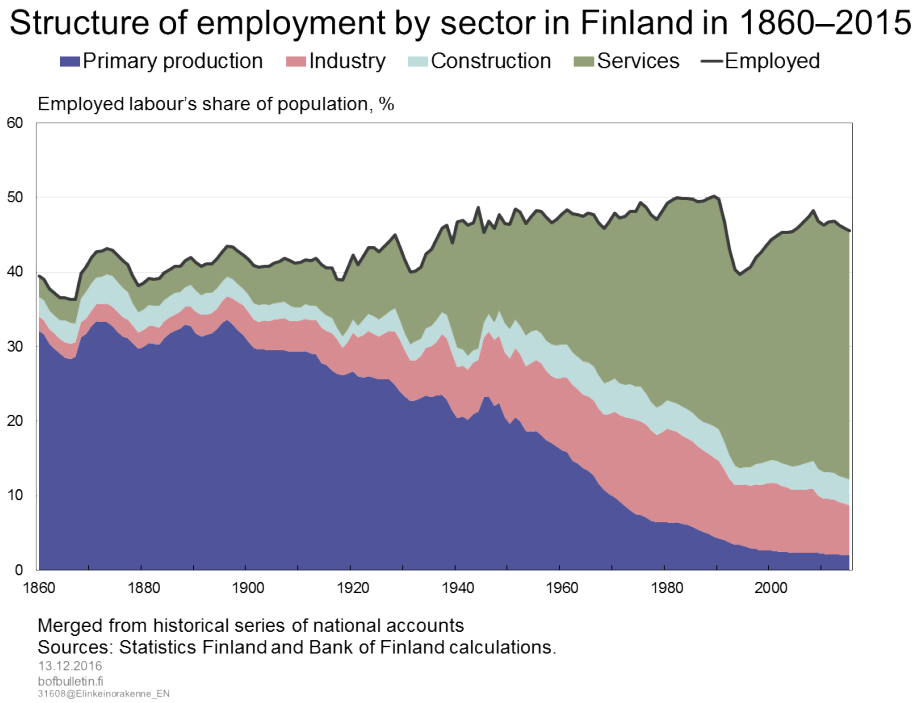


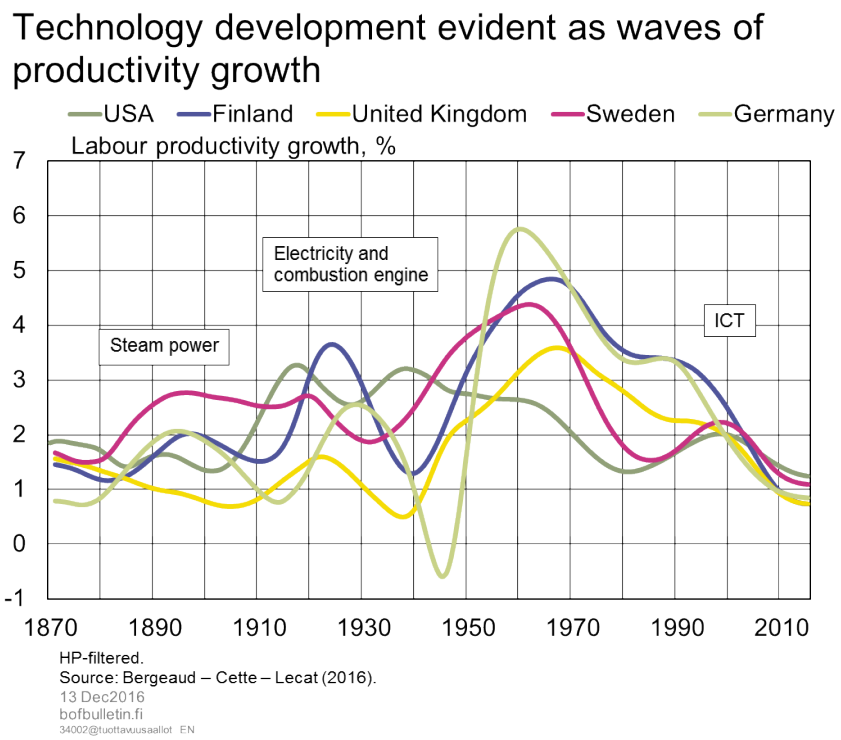
Chart 5.



Prior to the financial crisis, Finnish service-sector labour productivity growth was slightly higher than average in the euro countries, although slower than in the other Nordic countries. In the post financial crisis period, labour productivity development has also been slower than in the euro countries.

