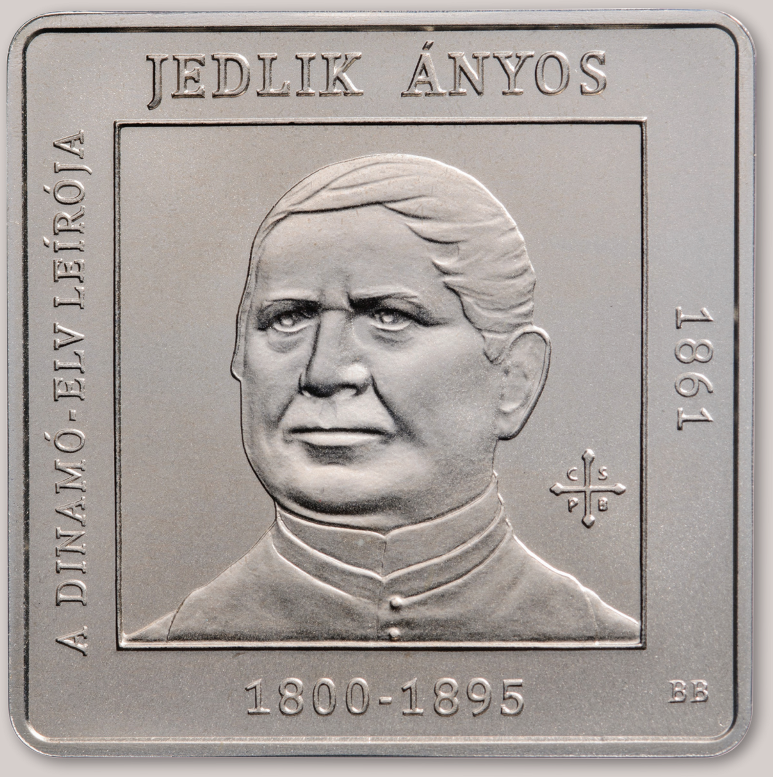
PRODUCTIVITY REPORT



2020
NOVEMBER

“Where would we be
if God deprived us of the ability to work?”

Ányos Jedlik, 1895

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Pursuant to Act CXXXIX of 2013 on the Magyar Nemzeti Bank, the primary objective of Hungary's central bank is to achieve and maintain price stability. Low inflation ensures higher long-term economic growth and a more predictable economic environment, and moderates the cyclical fluctuations that impact both households and companies. Without prejudice to its primary objective, the MNB supports the maintenance of the stability of the financial intermediary system, the enhancement of its resilience and its sustainable contribution to economic growth, as well as the economic policy of the government using the instruments at its disposal.

The Productivity Report provides support for the central bank in fulfilling its statutory duties, by facilitating an understanding of the drivers, breakdown and dynamics of economic growth and the key factors of convergence, which helps us to formulate and implement reforms aimed at improving productivity. The Productivity Reports does this in a complex manner, examining a wide range of efficiency indicators, including labour productivity as well as innovation, digitalisation and ecological productivity.

The analysis was prepared by the Directorate Economic Forecast and Analysis, under the general guidance of Gergely Baksay, Executive Director for Economic Analysis and Competitiveness.

In the preparation of the Productivity Report we relied on the latest data related to 2019 or earlier periods, available up to 26 October 2020; accordingly, the impact of the coronavirus pandemic that started in 2020 is not included.

Introduction

The Productivity Report is a new publication in the series of reports published by the Magyar Nemzeti Bank. The central bank's workshops prepare numerous analyses, but the Productivity Report is a long-awaited one, since up until now we have not been in a position to deal with the most important source of long-term economic growth and convergence in such volume and depth. The 2018 Growth Report was the last publication that discussed the importance of productivity in detail, coming to the conclusion that it is a key factor behind long-term economic convergence and is thus crucially important for all countries, similar to Hungary, that wish to escape the middle-income trap and join the club of the economic elite, i.e. the advanced economies.

The Productivity Report helps the central bank fulfil its statutory duties. The primary objective of Hungary's central bank is to achieve and maintain price stability. However, without prejudice to its primary objective, its mandates also include supporting the economic policy of the government. The Productivity Report facilitates this by promoting an understanding of the drivers, breakdown and dynamics of economic growth and the key factor of convergence, which helps us formulate and implement reforms to boost productivity.

Due to the COVID-19 pandemic, it is particularly important to analyse the productivity trends as thoroughly as possible. In the acute phase of the crisis, the most important duties include supporting employment and demand, as well as helping families, companies and economic sectors which are facing difficulties. However, the crisis is also accelerating the process of economic transformation, and thus as soon as the direct impacts diminish, competitiveness and productivity considerations will once again become more important. Crisis management can be truly successful when the long-term productivity impacts of each step and measure are taken into consideration.

This publication approaches productivity in a novel way. It attaches special importance to the efficiency of the traditional economy, i.e. (labour) productivity, but also includes three additional aspects in the analysis. Economic research in recent years has highlighted the fact that the efficiency of innovation systems can also vary over time and space, and thus our analysis covers the efficiency of innovation as well. Thirdly, we extend the analysis to data, "the oil of our age", which is becoming an increasingly important factor of production. The efficiency of processing and utilising the continuously increasing data assets is a key factor for modern economies; in line with this aspect, the Report examines the efficiency of digitalisation. Fourthly, as also discussed in the work '*Long-term Sustainable Econo-mix'* published by the MNB, it is not possible to achieve sustainable growth to the detriment of the ecological system, and thus we also deal with the ecological productivity of the economy in detail.

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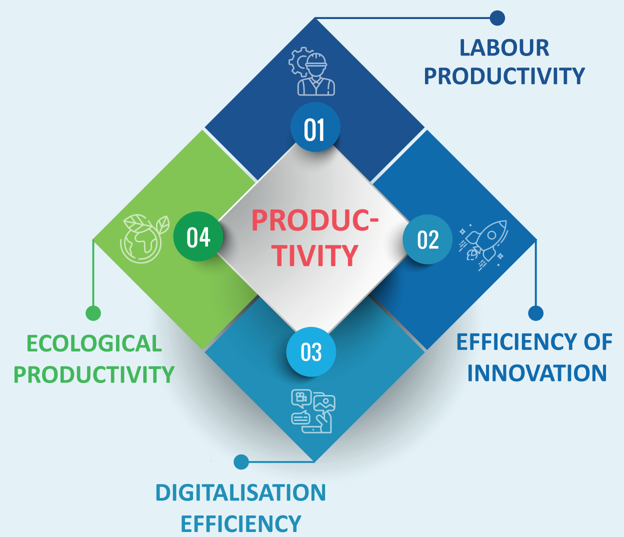
Executive Summary

In economic terms, productivity is very closely related to the notion of efficiency. Welfare can grow continuously in an economy if the efficiency of production/service processes increases tangibly over longer periods. Accordingly, the continuous, broad-based measurement and analysis of productivity is essential for monitoring changes in welfare. Productivity usually means efficiency ratios that show the value produced by one unit of resource absorbed. This Report refers to the value created as output and the expenditures as input. In contrast to the general practice, productivity is used in a broader sense, extending it to other areas as well, in addition to labour productivity.

According to the traditional approach, output is measured by value added, known from economics, while inputs are usually measured by the volume of labour absorbed. Value added per employee and per working hour is referred to as labour productivity. As productivity increases, the economy is able to produce more and more products and services by absorbing the same volume of labour force. This may stem from a rise in the capital intensity of production/service processes (increasing the capital stock per employee) or from the improvement of the technologies and procedures used in the economic processes. Productivity, i.e. the efficiency of the economy, determines a country's level of development over the long term. Hence, a sustainable increase in productivity is equally desirable for the economy and society. However, it is also important to consider what other consequences an improvement in labour productivity has. If these benefits can be realised in conjunction with higher external natural costs, excessive utilisation of the labour force and factors other than the labour force or obsolete production technology, then they only result in temporary improvement while undermining trend growth.

The purpose of the Productivity Report is to provide a comprehensive, objective view of Hungary's productivity situation. Accordingly, in addition to labour productivity, the Report also examines three additional pillars. Efficiency can be categorised as economic productivity in the narrow sense (labour productivity), innovation efficiency, digitalisation efficiency and ecological productivity (Chart 1-1). Labour productivity is the most traditional analytical framework, which, however, can no longer be interpreted on its own without the productivity pillars of the 21st century. For the measurement of productivity, we use numerous indicators that compare outputs valuable for society to input(s), which are available to a limited degree. Within the partial analyses, compiled along four dimensions, both the inputs used and the outputs are varied.

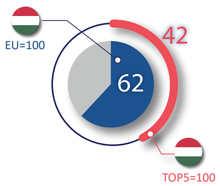
Chart 1: Productivity pillars



Source: MNB.

Hungary's productivity and efficiency indicators typically lag behind the average of the developed EU countries, which represents a growth reserve for the domestic economy. The advanced economies represent a high technological level and are well-supplied with goods and services. This is why it is worth examining Hungary's position in efficiency indicators compared to the EU countries. In the cross-sectional analysis, the comparison is made to the EU average and the other Visegrad countries. The productivity and efficiency differences also represent a growth reserve for Hungary, which is worth highlighting in terms of competitiveness. The unprecedented growth and convergence path between 2013 and 2019 which also maintained economic balance was based on targeted economic policy measures that successfully addressed the shortcomings of the economy and mobilised its resources.

LABOUR PRODUCTIVITY – THE AVERAGE OF HUNGARY'S LABOUR PRODUCTIVITY INDICATORS STANDS AT 62 PERCENT OF THE EU AND 42 PERCENT OF THE TOP5 EU COUNTRIES



In the past two decades, six shorter (typically 3- to 5-year) periods can be identified in relation to Hungarian labour productivity. In the period 1998–2001, and particularly in the second half thereof, labour productivity rapidly rose, while capacity utilisation indicated the maintenance of the balance. Although 2002–2006 was characterised by an apparently rapid increase in productivity, this was based on excessive capacity utilisation, which entailed a disruption of external and internal balance as well as a decrease in competitiveness. The structural problems (deteriorating investment ratio, excessive indebtedness, rising unemployment, build-up of imbalances) caused by the post-2002 economic policy and the 2008/2009 global financial crisis led to a major decline in labour productivity at the end of the 2000s. In the period of stabilisation from 2010 to 2012, productivity rose for 2 years, but capacity utilisation continued to decline due to the impact of the crisis.

The 2013–2019 growth and convergence period can be divided into two parts: 2013–2016 was primarily characterised by labour intensive growth, followed by robust growth in labour productivity from 2017, mostly borne by the domestic SME sector. The reforms implemented since 2010, together with the monetary policy turnaround in 2013, resulted in balance-preserving economic growth from 2013, which initially raised the low level of capacity utilisation, but did not yet boost productivity, due to its extensive nature. As a result of the previous reforms, after the previous extensive expansion phase, the Hungarian economy entered the intensive expansion phase between 2017 and 2019: with rising investment activity and continued maintenance of the balance, labour productivity continuously increased. Tightening labour market conditions also contributed to the more capital-intensive growth. Between 2013 and 2019, the Hungarian economy expanded at an annual average rate of 3.8 percent, exceeding the average euro area growth by more than 2 percentage points.

Owing to the central bank and government programmes, the labour productivity of domestic small and medium-sized enterprises increased significantly after 2013; accordingly, a large part of the growth in productivity was attributable to the SME sector. Nevertheless, there is still strong duality between small and large enterprises. Labour productivity at the level of the national economy rose by roughly 9 percent in total between 2013 and 2019. At the same time, productivity of the SME sector grew at a much faster pace, increasing by almost 30 percent until 2018. Thus, on the whole, the productivity duality of the Hungarian economy decreased significantly, but the labour productivity of SMEs remains at merely half the level of large corporations, and thus there is still room for labour productivity growth in the sector. At present, the level of labour productivity in the Hungarian national economy compared to the average EU labour productivity stands at 71.7 percent, while the labour productivity of SMEs compared to the average EU labour productivity is at 46.5 percent. Compared to the five EU Member States with the highest labour productivity, these values are 49.6 percent and 32.2 percent, respectively. The labour productivity of the Hungarian economy lags behind its economic development, which was roughly 74 percent of the EU average in 2019, and the development level can be improved primarily by increasing productivity.

The duality of the economy also declined in terms of the productivity of foreign-owned and domestic-owned companies. Duality in terms of productivity exists not only in the case of small and large enterprises, but also in the case of foreign-owned and Hungarian companies. Foreign companies are usually more productive than Hungarian-owned companies, which is also significantly related to enterprise size: foreign-owned companies are substantially larger on average. However, this is mitigated by the fact that since 2013 the labour productivity of Hungarian-owned companies rose to a larger degree than that of foreign companies. Since 2013, domestic companies have registered average growth of 5 , which in the last year with available data (2017) exceeded an annual growth rate of 14 percent. In terms of dynamics, foreign companies follow a similar pattern as the Hungarian ones, with lower growth in 2017.

In line with the megatrends of the 21st century, a new digital duality will also play a key role in the decade ahead. This new type of duality will develop between companies ready for innovation and those neglecting these processes. Only active participants in innovation and digitalisation can win in the future. The development potential is well reflected by the fact that while in Hungary one third of the companies may be regarded as digitally mature, the EU average is around 40 percent and the average of the TOP5 EU countries is almost 60 percent. In terms of innovation, the development potential is even greater, as only roughly one quarter of Hungarian companies innovate, while the EU average is over 50 percent.