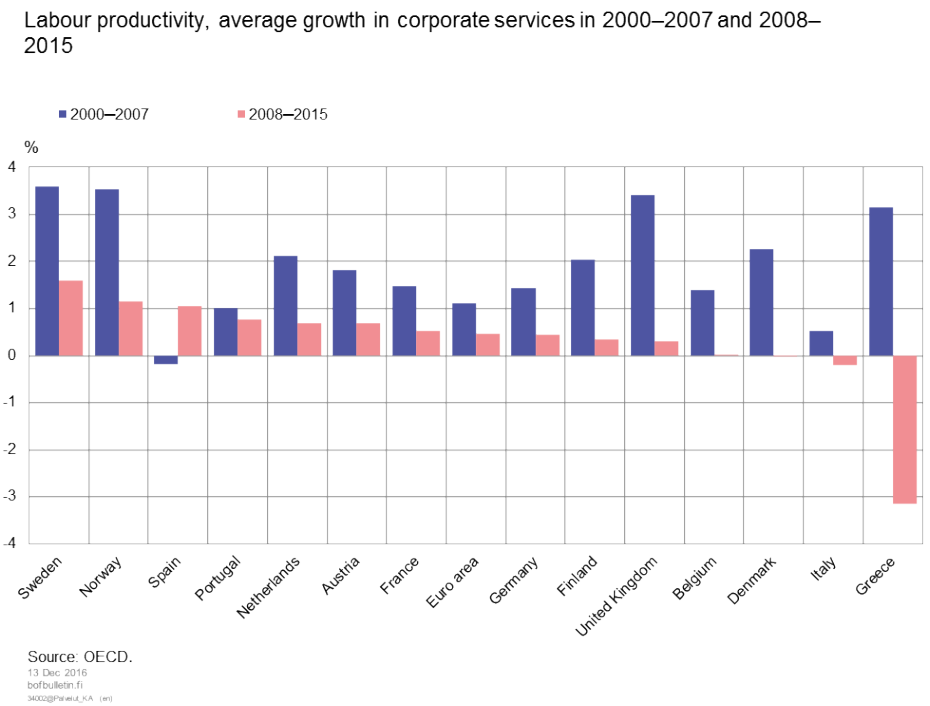
In the three decades prior to the international financial crisis, the total factor productivity of the Finnish private sector improved at an annual rate of about 2% (Chart 6). Productivity growth was high in primary production and industry as well as in the service sectors. In the period between the recession of the 1990s and the financial crisis, the growth of total factor productivity was particularly affected by the sharp upswing in the electrical engineering and electronics industry. Although the impact of other industrial sectors on the growth rate of the economy as a whole decreased, the impact of service sector productivity strengthened. After the financial crisis, average private sector productivity growth has been negative both in industry and in service sectors. Due to its small size, the rapid productivity growth in agriculture and forestry has only been able to provide slight support to the economy as a whole.

Chart 6.



The weak development in productivity is partly explained by a change in labour structure between the main industry categories. In the 2000s, the number of hours worked has primarily increased in industries where productivity growth is slow, while, at the same time, the number of hours worked has contracted in sectors with fast productivity growth (Chart 7). Among the exceptions are information and communications as well as energy, water and waste management, where both labour input and labour productivity have increased.

Chart 7.



The productivity paradox – weak productivity and massive ICT investments

The conflict between weak productivity development and massive ICT investments is referred to as the productivity paradox. Robert Solow noticed the problem already in 1987 and polemically wrote that you can see the computer era everywhere but in the productivity statistics.

Brynjolfsson (1993) made the productivity paradox concept better known and argued that IT in reality improves productivity. At the turn of the 2000s, productivity development slightly accelerated, and the productivity paradox was generally considered to be solved. After the financial crisis, productivity growth has again faded and in many countries it has even slowed to an extent that is hard to explain as being due to the economic cycle. The productivity paradox concept has again resurfaced as one theme of the digitalisation debate.

The weak development of productivity may partly be explained by measurement errors relating to, for example, the assessment of service-sector productivity and distinguishing ICT investment effects from other factors affecting productivity (Bean 2016). Often, digitalisation affects the quality of products, but measuring the development of quality in national accounts is methodologically very challenging.

Free commodities are not recorded in GDP, and thus many new digital services, such as social media, search and map services as well as cloud services partly remain unnoticed in statistics. GDP does not, moreover, show the widening range of digital services nor the increase in spare time. If new commodities brought about by digitalisation mostly go unnoticed in national accounts, traditional growth indicators may underestimate the improvement in wellbeing.

Recent research has shown that the slowdown in labour productivity or total factor productivity growth cannot be explained by growing ICT measurement errors alone. There were already considerable measurement errors prior to the recent slowdown in productivity growth, and after the contraction of the ICT industry's share of production the significance of the errors has decreased (Byrne et al. 2016). Productivity growth has also slowed down in a similar way in countries where consumption and production of ICT commodities are lower. The output gap due to the productivity slowdown is so large that it cannot exclusively be accounted for by ICT factors (Syverson 2016).