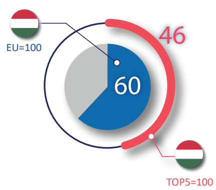
The productivity of manufacturing, market services and agriculture is similar, at around HUF 9 million per year and per employee. Construction deviates from this on the down side, while the productivity figures for the financial and infocommunication sectors are higher. The productivity of real estate transactions is outstanding, which is attributable to the extremely high monetary value per average transaction resulting from the special features of the sector.

The largest part of the annual average growth of around 3 percent in labour productivity measured in the past three years was linked to the service sector, with contributions from both knowledge-intensive and less knowledge-intensive sectors. On the average of the past three years, manufacturing and construction recorded average annual labour productivity growth of less than 1 percent and over 7 percent, respectively. The megatrends of the 21st century (increasing digital transformation, globalisation of services and changes in consumer habits) indicate that in the 21st century the role of the service sector will appreciate even more and its productivity will rise dynamically. In addition, the productivity of agriculture grew rapidly (by over 15 percent in total between 2013 and 2019), which is primarily attributable to mechanisation. In addition to the improved productivity of the sector, the volatility of its value added also declined due to modern technologies; at the same time, the dominance of cultivation and the reserves in irrigation still cause fluctuation in the sector's output. When analysing the Input-Output Tables we find that the productivity growth of sectors more deeply embedded in the economy has been more dynamic in the past period, which reflects the increasingly efficient domestic organisation of production chains.

The distribution of labour productivity is uneven in Hungary in regional terms as well: Budapest and the Western Transdanubia region stand out in this respect. However, the advantage of the capital is diminishing, since the labour productivity of Budapest showed no increase between 2012 and 2017, while two Transdanubian regions and Northern Hungary were characterised by average growth of over 2 percent.

The level of and growth in labour productivity is closely related to human capital. The rapid technological changes in the past period significantly increased demand for labour force with high cognitive skills. Based on the analysis related to Hungary, the statement that the more skill-intensive a sector is, the greater productivity it is coupled with, applies to all skills. Employees' willingness to learn also relates positively to the productivity level of the sectors. The desire for self-development is the strongest in the infocommunication and scientific research sectors.

Over the longer term, technological progress may significantly change the level of productivity through robotisation and automation as well. Hungary is in the vanguard among the OECD countries due to the fact that in the future it will most probably be possible to automate half of the jobs, and thus automation may strongly impact Hungary, and consequently labour productivity as well. In the future, the greatest challenge will be to increase labour productivity, which holds an even larger growth reserve, while maintaining or even increasing the employment rate. In view of the fact that the future requirements of the labour market are not yet known for the current education system, it will be particularly important to ensure that the policy is able to provide firm responses for the enhancement of employees' learning capacity (in addition to mastering practical knowledge). As regards physical capital, the improvement of horizontal (public) infrastructure and the provision of corporations with a predictable funding environment are critical for the enhancement of productivity.

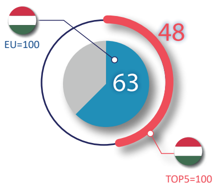


INNOVATION EFFICIENCY – HUNGARY'S INNOVATION EFFICIENCY AMOUNTS TO 60 PERCENT OF THE EU AVERAGE AND 46 PERCENT OF THE TOP5 EU COUNTRIES

The experiences of the past decades highlight the fact that the efficiency of the innovation system may also change in both space and time. The efficiency of the innovation system is meant to indicate how efficiently R&D expenditures and researchers are able to create new knowledge, new patents and new studies. In Europe, there is still a large gap between the leader and follower innovators. For the time being, our region belongs to the latter group, while the Scandinavian states and the Netherlands have been in the leader group for many years.

Innovation expenditures are on an upward trend in Hungary. Compared to 2012, R&D expenditures as a percentage of GDP rose by almost 20 percent, while business R&D expenditures registered growth of 40 percent. On the other hand, the ratio of innovative enterprises shows a downward trend and – in parallel with that – the registration of patent rights has also decreased. However, major improvement was achieved in the science citation index and in the number of business property protections (trademark, design patent). The gazelle index capturing fast-growing enterprises also reflects positive changes.

At the same time, the efficiency of R&D expenditures in Hungary lags behind the EU average. The increasing research and development expenditures result in a decreasing number of patents proportionally, and thus the Hungarian ratio is below the V3 average and falls substantially short of the EU average. Although the number of design patents and trademark protections, as an indicator which captures market innovation, appears to catch up (we compared the submissions with knowledge-intensive employment), Hungary's lag compared to the V3 and EU average is still substantial. The most important hindering factor is the fragmented innovation system and the dominant role of imports. Fragmentation can be observed at the relatively weak production relations between the knowledge-generating sectors and other sectors as well as at the high ratio of knowledge imports in production.



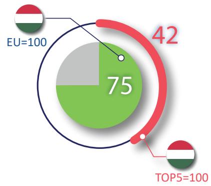
DIGITALISATION EFFICIENCY – HUNGARY'S DIGITALISATION EFFICIENCY IS AROUND 63 PERCENT OF THE EU INDICATOR ON AVERAGE, AND 48 PERCENT COMPARED TO THE TOP5 EU COUNTRIES

Digitalisation and the technological progress it induces represent new opportunities, but also require adjustment by all economic agents. By harnessing the achievements of the fourth industrial revolution a competitive advantage can be gained that may result in a long-term improvement in productivity, and thus boost welfare in a sustainable manner.

Based on digital infrastructure, Hungary belongs to the upper mid-range among the countries of the EU; nevertheless, the digital skills of the population lag substantially behind the EU average, and improvement in this respect offers significant growth potential. Despite the adequate availability of infrastructure conditions, the population's software and internet skills, such as word processing and internet browsing, are low. Hungary's efficiency ratio compared to the EU average and the average of the TOP5 EU countries is 68 percent and 55 percent, respectively. 51 percent of the Hungarian population has basic software skills, which lags behind the EU average of 61 percent and is substantially lower than the TOP5 EU countries average of 76 percent. In recent years, exploitation of the digital infrastructure by the population lagged behind the V3 countries as well, since the growth in internet coverage was not accompanied by the households' internet awareness.

The efficiency ratio of digital technologies among corporations is low in Hungary in an EU comparison, the improvement of which may also support sustainable convergence. Hungary's efficiency is about half of the EU average, while it is merely one third compared to the TOP5 EU countries. The countries with the highest corporate digital efficiency include Ireland, Belgium, Finland, the United Kingdom and the Czech Republic. Based on the Digital Economy and Society Index, which is prepared by Eurostat and measures the digital integration of corporation, Hungary is ranked 26th among the 28 Member States. According to the research, only a small portion of Hungarian firms invest in digital technologies. At the same time, the ICT specialists in employment ratio exceeds the average of the V3 countries and the EU Member States. On average, 81 percent and 27 percent of large corporations and SMEs, respectively, employ ICT specialists, which exceeds the EU average of 76 and 19 percent. Specialists equipped with digitalisation skills increase Hungary's digitalisation efficiency, and thereby productivity. Accordingly, it bears utmost importance to develop these skills for those entering the labour market and those already there, in parallel with development of technology.

The digital maturity of the state in Hungary exceeds the V3 average, but lags behind the EU average. Based on the completeness and interoperability indicators of Hungarian e-governance, digital developments are required to catch up with the other EU countries, as Hungary takes 22nd place in the EU ranking. Hungary's shortfall is particularly large compared to the TOP5 countries, as the Hungarian ratio compared to them is 65 percent. The 5 most developed countries in terms of the state's digitalisation are: Malta, Estonia, Lithuania, Latvia and Portugal. The digital administration system can be used with less obstacles more widely, which would save time for the population and reduce the administrative burdens of corporations. Owing to the development of e-governance, the operation of the state accelerates and becomes more cost-efficient.



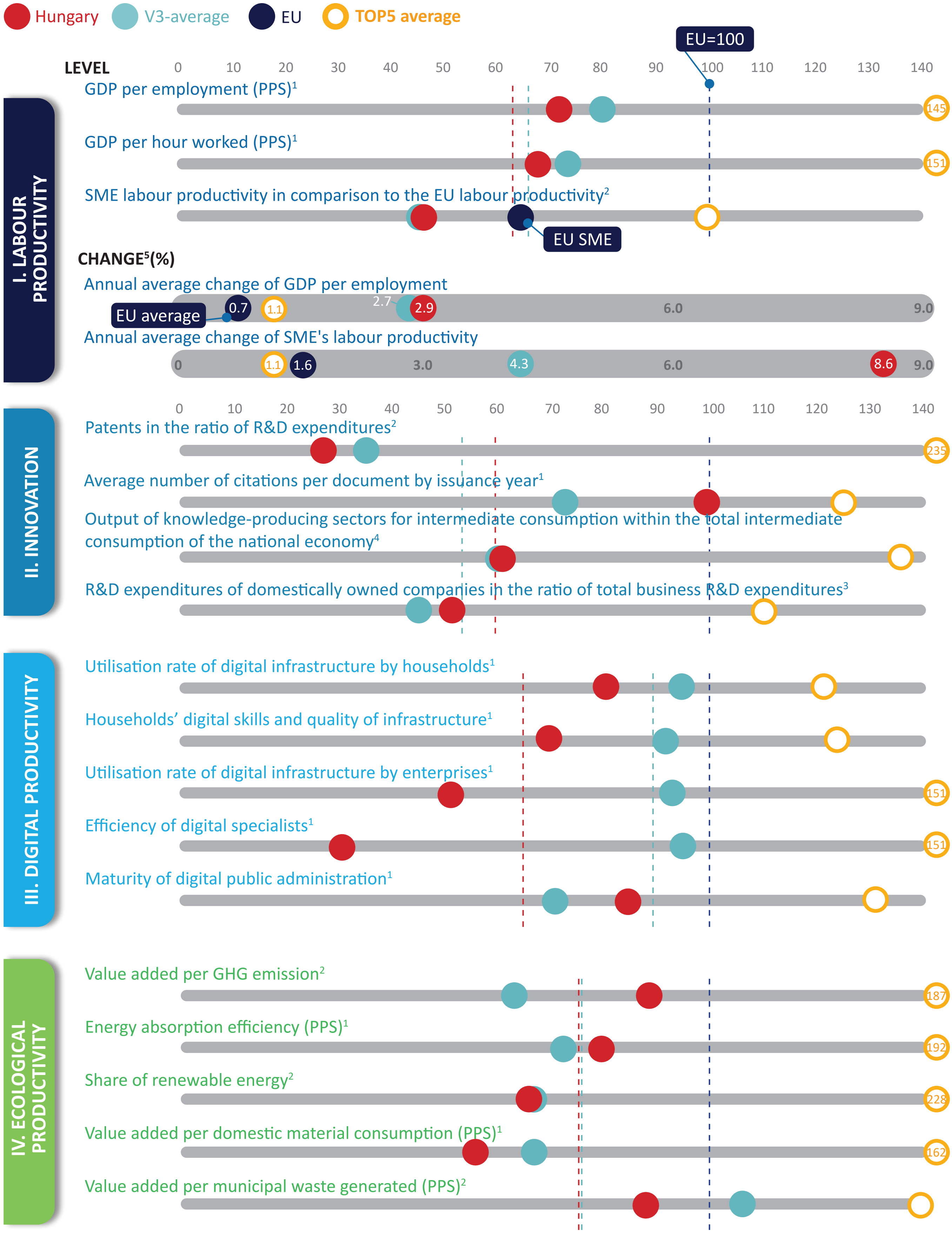
ECOLOGICAL PRODUCTIVITY – HUNGARY'S ECOLOGICAL PRODUCTIVITY IS 75 PERCENT OF THE EU AVERAGE, AND 42 PERCENT COMPARED TO THE TOP5 EU COUNTRIES

In our analysis, the basis of the 4th pillar, i.e. ecological productivity, is the proper use of natural resources and potentials. The preservation and liberation of these assets ensures the ecological sustainability of the long-term path of economic growth. The current magnitude of environmental pollution and the current rate of environmental degradation are one of the most important obstacle to long-term sustainable growth. One of the key indicators of ecological productivity is the value added per one unit of environmental pollution. With less environmental pollution, the same volume of goods and services can be produced, the higher the ecological productivity of a given economy is.

Hungary is ranked favourably in ecological productivity in a regional comparison. The value added per one unit of carbon dioxide emissions has improved significantly of late and is close to the EU average. In this respect, Hungary stands at 89 percent of the EU average, while compared to the average of the TOP5 EU countries this value is merely 48 percent. The order of the five most efficient countries is as follows: Sweden, Malta, Ireland, Denmark and France. Recently, there has been a positive change in ecological terms, but there is still room for improvement. On the other hand, the Hungarian economy fall short compared to the developed Western European countries in material productivity, while in a regional comparison Hungary's indicator can be considered average. In terms of material productivity, Hungary stands at 53 percent of the EU average, while compared to the average of the TOP5 EU countries this value is merely 33 percent. The order of the five most efficient countries is as follows: the Netherlands, the United Kingdom, Luxembourg, Italy and Belgium. In 2018, slightly more than 37 percent of municipal waste was recycled in Hungary, which somewhat exceeds the average of the region, but falls short of the EU average. Due to the penetration of renewable energy, dependence on fossil fuel declined by 15 percent in the past one and a half decades. Although the volume of electricity from renewable resources (produced from biomass, water, solar and wind energy) has increased significantly in Hungary in recent years, still only roughly 12 percent of total power generation comes from such sources. Among the EU countries, Sweden, Finland and Latvia are the leaders in the exploitation of renewable resources, where the ratio of renewable resources is at least 40 percent in each of those countries.

There is an improving trend in the green productivity ratios in a wide range of sectors. Over the past two decades, ecological productivity calculated as carbon dioxide emissions per unit of value added has almost doubled in manufacturing. The ecological productivity of the service sector rose by almost 40 percent. Under major volatility, there is moderate improvement in the ecological productivity of agriculture, reflected in improved crop yields. On the other hand, there is a deteriorating trend in construction, where ecological productivity decreased by 40 percent over the past two decades.

Chart 2: Value of the indicators in Productivity pillars (EU average = 100)



[1]Based on 2019 data; [2]Based on 2018 data; [3]Based on 2017 data; [4]Based on 2015 data; [5]Annual average growth for the year between 2017-2019. SMEs are covered until 2018 only.

Note: See more details in Annex.

Source: MNB-calculations based on Eurostat, European Commission, DIW, WIPO, ScimagoJr, IEA databases.

1 Labour productivity developments

In addition to the quantitative analysis of labour force and capital, the efficiency of the utilisation of these resources is also a key issue in terms of an economy's growth path. Resources on the supply side are limited. Accordingly, economic agents aim to use the available factors as efficiently as possible. Productivity appeared as early as 1776, in the work of Adam Smith, the founder of modern economics, who recognised that not all work or phases of work performed are useful (i.e. everything does not necessarily lead to a tangible product). It was also Smith who recognised the importance of the division of labour, which he described in his famous pin factory model. Ever since Smith, productivity has been a widely researched topic both in microeconomics and macroeconomics. In addition, one of the most important targets of economy policy-making is to increase the ratio of output per unit of input.

In this section, we briefly summarise the global economic megatrends related to labour productivity and the various explanations of those. After this, we analyse developments in Hungarian labour productivity. At the global level, growth in labour productivity is characterised by cycles, which are usually identified with era-specific technologies. The last productivity cycle reached its peak at the turn of the millennium, and has been steadily decreasing since then. Since the 2008/2009 global crisis, productivity growth has decelerated, despite the fact that infocommunication technology increasingly permeates our everyday life and companies' business activities. The phenomenon – also referred to as Solow paradox – attributes this to four factors: inadequate demand, a slowdown triggered by supply factors, decreasing innovation efficiency and GDP measurement difficulties.

Over the past two decades, six shorter (typically 3- to 5-year) periods can be identified in Hungarian labour productivity. In the period between 1998 and 2001, and particularly in the second half of it, labour productivity rose rapidly, while capacity utilisation indicated that economic balance was being maintained. While the period 2002–2006 was characterised by a seemingly fast increase in productivity, this was based on excessive capacity utilisation, which entailed disruption of external and internal balances, as well as a deterioration in competitiveness. The structural problems (declining investment ratio, excessive indebtedness, rising unemployment, accumulation of imbalances) caused by the post-2002 economic policy and the 2008/2009 global financial crisis led to a large decline in labour productivity at the end of the 2000s. In the 2010–2012 stabilisation period, productivity rose for 2 years, but capacity utilisation continued to fall due to the impact of the crisis. As a result of the successful, post-2010 fiscal reforms and the shift in monetary policy, Hungary has been on a balanced growth path since 2013. The first years of this period were characterised by extensive growth, during which capacity utilisation was rising, which was not yet accompanied by increasing labour productivity. However, from 2017 the accomplishments of the previous reforms also enhanced labour productivity, in conjunction with increasing investment activity and preservation of economic balance at the same time. Between 2013 and 2019, the Hungarian economy's annual average rate of growth amounted to 3.8 percent, exceeding the euro area growth rate by more than 2 percentage points.

Although labour productivity growth at the level of the national economy was significant from 2017, the labour productivity of Hungarian SMEs already picked up after 2013, due to the central bank and government programmes. While total labour productivity in the national economy grew by almost 9 percent between 2013 and 2019, SMEs registered growth of almost 30 percent (up to end-2018). Trends in recent years have been favourable, but the labour productivity of SMEs is still merely half that of large enterprises, and thus there is space for further improvement. At present, the level of the Hungarian national economy labour productivity compared to the EU's average labour productivity stands at 71.7 percent, while this ratio is 46.5 percent for SMEs. Compared to the TOP5 EU countries in terms of labour productivity, these ratios are 49.6 percent and 32.2 percent, respectively. If one compares the labour productivity of Hungarian small and medium-sized enterprises to average labour productivity in the EU, it is close to 65 percent.

In line with the megatrends of the 21st century, a new duality will also play an essential role in the convergence to be achieved in the decade ahead. This new type of duality will develop between companies ready for innovation and digitalisation and those lacking these aspects. Only those who actively engage in innovation and digitalisation can be winners in the future. The development potential is well reflected by the fact that while in Hungary one third of the companies may be regarded as digitally mature, the EU average is around 40 percent and the average of the TOP5 EU countries is almost 60 percent.

Of the main sectors of the national economy, market services, manufacturing and agriculture exhibit similar labour productivity: in these sectors the value created per employee amounts to HUF 9 million, while in construction it slightly exceeds HUF 6 million. As regards the annual changes, the majority of the annual average growth of around 3 percent in productivity over the past three years was linked to the service sector, with contributions from both knowledge-intensive and less knowledge-intensive sectors. In 2019, the productivity level of the service sector rose to its high for the decade compared to the national economy average. The megatrends of the 21st century (increasing digital transformation, globalisation of services and changes in consumer habits) indicate that the role of the service sector will become even more important and its productivity will rise dynamically in the 21st century.

The level of and growth in labour productivity is closely related to the quality of human capital. The rapid technological changes in the 20th century significantly increased demand for labour force with high cognitive skills. Data related to Hungary support the fact that the more skills an employee is required to have in a sector, the higher the productivity of that sector is. Accordingly, the complexity and complementarity of human capital are of the utmost significance. In addition, employees' learning level is related positively to the productivity level of the sectors. The strongest need for self-development can be identified in the infocommunication and scientific research sectors.

Over the longer term, technological progress may also significantly alter productivity levels via robotisation and automation. Hungary belongs to the group of OECD countries, in which the exposure to automation is high. In the future, it will likely be possible to automate half of all jobs, and thus automation may strongly impact Hungary, and consequently labour productivity as well. In 2018–2019, certain sectors substituted labour force by increasing capital intensity, after the tightening in labour market conditions. Substituting capital for labour was typical mostly in agriculture, where capital intensity deepened significantly. Productivity growth did not follow this process, confirming the lower level of capital's production elasticity.

In addition to the human capital and technology applied by an enterprise, the age (maturity) of the enterprise may also substantially influence productivity. The age profile of enterprises had a special pattern in the period 2013–2018. Labour productivity increases rapidly until enterprises reach the age of 3, achieving its highest value in the 8th year after more moderate growth, and then flattens out thereafter. In the last two years of the period (2017–2018), median labour productivity was higher in each age bracket than for the entire period (2013–2018).

Participation in external trade is accompanied by higher corporate employment, labour productivity and technology levels. Exporter and importer companies are more competitive both in the foreign and domestic markets. The productivity of typical exporter SMEs rose steadily in the period 2013–2018. Hungarian SMEs participate in external trade to a lesser degree than Austrian or German SMEs, where companies of similar size are typically more active compared to other countries of the region. There are major differences between the industries: the smallest within-industry difference was registered in construction, while the largest difference was seen in the infocommunication sector. While in construction a typical exporter company was twice as productive as a company selling only in the domestic market, this rate is nine-fold in the ICT segment.

1.1 Introduction – The relationship between productivity and welfare

The general indicator which is used for the assessment of economic performance – and ultimately of welfare – is the gross domestic product, i.e. GDP. As an economic indicator, the objective of GDP is to quantify the aggregate value of products and services produced in the country, which can satisfy the needs of the respective society in a given period (quarter or year). The GDP concept and the national accounts framework, compiling the indicator from its elements, have been widely criticised in the past decade, but no generally accepted alternative has been identified so far.[1] Attaining higher living standards is important not only due to economic and statistical considerations, but also for individuals; accordingly, it is important from a welfare point of view how many people "share in" the volume of goods and service presented by GDP. In view of this, the most frequently used welfare index is gross domestic product per capita.

1 Hoekstra (2018) makes a proposal for the evolutionary process of replacing GDP by 2030. There are several alternative indicators to measure welfare (e.g. Human Development Index, Happy Planet Index, see Szigeti, 2011), but in economics GDP per capita is the generally accepted and currently used measure. The present measurement difficulties are emphasised, among others, by Matolcsy – Nagy – Palotai – Virág (2019), and the Magyar Nemzeti Bank had also discussed the issue in several previous publications (see e.g. Section 4 of the 2017 Growth Report, and Subsection 2.3 of the work entitled Long-term sustainable econo-mix).

The relationship between welfare and productivity can easily be described by the formula below. This formula separates the impact of demographic change, activity, employment and labour productivity in the change of GDP per capita (see the formula below and later Chart 1-5). The demographic impact appearing in the correlation indicates the ratio of persons of working age to the total population. This factor essentially changes slowly, over several decagdes. Raising the ratio of persons of working age is able to increase GDP per capita only up to a certain level.

$$\frac{\text{GDP}}{\text{(Total) population}} = \underbrace{\frac{\textbf{GDP}}{\textbf{Employees}}}_{\textbf{Productivity}} \times \underbrace{\frac{\text{Employees}}{\text{Economically active persons}}}_{\text{Employment index}} \times \underbrace{\frac{\text{Economically active persons}}{\text{Persons of working age}}}_{\text{Labour force participation rate}} \times \underbrace{\frac{\text{Persons of working age}}{\text{Total population}}}_{\text{Demography}}$$

Labour market indicators are important factors in GDP per capita: i.e. the activity rate and the employment rate.[2] The labour force participation rate is the percentage of the employed and unemployed persons (economically active persons) in relation to the working age population. This indicator is not identical with the activity rate, which is the percentage of active persons in relation to the total population. The employment index corresponds to the employment rate, which shows the percentage of active population in employment on a ratio scale. Similarly to demography, activity and employment components are also able to increase employment per inhabitant only up to a certain degree, as its steady increase is hindered both by physiological and biological limits.

Thus, the correlation demonstrates well that over the long term labour productivity (GDP per employee) fundamentally determines the standards of living, and consequently this feature of it makes it a key factor for all economies. Labour productivity includes all factors that make employees produce goods and services more efficiently. Accordingly, labour productivity simultaneously reflects the capital and technology level of the economy.

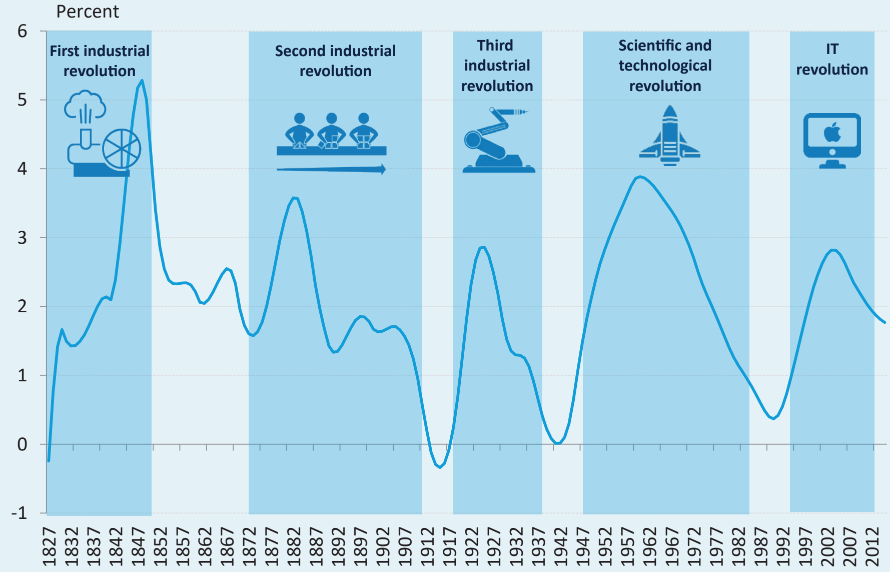
1.2 Global productivity trends

When analysing productivity over the long term, one can observe that in the past 200 years global GDP per capita increased almost every year, accompanied by strong volatility however. As result of industrial revolutions, productivity accelerated significantly, resulting in a general rise in welfare around the world. At the peak of the cycles, growth exceeded 3 percent on several occasions, while during the first industrial revolution, in the 1840s, it reached 5 percent. The duration of declines also varied: in certain periods global GDP was achieved with unchanged productivity[3] (Chart 1-1).

2 The correlation may be also supplemented by the number of working hours per employee.

3 Long time series are available only for GDP per population, which – although differs from productivity – still reflects long-term trends well.

Chart 1-1: Annual change in global GDP per capita



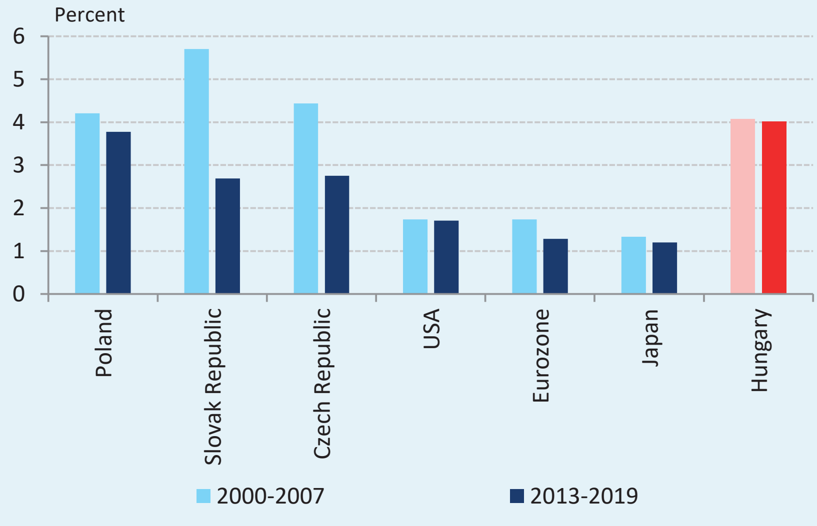
Note: Smoothed by HP filter.
Source: MNB calculations based on Maddison.