The productivity paradox can also be due to the fact that restructuring caused by digitalisation may have negative growth effects in the short term. Newcomers may weaken the position of competing companies, which slows down growth on a national level. Correspondingly, technological unemployment and reassignment of staff may temporarily weaken the development of productivity in the economy. If the benefits of the new technology are realised after a delay and the negative impacts of restructuring are strong to begin with, digitalisation will not be reflected immediately in productivity statistics. It should be noticed that use of mobile equipment and services, in particular, has not increased until the last few years. As competition and technology have developed, prices for communication services have plummeted and consumer habits and requirements have changed.

Weak productivity development has also been attributed to various factors that hold back change, such as poor ICT management, limited digital expertise and regulation. The general view is that the benefits of digitalisation derive from the fact that digitalisation enables a total restructuring of production processes instead of carrying out the old processes with new equipment (so-called digitising or pseudo digitalisation). Many also emphasise the significance of management and a willingness to change in the realisation of productivity benefits. Many businesses have complained, in particular, about a lack of top ICT experts. The slow pace of change may, in turn, also partly be explained by regulation that hinders the entry of new operators into the market and the adoption of new technology. On the other hand, functioning regulation may also protect consumers from the side effects of the new technology, such as possible health problems. Regulation may also increase competition through standardisation, for example, and thus promote productivity growth.

The question as to whether digitalisation can accelerate productivity growth has divided economists into optimists and pessimists. The so-called techno-optimists believe that the best is still ahead and a new wave of productivity growth can be expected (Brynjolfsson – McAfee 2014, Mokyr 2014, Pohjola 2014). Techno-optimists have predicted that, compared to earlier corresponding technological advances, the latest wave will affect several sectors and that change will be faster. On the other hand, techno-optimists often take a pessimistic view of the economy's and society's capacity to adapt to change.

Economists representing the techno-pessimists have, in turn, estimated that productivity growth is genuinely slow and that digitalisation's accelerating effect on economic growth is already fading. Gordon (2016) has argued that ICT development has not been able to improve the wellbeing of people in the same way as the large technological revolutions of past centuries. Technological development has been striking, but its benefits have been limited to a narrow sub-area, primarily to entertainment, communication and data processing. It is possible that a large part of the easy and obvious applications of digitalisation have already been utilised, that is the low hanging fruit has already been picked (Cowen 2011).

Productivity growth underpinned by innovations and international trade

Due to insufficient incentives, the private sector tends to invest less in research and development than would be favourable for society. On the other hand, the traditional view is that the public sector is not so good at selecting products or sectors prone to growth. Takalo (2014) has listed recommendations for innovation policy based on economic research. Growth can be supported by, for example, public sector investment in education, basic university research, and funding for the private sector's early-stage research and development activity.

The traditional view in economics is that protection of intangible rights (e.g. patents) encourages innovation, but this view has been questioned in recent empirical research. In practice, the impact of strong patent rights on productivity growth may also be negative due to various efficiency losses (Boldrin – Levine 2013).

A policy aimed at productivity growth typically emphasises the significance of creating innovations, but productivity growth does not necessarily require new inventions. Often, solutions that would facilitate an improvement in productivity already exist and are deployed elsewhere. Holmström et al. (2014) have highlighted the imitation of ideas that have already proved to be successful as a means of raising productivity. Schumpeterian growth models, in particular, have emphasised imitation as a method of approaching the technological forefront. In the same way as

today's emerging economies, Finland became prosperous in the first half of the 1900s by copying ideas and solutions from other, more advanced countries. Even in the 2000s, Finland has to bridge the gap to the technological forefront (Berghäll 2016).

A small country cannot possibly develop all the technology it needs itself. The Finnish share of R&D expenditure in the OECD countries is only 0.6%. Most of the available technology is developed outside Finland, so the productivity of domestic production is essentially dependent on how well the country succeeds in utilising foreign technology.

Investment policy may also have a bearing on productivity development. The recent weak development of investments and capital stock has been elaborated on in reports[1] published earlier by the Bank of Finland. Digitalisation can bring greater efficiency to the utilisation of traditional capital and thus decrease the need for new investments. The industrial internet can enhance the performance of production processes and also improve the functioning of traditional machinery. Improved performance means that production is carried out with a smaller quantity of capital and investments than before. Correspondingly, platform and sharing economy applications may decrease investment purchases, when, for example, apartments and cars are put to more efficient use.

Competition encourages businesses to improve productivity and create new products for the market, but a strong competitive position brought about by innovations is temporary. Aghion et al. (2005) have pointed out that too much market competition may weaken incentives to innovate. If the competitive edge brought about by new and better products quickly vanishes due to competition, businesses do not have time to cover their product development costs through momentary peaks in revenue. Competition policy has traditionally been aimed at preventing the market from focusing on a limited number of participants, but a new challenge is that in digital markets there is a strong tendency to focus on only a few participants. Consumer benefits from services may genuinely grow as market shares increase.

In a digitalising world, an increasing share of the production has to compete in international markets. For a small country, this means that changes in market position may be rapid and success may be profitable but fragile, as seen in cases such as Nokia and the video game industry. Rapid changes shake the structures of a small economy, and pose challenges for the economy's capacity to adjust. On the other hand, international digital marketplaces may provide new opportunities for more remote areas and smaller businesses, when the threshold to move into international markets gets lower and lower.

There is a high consensus among economists about free trade's positive impact on overall wellbeing. When all actors concentrate on their own areas of expertise, productivity and GDP

increase and all of the participants benefit. However, the consensus is almost as large on the fact that the benefits of free trade are unequally distributed. The benefit to some participants may even decrease as a result of free trade.

Limitations set for free trade may therefore dampen productivity growth, as they can be compared to restrictions on technological development. According to economics, free trade affects innovations through two channels. Improved market access increases corporate profits and may thus lead to increased innovation. On the other hand, tightening competition threatens the profits of established businesses when new participants join the market, which may encourage established businesses to innovate in order to fare well in this competitive environment (Aghion 1997, 2005).

Reduced profit margins due to increased business competition may also, however, lead to opposite effects. Furthermore, they may cause a reduction in income from innovations, so innovations may decline as a result. Whether extended free trade will have a positive or negative effect on innovations, technological development and productivity, is ultimately an empirical question.

According to Coelli et al. (2016), trade liberalisation has a large positive net effect on innovations. They argue that both market access and harder competition have a positive effect on increasing innovations, which suggests that trade policy has a very large impact on long-term corporate development, productivity and economic growth.

Unemployment caused by technological development

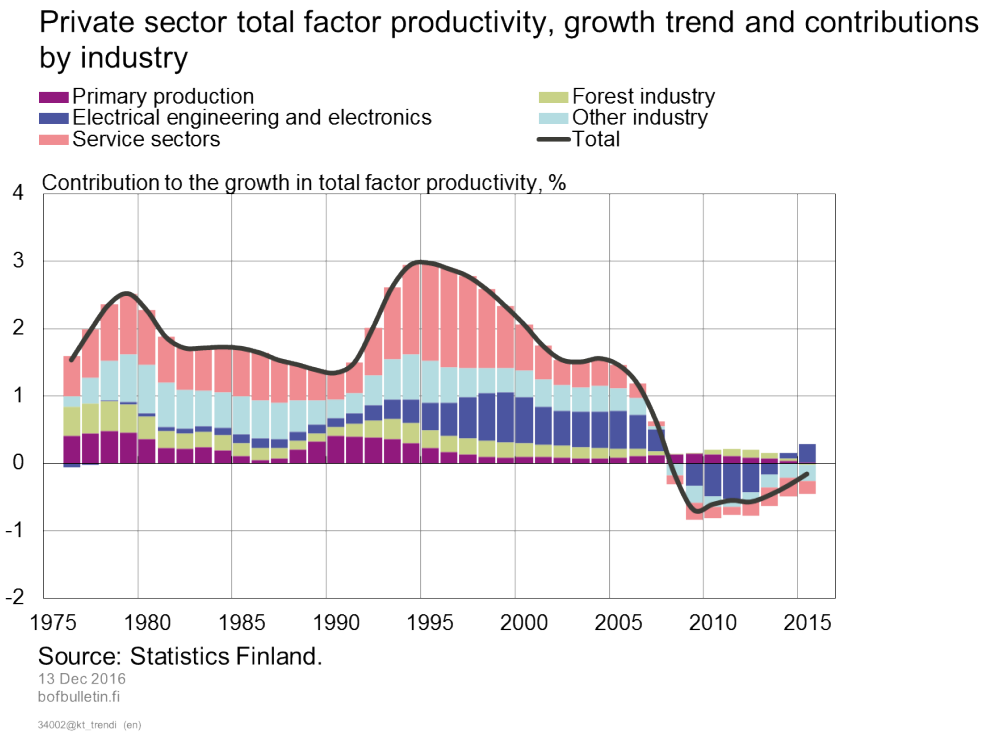
Ever since the outset of the industrial revolution, technological evolution has been associated with the concern that new machines and equipment would lead to a permanent deterioration of employment and increase in unemployment. Keynes called this phenomenon technological unemployment and he established the concept already in the 1930s.

In recent decades, technological development and globalisation have continued to reshape forcefully the labour markets of developed economies. Labour markets have become polarised, both in Finland and generally in developed economies. Jobs of an average wage and routine nature, which are easy to outsource, have decreased, while the proportion of high and low wage work has increased (see also the Bank of Finland article Polarisaatio Suomen työmarkkinoilla (Polarisation in the Finnish labour market)). The acceleration of structural change in the labour market has intensified fears of technological unemployment.