Following the turn of the MILLENNIUM, productivity growth once again entered the decelerating phase of the cycle, falling to an annual rate of less than 2 percent in the global economy.

1.2.1. Deceleration in productivity: role of supply factors

Classical economics essentially attributes the decline in productivity to the decreasing efficiency of innovation (Bloom et al., 2017). One global phenomenon observed in connection with this is the decline in the investment ratio and/or the stabilisation thereof at a moderate level, which points to a slower increase in capital intensity and thus in productivity (Chart 1-2) (ECB, 2017). Specialist literature mentions stagnation in the quality of education as an additional factor. The substantial increase in technological complexity (e.g. artificial intelligence, Big Data, appearance of sensors, etc.) complicates and prolongs the process of adaptation and penetration. These factors represent difficulties in relation to boosting production primarily at smaller enterprises. (For more on the efficiency of digitalisation, see Section 3.) In contrast to previous industrial revolutions, it is substantially more difficult to manage and integrate the new tools, and thus understanding their use is also more time-consuming. Accordingly, it is a special feature of technological innovation that only narrow economic groups (ICT conglomerates and their subsidiaries) are able to benefit from the economic impacts of gains in productivity (Andrews et al., 2015).

Chart 1-2: Annual change in GDP per capita in selected countries



Source: MNB calculations based on OECD.

As regards the future of productivity, those approaching the issue from the supply side can be divided into two main groups, depending on how they assess the impact of future technological innovations on productivity.

- **The group of 'techno-optimists' expects the productivity growth rate to return to previously observed levels with the onset of a new wave of innovations.** In order for this to occur, productivity must not only be concentrated at the top-ranking holding companies and a general-purpose technology, such as the steam engine or electricity during the previous industrial revolutions, will have to spread. In our age internet, electro-mobility or the storage of electric energy may play such a role. Most analyses expect mobile internet to exert the greatest economic impact over the next 10 years. In addition to those listed before, promising developments include cloud technology, robotics and autonomous cars. The penetration of artificial intelligence (AI) may usher in a new age of technology.

- **By contrast, 'techno-pessimists' forecast lower growth due to the ageing of the society, decreasing R&D efficiency and rising inequalities within the society.** As the result, techno-pessimists believe that the present low productivity growth may become endemic over the longer term as well (Gordon, 2018). Another a significant decelerating factor is that growth in trade is also slowing down in parallel with the development of global production chains. In the opinion of techno-pessimists, previously successful productivity increasing schemes cannot be followed either, as the gradual raising of R&D expenditures alone is not accompanied by higher value creation per unit of efficiency.

1.2.2. Role of demand in productivity

In addition to supply side explanations, analyses examining the long-term effects of economic cycles gained increasing importance after the crisis. In part, these explanations argued that – contrary to previous conventional economic wisdom – cycles do impact the trend, i.e. in the case of a prolonged downturn both the potential output (hysteresis) and growth rate (super-hysteresis) will be lower. Pre-crisis mainstream economics identified the growth trend and the business cycles fluctuating around the trend as separate factors. By contrast, the followers of the new school emphasised that after the 2008/2009 crisis the welfare consequences of the earlier higher productivity growth will no longer be available. In recent years, this phenomenon was observed in numerous advanced economies.

The underlying reasons for hysteresis are rather diverse, and the most common explanation is based on human capital. According to the cycle-based explanation, if unemployment fails to return to the previous trend – as was the case in many countries in Europe – it may generate long-term unemployment in the group of unemployed persons. The market skills of those absent from the labour market for a longer period decays, their attitude to work deteriorates and simultaneously with this long-term unemployment results in undesirable psycho-social effect (hopeless unemployment). Impaired self-esteem triggers a negative spiral: previous professional relations fade, mental and physical health deteriorates and ultimately employability decreases[4].

Another dimension of analysing the impact of the demand side on productivity is the role of the government budget in economic crises. Bianchi et al. (2019) emphasised that several European countries introduced austerity measures in response to the global economic crises in order to reduce their deficits. Since new technologies are capital intensive and rely on strong demand (adapted to the economy endogenously), fiscal austerity also hinders the spread of productivity (technology) (Bianchi et al. 2019). Due to this, recovery from the crisis may drag on and retrenchments may generate extra opportunity costs. Fiscal policy also plays a central role in the cyclical explanations. In this approach, the budget can absorb the natural fluctuations of the economy if – during periods of boom – it is able to accumulate reserves, which are then used in periods of recession to finance demand stimulating reforms (countercyclical fiscal policy).

The decline in productivity growth may be also explained by the deleveraging implemented as a result of the crisis. In every country (developing or developed), deleveraging triggered different economic policy adjustments regardless of the fact that otherwise they were exposed to the same global trends (Kiss–Szilágyi, 2014). Deleveraging by households and the government curbed aggregate demand, as a result of which corporations restrained their production, thereby triggering recession. In Hungary, idiosyncratic factors also exacerbated the crisis (penetration of foreign currency loans and the exchange rate crisis). On the whole, an economic environment characterised by depressed aggregate demand has developed globally, resulting in a persistent decoupling from the previous economic (and productivity) trends, i.e. hysteresis (for more details on this phenomenon, see MNB, 2016 Growth Report).

1.2.3. Alternative explanations

According to Kozloswski et al. (2016), the manipulation of economic psychological factors also prevailed in the period of recovery. In other words, one reason why the crisis was able to drag on was that before the onset of the crisis it was not deemed probable that it would occur. Unexpected events strengthen the precautionary considerations of economic agents, which generates additional decline. The Great Recession resulted in a permanent change in the behaviour of actors.

The slowdown in productivity may also be attributed to measurement reasons. Quantifying the diverse new economic activities poses challenges for statisticians. The main sources of bias include the mismeasurement of qualitative leaps, the contingent management of the increased role of services, the omission of free contents from statistics and the underestimation of the role of the sharing economy. The followers of this school are of the opinion that productivity has not decreased significantly, we only "lost sight of it." Since in practice there are only experimental measurements with regard to the interpretation of productivity in this way, in this publication we only deal with this question in this column.

4 For details on other reasons, see Section 1 of the 2016 Growth Report.

Box 1-1: Measurement of productivity and alternative indicators

The issue of productivity measurement is complicated, particularly in modern economies. Productivity quantifies the value (added) that an enterprise, region, country or sector is able to produce using one unit of input. However, the value of produced goods decouples from the easily measurable features of products/services due to the fact that in today's economies the value increasingly depends on the quality, timeliness, customisability, convenience and variety of the product. In addition, with the passing of time, products (outputs) change both in terms of quality and composition. On the other hand, a further circumstance that complicates the measurement of productivity is that not all resources that are used are comparable and measurable. In addition to the above production factors and the productive use, intermediate consumption includes the training of employees, the volume of the "organisational capital", cultivation of supplier relations (idiosyncratic capital) and investments in new business procedures. In view of the above, productivity indices may be calculated in several ways.

Labour productivity is the most frequently used indicator, which indicates the output/value added per employee or working hour and the change therein. In microeconomics, this appears as the average product of labour. Based on the principle of calculating labour productivity, alternative productivity indicators – used to a lesser degree in practice, but which can be construed in theory – may be defined. Such indicators may include, e.g. value added as percentage of machine-hour or value of tangible assets (capital productivity), GDP as a percentage intermediate consumption (material or energy productivity) and values related to other factors utilised in production.

The cyclical change in capacity utilisation may significantly distort the productivity time series. Companies tend to respond to increasing demand by more intensive utilisation of capital and labour, which is linked more to the economy's short-term cycles than to its long-term path and to the productivity growth determined by the supply side. Accordingly, productivity time series are procyclical, which complicates the separation of the permanent and temporary change in productivity at a given point of time. This necessitates the use of other data and information for the assessment of productivity over a shorter horizon; these may include the enterprises' capacity utilisation index and the entirety of the indicators reflecting external and internal balance.

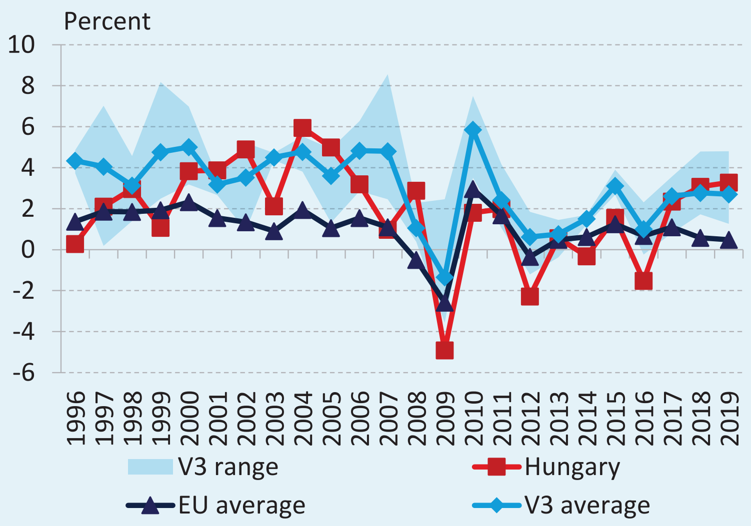
When calculating the change in multifactor productivity or total factor productivity, we mean the increment in excess of the impact exerted by the quantitative change in capital and labour (separately and together) on output. The indicator thus determined – based on general belief – results in productivity stemmed from technological origin; however, as noted above, productivity may be boosted by several other factors as well. The drawback of the indicator is that it is extremely sensitive to the assumptions related to inputs (initial capital stock, amortisation) and is significantly influenced by the specification and parameters of the production function.

On the whole, it is easier to calculate the individual factors of productivity, but they also reflect impacts pointing beyond them and cyclical processes distort them. In theory, the total factor productivity captures technological progress better, but it cannot be observed directly and its result largely depends on the estimation procedure. In this analysis, we regard labour productivity as the key index, which is supplemented – in Section 2-4 – by the measurement of the efficiency and productivity of criteria that have gained importance in the 21st century (innovation, digitalisation, the green economy).

1.3 Changes in labour productivity in Hungary

On the average of the past 20 years, Hungary's labour productivity rose by 1.9 percent, in sync with the business cycles (Chart 1-3). During the past two decades, six shorter (typically 3- to 5-year) periods can be identified in Hungarian labour productivity. In the period between 1998 and 2001, and particularly in the second half of it, labour productivity rose rapidly, while capacity utilisation indicated the preservation of economic balance. Although the period 2002–2006 was characterised by a seemingly fast increase in productivity, this was based on excessive capacity utilisation (Chart 1-4), which entailed the disruption of external and internal balance as well as a deterioration in competitiveness. The structural problems (declining investment activity, excessive indebtedness, rising unemployment, accumulation of imbalances) caused by the post-2002 economic policy and the 2008/2009 global financial crisis led to a large decline in labour productivity at the end of the 2000s. During the 2010–2012 stabilisation period, productivity rose for 2 years, but capacity utilisation continued to fall due to the impact of the crisis. Together with the monetary policy turnaround in 2013, the reforms implemented since 2010 resulted in balanced economic growth from 2013, which – due its extensive nature – initially raised the low level of capacity utilisation, while productivity has not yet started to increase. **As a result of the earlier reforms, after the previous extensive expansion phase, the Hungarian economy entered a phase of intensive expansion between 2017 and 2019: in conjunction with rising investment activity and the continued preservation of economic balance, labour productivity rose continuously.**

Chart 1-3: Annual change in labour productivity in the Visegrad countries and in the European Union

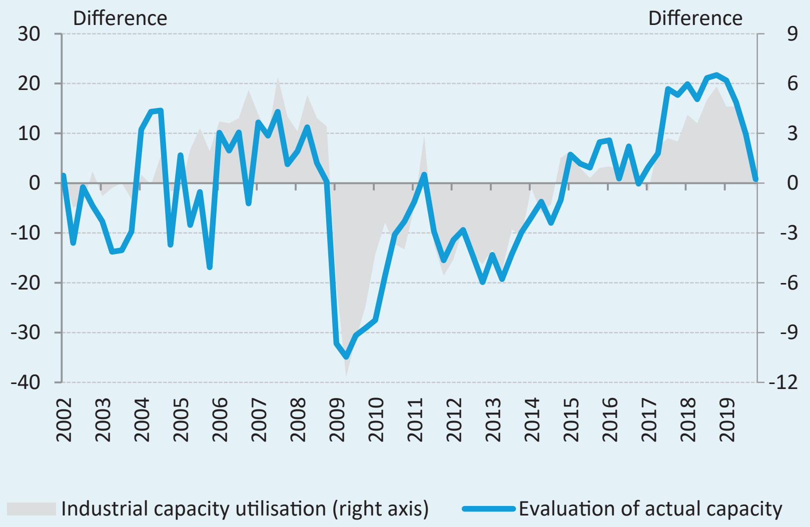


Source: MNB calculation based on Eurostat data.