Technological unemployment has already been a theoretical threat for a long time, but it has not materialised at the level of the whole economy, even though there has been an extended period of

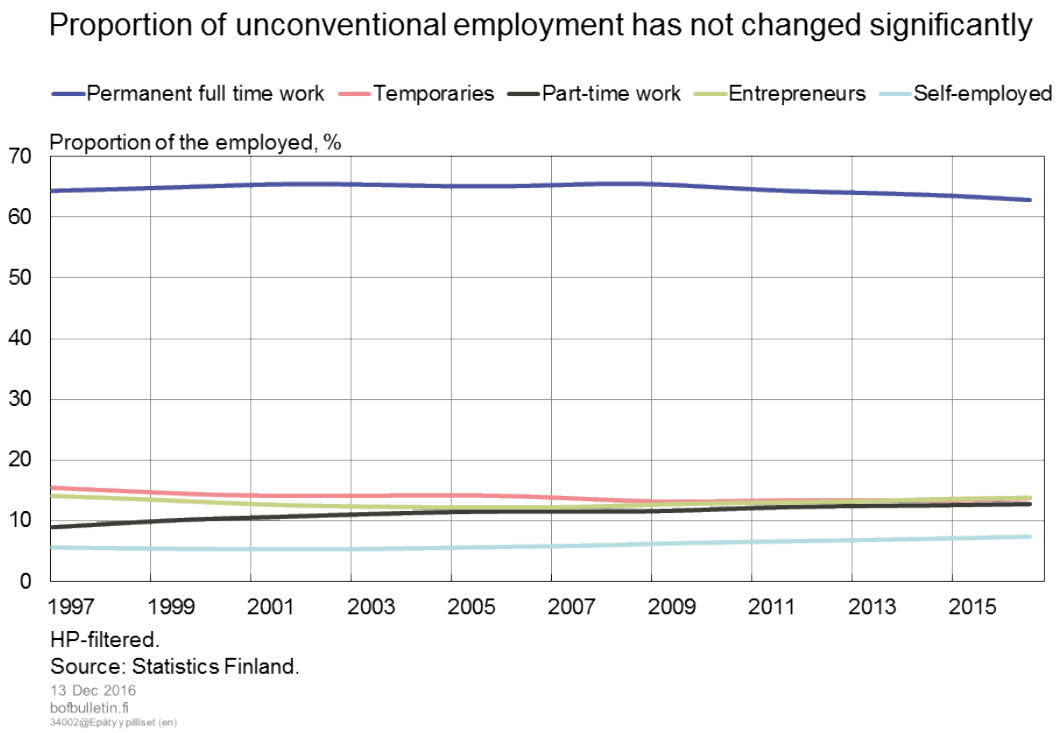
rapid technological development. The quantity of work has not decreased in the long term, although the nature of the tasks performed has certainly changed. In Finland, too, the rate of job creation has in the long term been higher, on average, than the destruction rate, although that is not the case at present owing to the protracted recession. It has also been postulated that structural change leads to increased uncertainty in labour markets and to an increase in unconventional employment. According to Pyöriä – Ojala (2016), there is, however, little empirical evidence of work precarisation. Part-time or temporary work, at least, has not increased dramatically since the mid-1990s (Chart 8).

Chart 8.



Although the production structures of the economy have undergone immense change over the past decades, the employed as a proportion of the entire population have remained relatively stable. In Finland, the deep recession of the early 1990s caused an exceptionally deep reduction in employment (Chart 9), and since then the proportion of the employed has not fully recovered to the level preceding that recession. This reflects both the recent recession emanating from the financial crisis and also the steep decline of the working-age population since 2011. Due to these special factors, looking at the development of employment in recent years, it is difficult to distinguish, on the one hand, the impact of international trends and supply factors and, on the other hand, the impact of country-specific cyclical factors.

Chart 9.



Why has the threat of technological unemployment not materialised?

Autor (2015) identifies three mechanisms that explain why the threat of technological unemployment has not materialised. First, new technologies replacing manual labour often require new types of workers. If work and capital complement each other, technological development creates new, more productive jobs for those capable of operating new machines. For example, in expert work, computers facilitate work and improve the employee's productivity. On the other hand, the demand for labour may be reduced where technology is a substitute for work. For example, the digitalisation reform of the tax administration rendered the work of tax return inspectors largely unnecessary by automating the tasks. Historically, technological innovations have largely been complementary to labour, which has shown as an increase in the capital intensity of production, i.e. the increased use of capital per employee (Jalava et al. 2006).

Secondly, elasticity of wages may mitigate the increase in unemployment as the demand for labour ousted by new technology decreases. If labour market institutions allow for wage elasticity, it may help preserve the jobs concerned by slowing down the growth of labour costs.

Thirdly, the impact of new technology on employment is largely dependent on the price elasticity

in the demand for the goods concerned. For example, the demand for smart phones is largely dependent on their price. Therefore, the decrease in prices during Nokia's peak years caused by an improvement in productivity increased the demand for phones to such an extent that more personnel than previously were employed in their production. On the other hand, if the demand for a good does not increase when the price falls, improvements in productivity mean that a good can be produced with a lower number of employees. This has been the case in, for example, agriculture, since the demand for food has not increased as rapidly as agricultural productivity. Also in this case, however, the improvement in productivity has enabled an increase in consumption and employment in other parts of the economy.

In addition, Acemoglu – Restrepo (2016) point out that automation has an impact on the incentives of businesses to develop technologies and more complex working tasks than before. Where automation replaces workers and lowers labour costs, further increases in automation become less attractive from a business perspective. At the same time, incentives to develop new and more complex working tasks for employees are strengthened. In the Acemoglu – Restrepo model, these mechanisms restore the proportion of labour to the previous equilibrium, although inequality increases due to the shift.

Technological development and decrease of labour income share

In addition to the threat of technological unemployment, there have been concerns that the new technology would lead, at the level of the whole economy, to an increase in income differentials and in the capital income share, with labour being replaced by robots and computers. In the digital economy, differences in productivity may be exceptionally large, and the number of employees has decreased rapidly in many sectors. If technological development is very fast and weighted towards innovations replacing labour by machines, it is plausible that the change would lead to a decrease in the labour income share.

In the OECD countries as a whole, it has been found that the labour income share has contracted in recent decades while income differentials have widened[2] (OECD 2016), although there are large differences across countries. Finland belongs to the minority among the OECD countries where the labour income share has increased. In practice, the entire contraction of labour income share in other OECD countries occurred already before 2005, and therefore the phenomenon would seem to be structural. In the recession following the financial crisis, the labour income share partly recovered as corporate profits steeply declined.

According to the OECD, some of the decrease in the labour income share is explained by an

increase in housing or other asset prices. Another underlying factor is the entry of medium and low wage countries, China in particular, into the international markets. The increased income differentials are mainly explained by the very rapid expansion of the income of the highest-earning 1% of the population.

The contraction of the labour income share is a global phenomenon that has continued since the 1980s. Neiman (2014) noticed this contraction in the majority of the 59 countries he reviewed, and in most sectors. Neiman demonstrated that the decrease in the relative prices of investment goods, which is often associated with the advancement of information technology and computerisation, has incentivised companies to shift to more capital-intensive production. According to Neiman, this explains approximately half of the decrease in the labour income share, even taking into account the increase in profit shares, capital-saving technological development and the changing skill structure of the labour force.

Professions jeopardised by technological development

Recent studies in Finland and globally have aimed to estimate which professions are most likely to disappear as a result of technological development and how high a proportion of jobs is threatened. Frey – Osborne (2013) estimate that in the United States, 47% of present jobs are at risk of extinction. Using the same methodology, Pajarinen – Rouvinen (2014) in turn estimate that in Finland, 36% of jobs are at great risk of being replaced. The proportion is high, but it should be noted that the risk may not necessarily materialise with respect to all of the jobs. Neither do the above-mentioned studies take into account new, replacement jobs emerging in other sections.

Autor et al. (2013) have categorised jobs with the aid of two dimensions, on the one hand into routine and non-routine tasks and on the other hand into manual and cognitive tasks. The polarisation of the labour markets observed in recent decades is characterised as a non-routine-biased technological change. In contrast with the skill-biased technological change that preceded the polarisation, the polarisation has led to a reduction in jobs with medium wages.

The ICT development enables the transfer of many tasks that traditionally required human work to computers and robots. In particular, computers are capable of fast and cost-effective performing of tasks requiring simple calculations, data processing and the application of mechanical decision rules. The jobs in peril are therefore those based on routine execution, regardless of whether the work is cognitive or physical.

Technological change also enables automation increasingly in non-routine tasks. Artificial intelligence, big data, development of algorithms, machine vision and other new technologies are leading to the possibility that many non-routine tasks will also be performed by computers and

robots in the future. Tasks that can be shifted to machines have increased while the relative advantage of human labour has narrowed.

In terms of long-term employment prospects, it is crucial how successfully new meaningful work can be found for the employees made redundant by technological development. From the perspective of productivity, the kind of new work that emerges to replace the obsolete tasks is also important.

What kind of work is needed in the future?

New jobs have appeared in sectors that have emerged as a result of technological development. In recent decades, technological development has increased the demand of labour in tasks requiring a high level of education as well as complex communications and problem-solving, in addition to low wage manual tasks that cannot be transferred to machines. It is by no means certain, however, that development will continue exactly like this into the future.