Labour productivity growth was sustainable between 1998 and 2001, but in the period thereafter, it became unsustainable due to the build-up of imbalances. As a result of the irresponsible, overspending fiscal policy that commenced in 2002, the capacity utilisation ratio increased and exceeded the equilibrium value by 2008. At the same time, the current account deficit and government debt both increased (moreover, in an unfavourable structure). The penetration of foreign currency lending further exacerbated the structural problems.[5] During this period, Hungarian economic policy measures reduced Hungary's competitiveness to an increasing degree (Matolcsy, 2015). The investment ratio started to decline, as enterprises – which reined in their investments – tended to respond to the demand supported by the fiscal impulse and the favourable international economic activity by greater utilisation of capacities. Attempts to adjust the unsustainable government budgetary processes were made in 2006 and in 2009 as well. Although these efforts reduced the previously high public deficit that had been in place for years, the adjustment was implemented in an unsuitable structure, and thus in fact the measures only continued to weaken the fundamentals of the domestic economy. Capacity utilisation rapidly declined after the outbreak of the crisis and production was characterised by unutilised capacities.

5 The general macroeconomic developments of the past 20 years are well summarised in Chapter 9-10 of the book by Virág (2020).

Chart 1-4: Capacity utilisation and evaluation of actual capacity



Note: Deviation from historical average.
Source: MNB calculation based on ESI data.

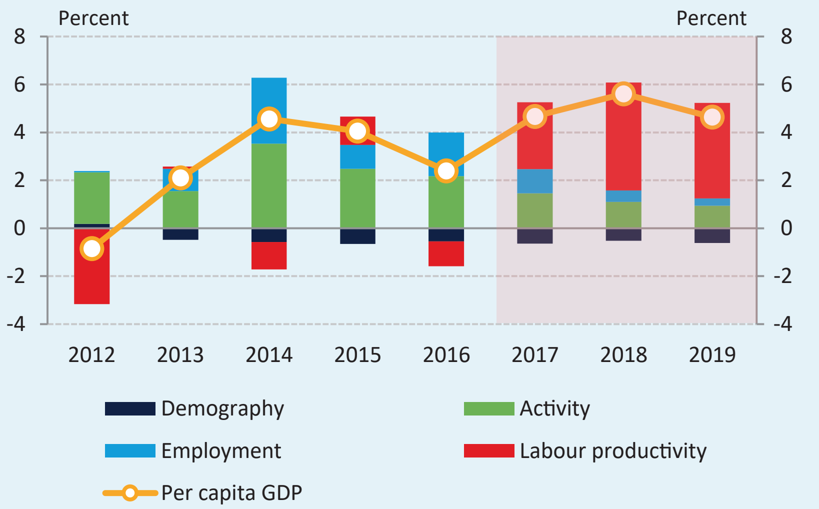
The balanced economic growth that started to emerge from 2013 was initially strongly extensive, as it was based on raising the utilisation of labour input. As the labour market moved ever closer to full employment, enterprises responded to the pick-up in demand with a sharp increase in investment, and thus the previously extensive growth became increasingly intensive from 2017. 2010 marked a major turnaround in Hungary's economic policy. Owing to the reforms, the disciplined fiscal policy and the shift in monetary policy, the economy has been on a growth path since 2013. However, this growth was not uniform in terms of its structure. Examining the developments in labour productivity, there were essentially two sub-periods. From 2013 to 2016, economic growth was mainly supported by the increase in labour input, i.e. by the substantial increase in activity and employment components (Chart 1-5). A major part of the growth was attributable to the upturn in labour market activity, while the demographic trends and the underlying labour productivity developments exerted negative impact on economic growth.

Thanks to the structural labour market reforms that were implemented, growth was extensive from 2010. The reduction in labour taxes, the introduction of the flat-rate personal income tax, the tightening of retirement conditions, the reform of the employment benefit scheme, the introduction of the Job Protection Action Plan and the expansion of public employment largely supported the flow of groups that previously had not been attached to or had been less attached to the labour market into activity and employment**.** In the past, Hungary had one of the lowest employment rates in the European Union: this was successfully remedied by the fiscal, labour market and tax reforms after 2010.[6] Since the labour productivity of new labour market entrants was below the average, average productivity has not yet increased in parallel with the growth in employment. However, demographic and labour market constraints became increasingly effective in the pre-pandemic years, and thus it was vital to raise labour productivity in order to maintain sustainable growth (MNB, 2018).

Between 2017 and 2019, the bulk of the economic growth was already attributable to the significant rise in labour productivity. Thanks to the measures taken by the government and the central bank, national economy labour productivity started to grow from 2017, in conjunction with a continued improvement in the financing environment, strong growth in investment activity and steadily balanced budget conditions. The rise in the investment ratio made major contribution to productivity growth, which boosted the efficiency of labour force via increasing capital intensity.

6 According to estimations, the aforementioned measures exert their impact over the medium term (over a horizon of approximately 6-10 years) (see the latest results on this in the paper of Szoboszlai et al. (2018)), and thus the adjustment procedures were in progress also in the period under review.

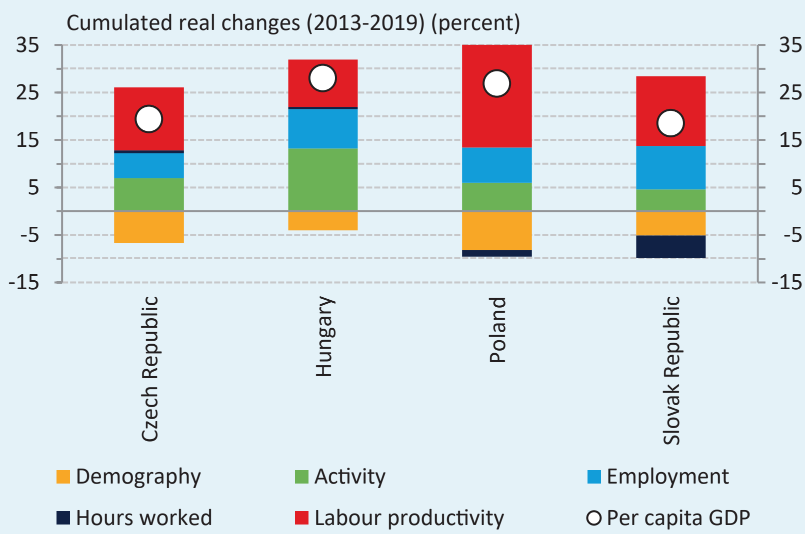
Chart 1-5: Breakdown of annual change in GDP per capita in Hungary



Source: MNB calculation based on Eurostat data.

On the whole, following the crisis, growth in the V4 region was primarily attributable to improved efficiency, while in Hungary it was due to the labour market reforms (Chart 1-6). By expanding the labour force, Hungary capitalised on the growth potential resulting from this, while on the other hand the stabilisation of labour market supply exerts its growth impacts over a shorter horizon than labour productivity, and thus for the purposes of economic planning this sequence is more desirable than the opposite. Productivity growth in conjunction with almost full employment created higher value added than the same (or even higher) productivity growth taking place with unutilised labour supply.

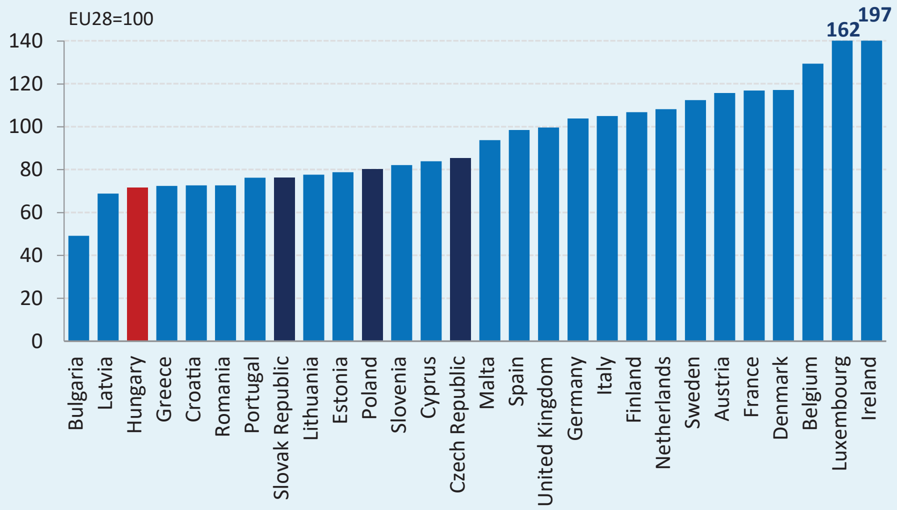
Chart 1-6: Decomposition of the cumulated (between 2013 and 2019) change in real GDP per capita



Source: MNB calculation based on Eurostat data.

The strong growth in labour productivity since 2016 supported convergence to the EU average. In the period 2017–2019, labour productivity rose by almost 3 percent on average, and thus it not only maintained but also accelerated economic growth and real economic convergence. In 2019, Hungary's labour productivity was 71.7 percent of the EU average (in 2016, it stood at roughly 68 percent). Apart from the EU average, Hungary production efficiency can be also compared with the leaders of Europe. The five most productive countries in terms of value added per employee are: Ireland, Luxembourg, Belgium, Denmark and France. Compared to the average of these EU countries, Hungary's labour productivity is around one half of it (49.6 percent). Thus, there is still plenty of room for a further increase in labour productivity in an international comparison.[7] Accordingly, the current situation offers considerable growth potential: looking ahead, after overcoming the economic difficulties caused by the pandemic and protecting jobs, a significant increase in labour productivity will form the basis for Hungary's convergence (Chart 1-7).

Chart 1-7: Labour productivity level in the Visegrad countries and the European Union (2019)

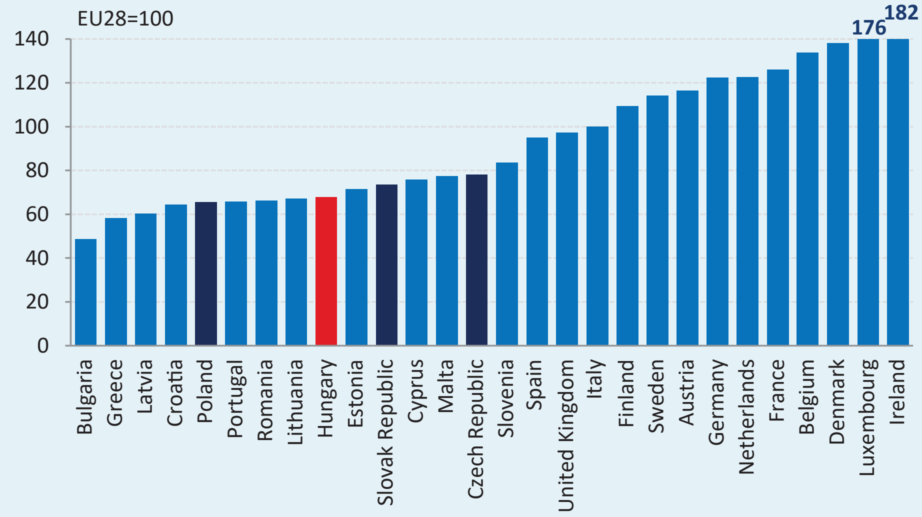


Note: Calculated on a PPS basis.
Source: MNB calculation based on Eurostat data.

When examining the economic value per working hour, Hungary's position is more favourable in the European ranking (Chart 1-8). This statistic takes into consideration not only the number of employees, but also the average number of hours that employees work in the respective country. In Hungary, productivity per working hour reached 67.9 percent of the EU average in 2019, ahead of Romania (66.2 percent), Poland (65.5 percent) and Croatia (64.4 percent). In terms of value added per working hour, the group of leaders in the EU consists of the same countries as for the ratios per employee. The value of the Hungarian indicator for working hours is slightly less than 45 percent (44.9 percent) compared to the five most productive European countries.

7 Comparing the levels of GDP per employee (labour productivity) between countries is based on GDP measured in purchasing power parity. The use of the indicator is justified by the fact that we should eliminate from the comparison the impact of price differences when examining the output of economies in terms of welfare.

Chart 1-8: Working hour-based labour productivity level in the Visegrad countries and in European Union (2019)



Note: Calculated on a PPS basis.
Source: MNB calculation based on Eurostat data.

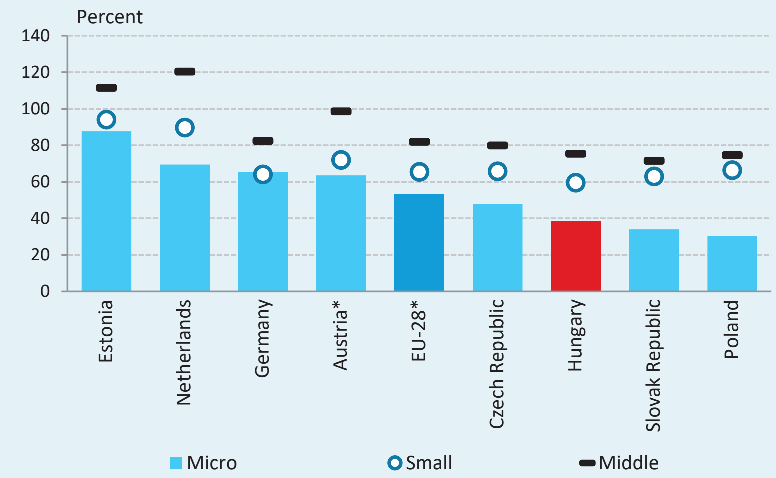
While there are still untapped reserves in the Hungarian labour market, continued convergence can mainly be achieved by further boosting labour productivity. The headcount of inactive groups has significantly decreased, and therefore, their involvement may contribute to economic growth only to a limited degree, i.e. supply constraints are expected to arise in the labour market. Although the economic downturn resulting from the coronavirus triggers reallocation between sectors, over the long term a demographic turnaround may be the solution to the supply constraints in the labour market. However, this will only make its impact felt one generation later. Consequently, improvements in efficiency and productivity will become the new drivers of economic growth in the future. The Magyar Nemzeti Bank prepared a competitiveness programme comprising 330 points (MNB, 2019a), presenting the potential measures leading to this. One key point in the programme is to raise capital intensity. However, it should be emphasised that an increase in capital intensity in its own right is not sufficient for sustainable convergence and growth: this should be accompanied by technological progress and qualitative improvement in human capital.