In tasks where automation cannot entirely replace the labour input of the employee, development typically increases the productivity of the employees. There has been discussion about a new division of labour between computers and humans (Levy – Murnane 2004). The irreplaceability of human labour can be explained by two paradoxes illustrating the challenges relating to the development of computers and robots.

The so-called Moravec's paradox refers to the observation that while many tasks requiring high intelligence are easy for computers, simple tasks relating to observation and motorics are difficult for them. For example, computers are good at playing chess but lousy at football. There are many tasks that have proven impossible to transfer to a computer, but more and more tasks are being performed by machines as development moves ahead.

Meanwhile, Polanyi's paradox postulates that we know more than we can tell (Autor 2015). People are capable of performing multi-phase tasks and complex deductions without being able to describe in detail how they do it. At the same time, the programming of computers and robots requires that data processing and functions are described in detail and written as a programme which is executed precisely and without exceptions by a machine.

Both Moravec's and Polanyi's paradoxes help understand what types of labour are also likely to be in demand in the future, but as technology evolves, the limits set by the paradoxes will be tested. With the help of developments in artificial intelligence and of different kinds of learning algorithms, more and more functions can be performed where the programmer does not explicitly describe the operating mode to the machine.

In the wake of technological development, the cooperation and complementarity of employees and computers are also highlighted. Digitalisation can be seen as part of the increasing capital-intensity of production, where the amount of ICT capital at the disposal of the employees increases and the productivity of labour improves.

It has been observed in many working tasks that a combination of computers and teams results in the best productivity. As the extent of information and complexity relating to the task increases, expertise will often have to be split into mutually independent parts, or modules, and the parts allocated to a larger team than before. For example, as regards scientific publications and patents, a trend has been found that individual studies are focused on ever narrower topics while the average number of researchers per study has increased (Wuchty et al. 2007). Besides potentially leading to increased complexity of work, digitalisation also offers new tools to support team work (Jones 2009).

In terms of the development of productivity, it is important how many cognitive jobs with high productivity are created in Finland as opposed to manual jobs with low productivity. In this respect, the education structure of the population and the supply of labour for jobs requiring a high level of expertise are key factors.

Limitations of labour supply

Labour input is one of the cornerstones of economic growth in addition to capital formation and productivity, and therefore labour supply and factors affecting it are material for long-term growth. The number of the working population relative to those not working is the most important indicator of the potential to fund the welfare state.

In most developed economies, the ageing of the population has begun to limit the supply of labour, and this trend will continue for quite some time. In Finland, the contraction of the working-age population has been particularly fast and it began earlier than in most other countries (see also Demographic change reduces labour force and number of employed).

Another factor with a major impact on the development of labour supply is whether recessions leave a permanent mark on the labour participation rate. According to Jaimovich – Siu (2015), employment in the United States has been found to continue to develop weakly following the recessions of 1991, 2001 and 2009 for a protracted period, even after the economic recovery had started. According to them, jobs in the middle ground of the distribution of wages, in particular, have disappeared in connection with the recessions. This jobless recovery phenomenon is specifically related to a reduction in jobs based on routine tasks. The recovery from the post-financial crisis recession in developed economies has been largely different, however, from the

recovery after previous recessions. It has been characterised by clearly lower growth of productivity as well as surprisingly solid employment growth. Barro (2016) describes this period as job-filled non-recovery.

In Finland, part of the working-age population ended up outside the labour force permanently as a consequence of the recession of the 1990s. With a view to longer-term development, the present employment situation exhibits some features meriting concern. The participation of young people in the labour market has been clearly weaker than average, and the growth of long-term unemployment in recent years has been concentrated increasingly on young age cohorts. Labour market development has been weakest for those aged 25–34 but the participation rate of 35–39 year-olds has also decreased since 2008. The proportion of youth not in employment, education or training has also shown an alarming increase.

Thirdly, particularly in the United States, there has been debate about the decrease in the participation rates and the underlying reasons (Eberstadt 2016). Particularly, there has been a trendlike decline in the labour participation rate of low education males at their best working age (25–54 years) (Council of Economic Advisers, CEA, 2016). The participation rate of such employees has declined since the mid-1960s, especially in the context of recessions, and it has not recovered in the subsequent economic upswings.

The participation rate of each new age cohort is lower compared to the previous cohort, which rather points to a lower labour participation rate for all age groups than any shocks met at a certain age or the characteristics of any given cohort. The Council of Economic Advisers (CEA) has argued that changes in social security do not explain the weak labour market performance of males with low education. Similarly, the decline in labour participation probably does not reflect any increased valuation of leisure time, since a considerable proportion of the group outside the labour force are living below the poverty threshold. In contrast, according to the CEA, changes in the demand for labour are an important explanation of the weak labour market performance of males with low education. The changes may reflect technological development, automation and globalisation, since technological development and international competition decrease the demand for low education labour.