1.4 In-depth analysis of Hungarian productivity growth in the 2013–2019 growth period

1.4.1. Comparisons by enterprise size

In the developed European countries, the productivity gap between small and medium-sized enterprises on the one hand and large corporations on the other is narrower than in the countries of the region and in Hungary. The degree of the duality – i.e. the productivity shortfall compared to large corporations – contains important additional information on the performance of corporations in the economy (Chart1-9). The labour force productivity of German SMEs is roughly two thirds/four fifths of that of the large corporations, while in Austria there is no substantial difference between medium-sized and large corporations in terms of productivity. The productivity of medium-sized enterprises in Estonia and the Netherlands is special in the sense that – compared to large corporations – the corporate value added per employee is higher (by 11 percent and 20 percent, respectively). In a statistical sense, economies of scale is an – unobserved – corporate metric engendering a productivity advantage, which implies that, in its own right, the productivity of large corporations exceeds the indicators of smaller enterprises. However, the example of Estonia and the Netherlands clearly reflects that productivity is determined not only and not uniformly by economies of scale. In the countries of the Visegrad region, the ratios of small and medium-sized enterprises range between 59 and 80 percent. Within the countries presented, Hungarian small enterprises have the largest relative productivity lag. In addition to the duality within the country, the productivity of Hungarian small and medium-sized enterprises represents a growth reserve, in an international comparison as well. At present, the labour productivity of Hungarian SMEs amounts to 46.5 percent of the EU's average labour productivity, while in 2018 it was 32.2 percent compared to the TOP5 EU countries with the highest labour productivity.

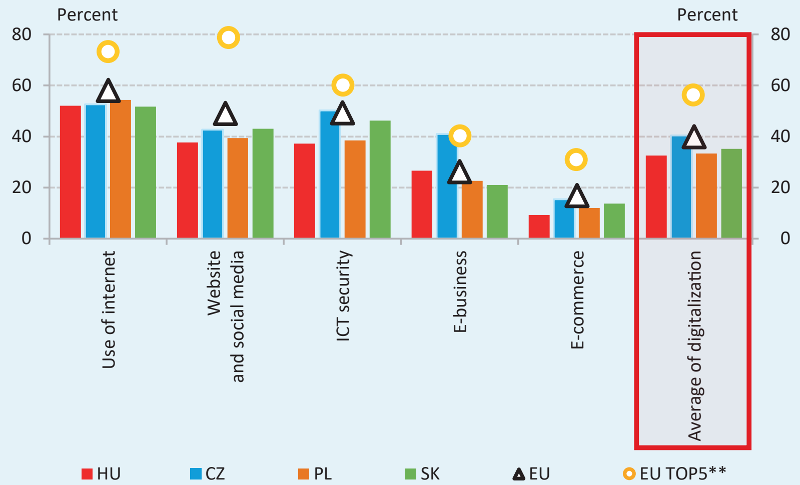
Chart 1-9: Labour productivity as a percentage of large corporations (2017)



*Note: GDP calculated at market prices. * 2016 data are not available for Austria and the EU-28.*
Source: MNB calculation based on Eurostat data.

In line with the 21st-century megatrends, a new kind of duality will also play a key role in economic convergence in the decade ahead. This new duality will develop between companies which are ready for innovation and digitalisation and those which neglect these processes. Only firms which actively participate in innovation and digitalisation will be able to prevail in the future. The development potential is well reflected by the fact that while in Hungary one third of the companies can be considered digital, the EU average is around 40 percent and the average of the TOP5 EU countries is almost 60 percent. The new duality observed in the 21st century is determined by the level of digitalisation, rather than by differences in size. Based on the Eurostat data, in Hungary only every third company can be regarded as digitally mature. The use of internet services is less common with Hungarian enterprises, and they perform poorly in IT security measures and the use of e-administration, while other advanced technological solutions is also not typical. On the whole, major digital development potential can be identified in this area (Chart 1-10).

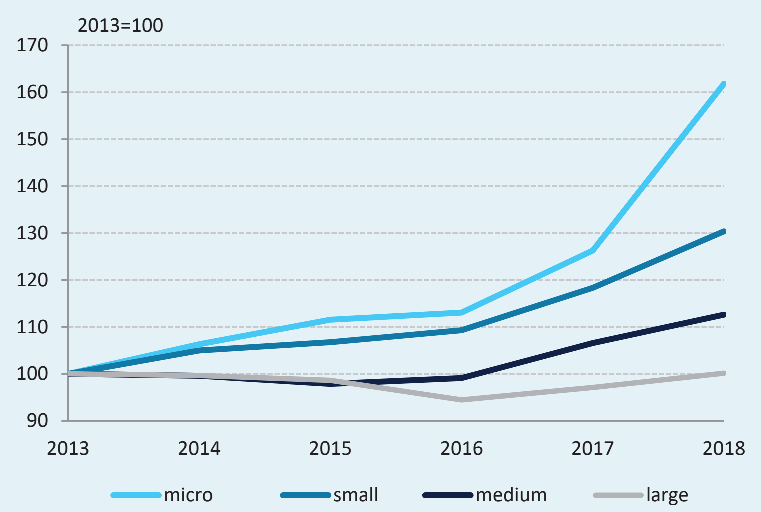
Chart 1-10: Penetration of digitalisation among enterprises based on areas of digitalisation (2019*)



** Data for e-business are from 2018.*
*** Based on varying composition.*
Note: Enterprises with more than 10 people. We considered 20 indicators, taking into account 4 indicators per pillar on average. The chart contains the averages by themes, which show the percentage of corporations that are characterised by the respective indicator. In the case of two indicators – due to their nature – only an alternative benchmark is available, but those are also included in the averages.
Source: MNB calculations based on Eurostat data.

For the SME sector, the productivity gap is an important growth reserve, which has already made major contribution to the growth seen in recent years. 99.2 percent of Hungarian corporations are micro and small enterprises. The average annual growth in productivity in these size categories was over 4 percent in the 2013–2018 growth period (Chart 1-11). Owing to this, the domestic productivity gap is narrowing, which reflects a decreasing duality in Hungary. Due to the favourable trends in recent years (2016–2018), increasing productivity growth can be identified in all size categories of the SME segment; nevertheless, the productivity level of these companies is still merely half that of large corporations. In the same period, the labour productivity of large corporations stagnated.

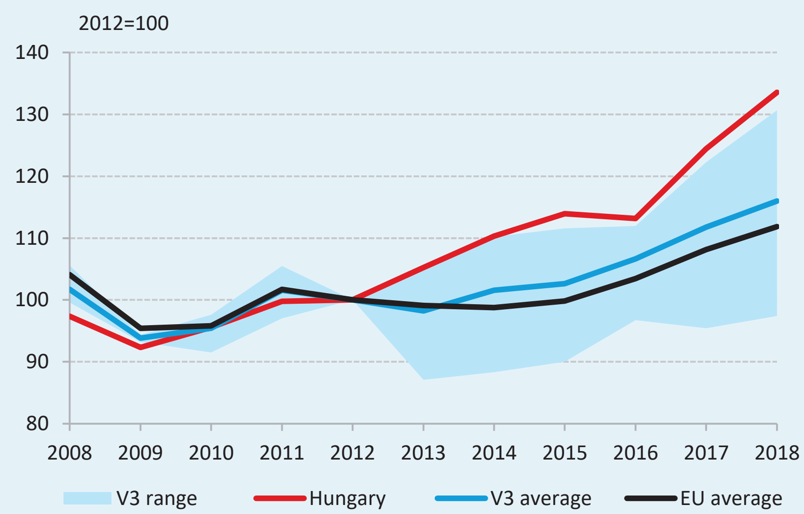
Chart 1-11: Changes in SMEs' real labour productivity in Hungary in a breakdown by enterprise size



Source: MNB calculations based on HCSO.

The productivity growth of the Hungarian SME sector is extremely dynamic, not only compared to large corporations but also to other SMEs in the region. Owing to the rapid economic growth in the period 2017–2018, the productivity of the Hungarian SMEs rose faster than the regional average (Chart 1-12). This may have been equally supported by burgeoning domestic demand, the affordable sources of finance provided by the central bank's programmes and the EU grants.

Chart 1-12: Labour productivity of SMEs in a regional comparison

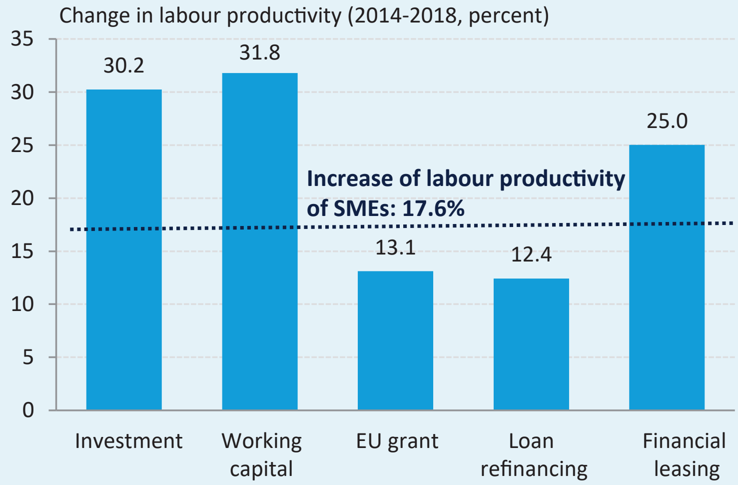


Source: MNB calculations based on European Commission, Eurostat and DIW.

Box 1-2: Productivity of enterprises that benefited from FGS

The Funding for Growth Scheme intended to foster the penetration of corporate loans by easing credit constraints, thereby ensuring growth in the SME sector's outstanding borrowing in a sound structure, which supported increase in the sector's competitiveness and productivity. Chart 1-13 presents the changes between 2014 and 2018 in the productivity of enterprises financed in 2014. In the case of loans, we assume that depending on the loan purpose their impact on the enterprise's performance may be felt with a lag of several years. This depends on the timing of asset purchases and orders after disbursement, the capitalisation of productive capacities and the development/stabilisation of customer satisfaction. As regards productivity, it is important to know the purpose of borrowing. Chart 1-13 presents the change in median productivity in a breakdown that shows the development of the productivity of enterprises that benefited from FGS loans in 2014. In 2014, loans were available – with the exception of factoring – for participating in tenders, for investment and for working capital financing as well as for the purchase of related real property; funding was also available in financial lease schemes for the purchase of new or used assets, machinery and equipment. In the initial phase, in addition to new loans, loan refinancing was also rather common, which generated competition among banks on the one hand, and on the other hand – by reducing the debt servicing burdens of earlier (mostly foreign currency-denominated) debts – contributed to improving enterprises' creditworthiness, stimulating business activity, preserving jobs, and – via all of these aspects – to improving productivity.

Chart 1-13: Productivity of FGS-financed enterprises subject to corporate income tax in a breakdown by loan purpose (2014)



Note: The chart includes the data of companies that benefited from FGS financing in 2014 and submitted corporate income tax returns.
Source: MNB calculation based on tax registry data.

While the average growth in SMEs' labour productivity was 17.6 percent in total between 2014 and 2018, the SMEs that borrowed under FGS for investments and current asset management achieved growth in productivity which was almost twice as high. SMEs that borrowed under financial lease schemes also registered above-average growth (of 25 percent) in labour productivity. In the case of loans applied for the purposes of receiving EU grants, productivity increased by 13 percent, i.e. at a lower rate than in the aforementioned categories.

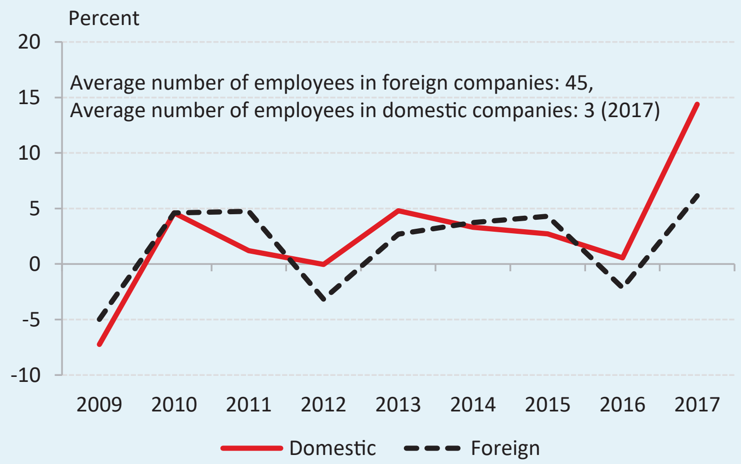
1.4.2. Productivity of Hungarian and foreign-owned enterprises

Duality in terms of productivity is found not only in the case of small and large enterprises, but also in the case of foreign-owned and Hungarian-owned companies. The analysis of duality according to size and ownership structure is correlated, since foreign-owned companies are usually substantially larger than Hungarian-owned ones[8]. Between 2013 and 2016, the productivity of the two groups increased at a similar rate; however, in 2017, productivity of Hungarian

8 In the Eurostat accounts the distinction between domestic and foreign ownership is based on control. Accordingly, it is established whether or not an enterprise is controlled by non-residents along multiple ownership dimensions, instead of considering only direct ownership subordination.

companies advanced substantially faster (Chart 1-14). In the 2009 crisis, productivity of both foreign-owned and Hungarian-owned companies declined; however, the rate of decrease registered by domestic companies exceeded that of foreign companies by more than 2 percentage points. This was followed by two years of adjustment, and then in 2012, while labour productivity of Hungarian companies did not change, that of foreign-owned companied declined by 3 percent compared to previous year. Since 2013, domestic companies have registered average growth of 5 percent, which improved considerably in the last year with available data (2017). In terms of dynamics, foreign-owned companies follow a similar pattern as Hungarian ones, with lower growth in 2017.

Chart 1-14: Annual change in labour productivity at enterprises in majority Hungarian and foreign ownership



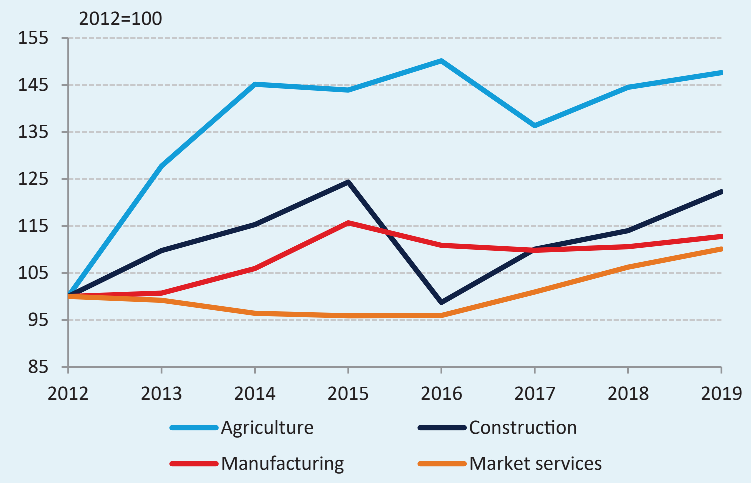
Note: The average employment of foreign and Hungarian companies is 45 and 3, respectively (2017).
Source: MNB calculation based on Eurostat data.

1.4.3. Industry analyses

The productivity of manufacturing, market services and agriculture is similar, at around HUF 9 million per year and per employee. Construction deviates downward from this level, while the financial and infocommunication sectors deviate upwards. The productivity of real estate transactions is outstanding, which is attributable to the extremely high monetary value per average transaction resulting from the special features of the sector (Chart 1-17).

The growth cycle ending in 2019 affected the dynamics of the individual industries' productivity differently (Chart 1-15). In the service sector, labour productivity followed a downward trend until 2016. Then, during the capital- and technology-intensive period, the sector registered a steep rise in productivity until 2019. In the period 2017–2019, on aggregate market services were characterised by robust productivity growth, averaging 4.7 percent for the three years, in conjunction with an almost steady employment rate. The real labour productivity of manufacturing has not changed significantly since 2015. The efficiency of agriculture improved between 2013 and 2016. Following the decline in 2017, the labour productivity of this sector rose by almost 9 percentage points. The largest fluctuations were observed in construction. Labour productivity in 2016 fell short of the 2015 peak by more than 20 percentage points, as the combined result of declining value added and rising employment. This suggests that – due to EU funding – companies assumed that the decline in output would be temporary and they did not reduce the number of employees. During the time of recovery in the sector's performance, commencing from 2017, corporations were able to utilise this. In construction, as a result of annual average productivity gains of over 5 percent in the period 2016–2019, last year's labour productivity – in real terms – was almost identical to what was registered in 2015.

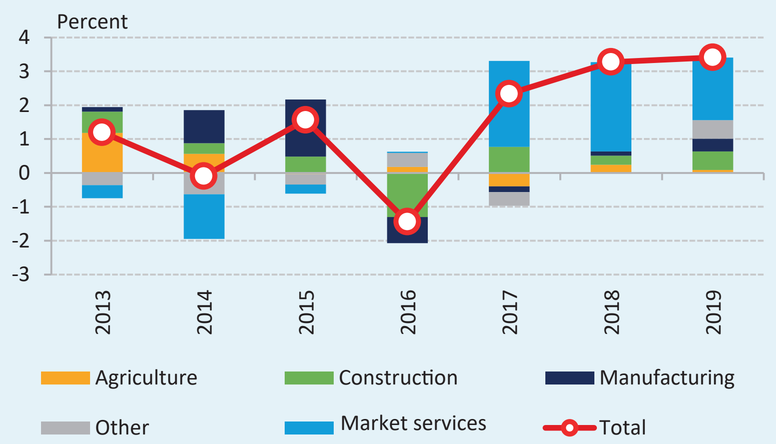
Chart 1-15: Change in real labour productivity of sectors in the national economy (2013–2019)



Source: MNB calculation based on Eurostat data.

In the period 2013–2016, the contributions by the sectors varied. From 2017, the improved productivity at the national economy level was shaped by the productivity growth in market services (Chart 1-16). At the beginning of the period, agriculture contributed to a large degree to the growth in national economy productivity. Its share in 2014 was also positive, while in the rest of the years – due to its weight – it shaped Hungarian productivity trends to a lesser degree. Apart from 2016, construction helped to boost national economy labour productivity. Manufacturing played a significant role in the development of productivity between 2014 and 2016, making a strong positive contribution in the first two years. Until 2016, the tertiary sector made no positive contribution to Hungary's productivity. The market services segment was a fundamental productivity-raising sector in the period 2017–2019. In addition, the data from the last two years (2018 and 2019) reflected a historic high in the service sector's productivity ratio. This is partly attributable to the key role of the service sector in the economy. On the other hand, the production megatrends (increasing digital transformation, globalisation of services and changes in consumer habits) point to an appreciation in the role of the service sector in the 21st century.

Chart 1-16: Breakdown of the change in labour productivity by sectors



Note: Weighted by employment. The other category includes the production of mining, water supply, electricity, gas and steam supply, municipal services, households and extra-territorial organisations and bodies.
Source: MNB calculation based on Eurostat data.

The post-2016 years can be characterised by capital- and technology intensive economic growth, with very large contribution by the individual sectors. In this respect, construction and trade were the drivers in the period 2017–2019, with annual average labour productivity growth of over 6 percent. These sectors are followed by the financial services and professional, scientific, technical activities sectors, which exhibited productivity growth of 5.7 percent. The productivity gain of infocommunication was 4.8 percent on average.

Chart 1-17: Labour productivity characteristics of Hungarian industries

Industry	Economic weight (based on value added, %)	Labour productivity (2019), million HUF/femployees	Average changes of real annual labour productivity (2013–2019)	Average changes of real annual labour productivity (2017–2019)
Manufacturing	21%	*9.4*	1.7	0.6
Wholesale and retail trade	19%	*6.7*	3.6	6.4
Public services	17%	*6.8*	-0.3	1.9
Professional, scientific and technical activities	10%	*7.8*	-0.8	5.7
Real estate activities	9%	*48.4*	-0.9	-3.0
Construction	6%	*6.3*	2.9	7.4
ICT	5%	*12.6*	0.5	4.8
Agriculture	4%	*8.5*	5.7	-0.6
Finance and insurance	4%	*16.2*	3.9	5.6
Other services	3%	*5.5*	-0.1	2.7
Market services	*50%*	*9.1*	*1.4*	*4.7*

Note: Market services include the following national economy branches: trade, infocommunication, finance and insurance, real estate transactions, professional, scientific and technical activities and other services.
Source: MNB calculation based on Eurostat data.

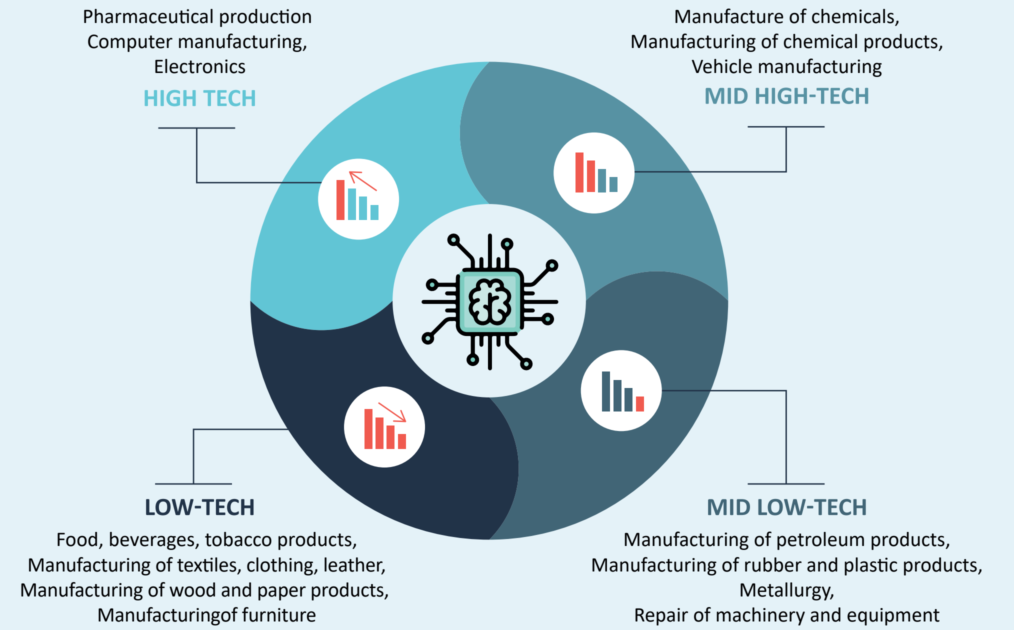
1.4.4. Comparisons by groups of technology- and knowledge-intensive industries

In addition to the statistical classification of sectors, it is increasingly common to categorise sectors by knowledge and technology intensity. Manufacturing and services account for roughly one quarter and one half, respectively, of gross domestic value added. In view of the fact that the two sectors comprise very diverse activities, it is necessary to break down the individual sectors (and sub-sectors) into further categories. Of the statistical institutes, Eurostat responded to the analysis requirement by creating groups of sectors based on technology intensity. We applied the classification based on technology both for manufacturing and services, also bearing in mind the methodological constraints of the classification (Chart 1-18 and Chart 1-21).[9] This kind of classification serves as a guideline for the differentiation of productivity growth stemming from technical change and qualitative change in the labour force.

The branches of manufacturing can be allocated to 4 categories based on technology intensity, depending on the ratio (typical for the EU average) of highly qualified labour force in the respective sector. Sectors with high technological intensity include the pharmaceutical industry, computer manufacturing and electronics. The medium-high sector includes the chemical industry, the manufacturing of machinery and appliances, and vehicle manufacturing. The medium-low category includes the manufacturing of petroleum products, rubber and plastic products, metallurgy, machinery and equipment, while the sector of low technological intensity includes the food industry, tobacco products, and the manufacturing of textiles, clothing and leather products, wood products, paper and furniture.

9 Eurostat prepares the classification based on aggregates calculated for several countries, based on employment categories. However, in practice, sectors tend to resemble each other less and less when crossing the border. This is due to, among other things, the international organisation of work, where outsourcers typically retained the activities of higher value added, while the assembly works were moved to countries characterised by lower wage costs. This phenomenon particularly affected electronics and vehicle manufacturing.

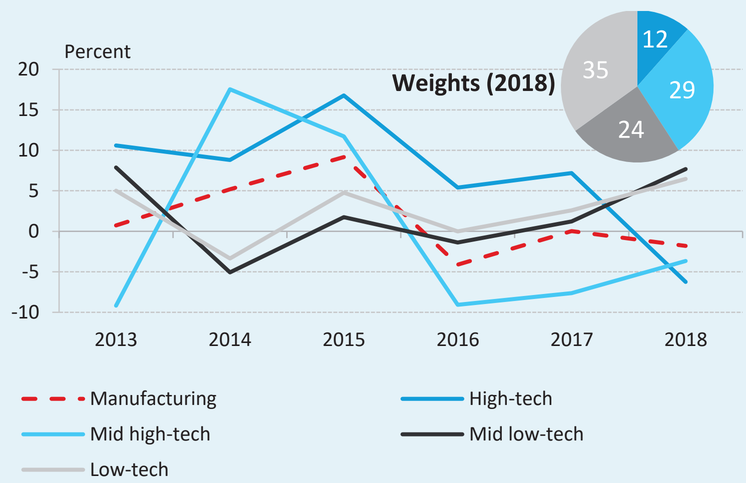
Chart 1-18: Breakdown of manufacturing by technology



Source: MNB based on Eurostat data.

Manufacturing productivity growth in the period 2013–2015 was attributable to the sector of higher technological intensity, while all segments registered stagnation for the next 3 years, except for the growth of the segment of medium-low technological intensity in 2018 (Chart 1-19). On the whole, between 2013 and 2018, the largest growth was achieved by the high-tech segment, registering an average growth rate of 7.1 percent. On the other hand, productivity of the segment of high and medium-high technological intensity was more volatile in the past period. This is evidenced by the fact that the robust productivity growth of 2014–2015 was offset by the decrease registered in 2016–2018. The productivity time series of the sectors of low and medium-low technological intensity moved in tandem until 2017. Although the sectors of medium-low technology achieved a productivity gain of almost 8 percent in 2018, productivity growth in manufacturing as a whole remained negative that year.