A similar trend cannot be observed in Finland, as the proportion of non-employed males at their best working age has declined since the deep recession of the 1990s and remained relatively stable in the 21st century hovering around 15%. At present, the proportion of unemployed males in Finland is roughly at the same level as in the United States. The trend has been very similar for Finnish women, although the proportion of non-employed women has been about 5 percentage points higher than non-employed males throughout the period.

Policy options supporting long-term growth

There is solid consensus among economists that when a sufficiently long period is being reviewed, the most important factor for economic growth and the improvement of the standard of living in particular, is technological development, which improves the productivity of labour.

Despite the stunning development of digital technology, productivity growth has slowed down considerably in recent decades and particularly in the period following the financial crisis. In Finland, this slowdown has been particularly abrupt. The international recession only partly explains the slower productivity growth.

In international economic debate and economics literature, it has been suggested that economic growth may have slowed down permanently because long-term growth factors have weakened. The population is ageing and technological development may also be slowing down, which is reflected as a deceleration of productivity growth. The combination of weak productivity performance and major ICT investments is paradoxical. The era of computers is seen everywhere else except in the statistics on productivity. This could be explained by measurement issues, short-term negative growth impacts of digitalisation or factors slowing down the spread of technological development. According to the pessimistic view, technological advancements in recent decades have been limited to areas that do not contribute to long-term growth, such as entertainment.

The views of economists on the potential of digitalisation to speed up the growth of productivity in the future are sharply divided, however. Technology optimists believe that the best is yet to come, and a new wave of productivity growth can be expected. The assessment of long-term economic prospects may be most challenging precisely with respect to technological development, since the prediction of new ideas and their usefulness is inevitably based on guesswork.

Ever since the outset of the industrial revolution, technological development has been associated with concerns that new machines and equipment lead to a permanent decrease in employment and an increase in unemployment. In the long term, however, the total population share of the employed has not declined significantly, although the tasks performed have certainly changed. In addition, a concern has been voiced that new technology leads to an increase at the level of the entire economy in income differentials and in the capital income share, as labour is being replaced by robots in the digital economy and differences in productivity are exceptionally large. In the OECD countries as a whole, the labour income share has indeed been observed to have contracted and the income of the richest 1% of the population to have grown more than that of the others.

In terms of long-term employment prospects, it is crucial how successfully new meaningful work can be found for employees made redundant by technological development. At the same time, in

terms of the development of productivity, it is important how many cognitive jobs with high productivity are created in Finland as opposed to manual jobs with low productivity. In this respect, the key factor is the education structure of the population and the supply of labour for jobs requiring a high level of expertise.

Characteristics limiting the potential of labour input to contribute to long-term growth are associated with development in the next few decades. The ageing of the population in developed countries is one such limitation. There has also been discussion about whether the recent recession may leave a permanent mark on the labour participation rate. In addition, it has been postulated that the trendlike decline in the participation rate observed in the United States reflects more generally technological development, automation and globalisation. It is not feasible to create endless economic growth by increasing the labour input, but this limit has not been reached yet in Finland. Therefore, increasing the participation rate through reforms that improve supply should continue to be one the key objectives of labour policy.

The government can support productivity growth through successful innovation, investment, competition, education and structural policy. As a rule, the public sector can sway the development of productivity only indirectly and over the longer term. The active innovation policy of the public sector is justified by the positive externalities of innovation activities and by the imperfections of the financial markets. The public sector is bad at selecting products or sectors prone to growth, but it should create an environment that is favourable for innovation activity. In addition, innovation policy may have an impact on productivity development, since the adoption of new technologies often becomes tangible through investment.

The streamlining of regulation and promotion of competition incentivises companies to innovate, but the competitive edge gained by innovation is only a temporary one. Competition policy has traditionally been used so as to prevent markets from being controlled by few participants. However, in the digital economy, natural monopolies emerge easily, and they should be allowed to exist from the viewpoint of economic efficiency.

Technological advancement and globalisation lead to faster evolution of economic structures than before. Rapid changes shake the structures of a small economy, posing challenges to the economy's capacity to adjust. As technological development shifts demand for labour from one sector to another, supply of labour should be able to shift with it. Lifelong learning and retraining of those losing their jobs may facilitate the shift of labour into tasks for which there is demand in the new technological environment. Change in the structures of professions and tasks is an inevitable result of technological development and rising living standards, but the human costs of change may be mitigated by improving the adaptability of labour markets and ensuring the existence of adequate social safety nets.

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Notes

1. See http://www.suomenpankki.fi/fi/suomen_pankki/ajankohtaista/muut_uutiset/Documents/mista-investointien-vaimeus-johtuu.pdf. http://www.eurojatalous.fi/fi/2016/artikkelit/kuihtuva-paaoma/. ↑
2. Increase in income differentials is here measured as the difference between average and median earnings. ↑

Keywords

economic growth, employment, productivity