Chart 1-19: Annual change in labour productivity in manufacturing by technology-intensity

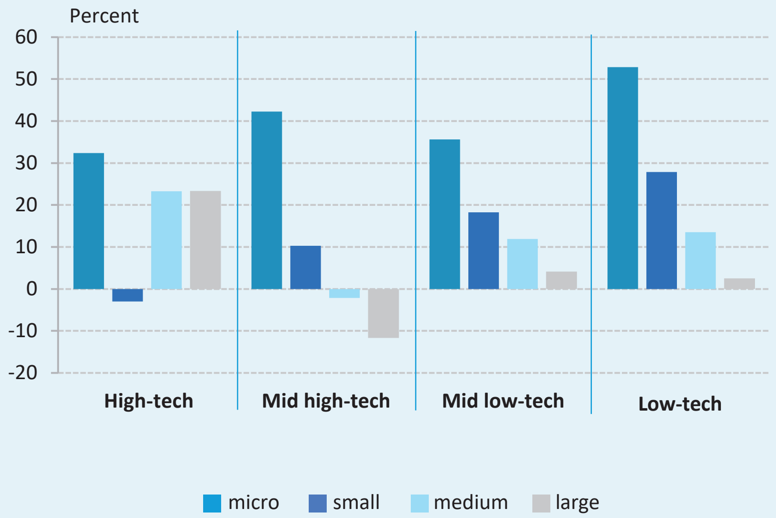


Source: MNB calculation based on Eurostat data.

Further analysis of the change in manufacturing productivity considering enterprise size categories shows that the sector's heterogeneous growth is even more diverse (Chart 1-20). The cumulated growth values vary on a wide scale. In 2012–2017, micro enterprises were able to achieve higher growth in labour productivity in all manufacturing sub-sectors.

Within that, outstanding growth was realised by the low-tech segments. By contrast, large corporations – other than the high-tech sector – underperformed compared to their SME competitors in manufacturing. The pattern that in the categories of larger enterprise size growth was lower in the period under review can be observed both in the medium-low and low-tech sector's enterprise size categories.

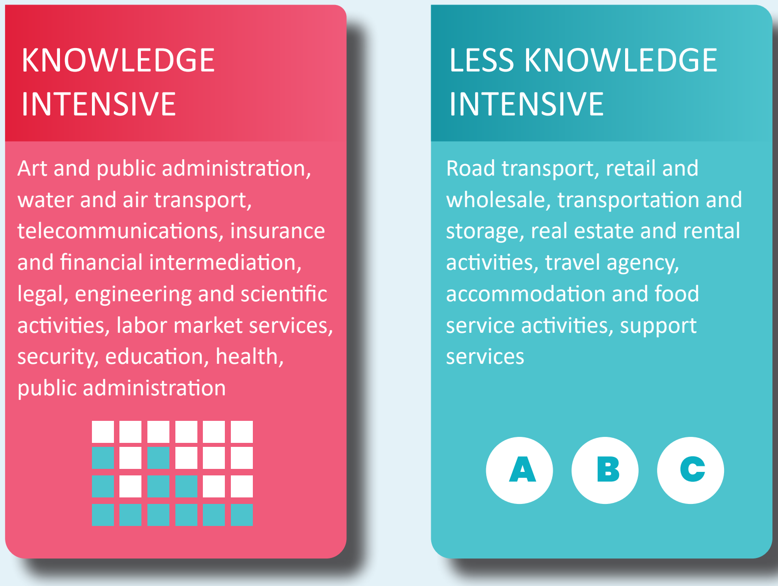
Chart 1-20: Cumulative change in labour productivity based on enterprise size and the technological nature of the sector between 2013 and 2018 in manufacturing



Note: Pursuant to the European statistical regulations, along the common principles and guidelines ensuring the confidentiality of the data used (due to the confidential nature of data), the Eurostat publishes no data in certain sector-size categories.
Source: MNB calculation based on Eurostat data.

Based on knowledge intensity, the industries of the service sector are allocated to two categories (Chart 1-21). The individual categories were developed in proportion to the ratio of highly educated employees in the sector, following the classification applied by the ISCO (International Standard Classification of Occupations) international nomenclature, which can be mapped with the Hungarian Standard Classification of Occupations (FEOR). The knowledge-intensive category includes water and air transport, telecommunications, legal, engineering and scientific activities, labour market services, security, education, healthcare and arts. The rest of the service sector branches were allocated to the less knowledge-intensive category, including road transport, retail and wholesale trade, transportation and storage, real estate transactions, rental activities, travel agency, accommodation and catering, support services.

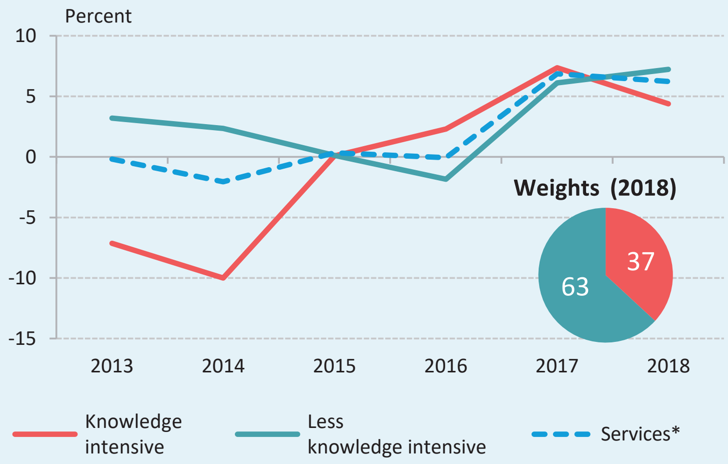
Chart 1-21: Breakdown of services by knowledge-intensity



Source: MNB based on Eurostat data.

Since 2013, the most dynamic growth was observed in knowledge-intensive services; however, prior to 2015 labour productivity declined substantially in this group. The service sector was characterised by low productivity growth in the four years preceding 2017 (Chart 1-22). The performance of the entire service sector was slightly better, which was attributable to the less knowledge-intensive services and their weight in total services. By contrast, outstanding growth of 6 percent and 7 percent was observed in 2017 and 2018, respectively, with a simultaneous, almost identical contribution by both of the subcategories.

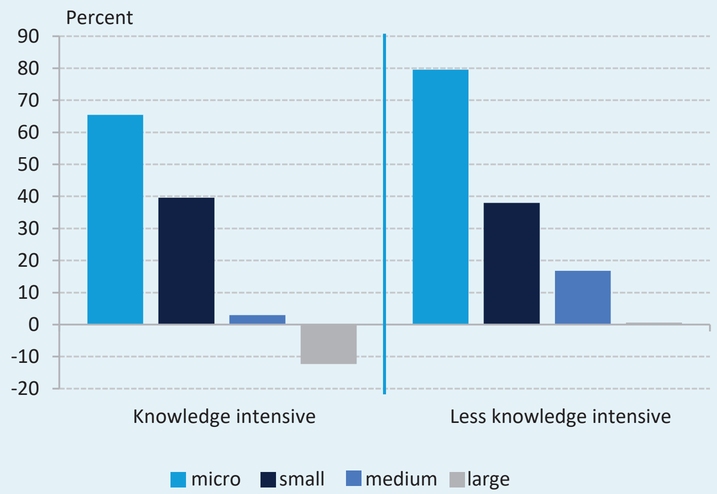
Chart 1-22: Annual change in labour productivity in services* by knowledge intensity



*Note: *Services without financial and public services.*
Source: MNB calculation based on Eurostat data.

In the period 2013–2018, a similar pattern was observed in the SME sector as in manufacturing, i.e. productivity growth was inversely proportional to enterprise size (Chart 1-23). The difference is even larger in the less knowledge-intensive sectors: the productivity of micro enterprises grew by 80 percent in the same period, while that of large corporations remained constant. Small and medium-sized enterprises exceeded their 2013 values in the same segment by 38 percent and 17 percent, respectively. Knowledge-intensive services are key to long-term productivity growth, and thus it is worth monitoring the performance indicators of the enterprises in this sector. In this area, micro enterprises, small enterprises and medium-sized enterprises improved their productivity by 65 percent, 40 percent and 3 percent, respectively. The productivity of large service provider corporations contracted by 12 percent in the period under review.

Chart 1-23: Cumulative change in labour productivity based on enterprise size and the knowledge-intensive nature of the service sector between 2013 and 2018



Note: Pursuant to the European statistical regulations, along the common principles and guideline ensuring the confidentiality of the data used (due to the confidential nature of data), the Eurostat publishes no data in certain sector-size categories.
Source: MNB calculation based on Eurostat and HCSO data.

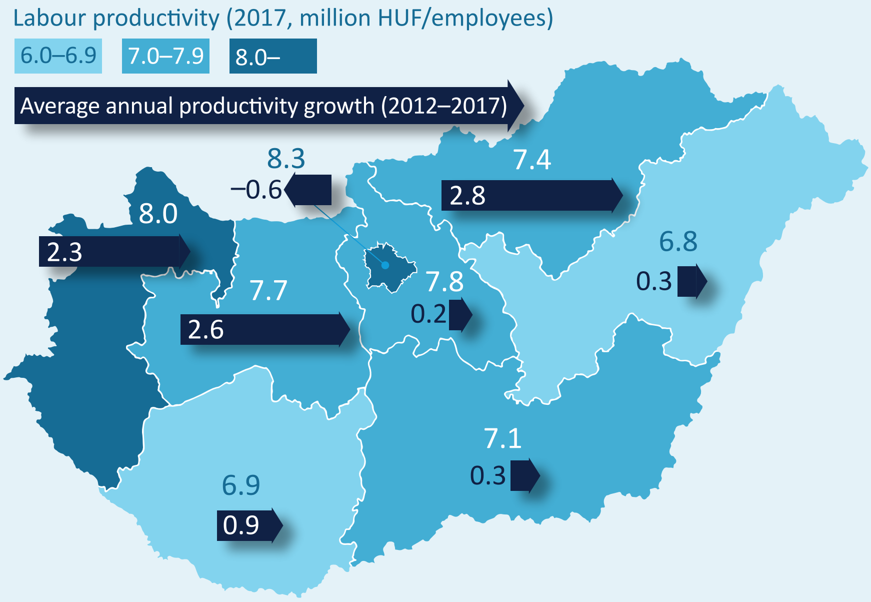
1.4.5. Regional heterogeneity

When examining the regional structure, Hungary is characterised by polarisation in terms of productivity: labour productivity in the regions of Central and Western Hungary exceeds the values registered by the eastern and southern regions (Chart 1-24). Since the labour productivity figure is suitable for international comparison, it can be also used for comparing the productivity of regions within the country. We examine real value added and employment ratios of the NUTS2 regions (Nomenclature of Territorial Units for Statistics) and of the capital, and the change therein over time, between 2012 and 2017. The comparisons of the levels were prepared based on data related to 2017. The highest productivity level was registered in Budapest (HUF 8.3 million/person), closely followed by the productivity of Western Transdanubia (HUF 8 million/person). Accordingly, the territorial distribution of labour productivity is uneven in the north-south direction, one consequence of which is the continued migration of labour force to the northern regions.

Between 2012 and 2017 no general territorial convergence could be observed. The highest dynamics were achieved in the Central and Western Transdanubia regions and in Northern Hungary. The performance of the three regions exhibiting high growth is attributable to the expansion of manufacturing. Between 2013 and 2017, manufacturing accounted for 65 percent of the growth, on average, in these regions, while the national average was around 20 percent.[10] Between 2013 and 2017, manufacturing employment grew by 43,000 persons in these regions, while it accounted for 40 percent of the manufacturing expansion in the country as a whole. The increase in employment is attributable almost in full to large manufacturing corporations. As the largest manufacturers in Hungary, Audi Hungária Zrt. in Győr and Robert Bosch Elektronika Zrt. based in Hatvan accounted for 6 and 4 percent of the growth in headcount, respectively. In the period under review, manufacturing accounted for roughly half of the investments, and thus the growth contribution of the sector was essential also on the expenditure side.

10 It should be noted here that the Structural Business Statistics (SBS) and the national accounts used for the calculation of regional performance show different figures for the growth contribution of manufacturing. The first shows a growth contribution of 14 percent, while the latter 25 percent.

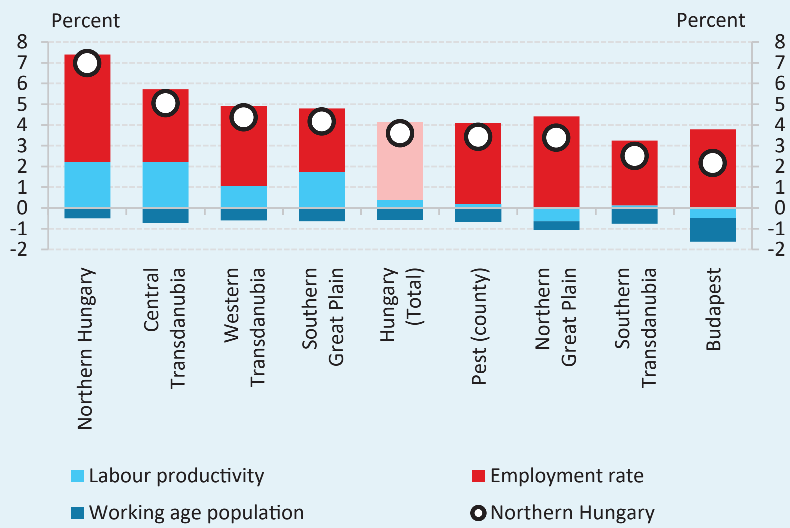
Chart 1-24: Labour productivity by regions and annual average growth in real labour productivity



Note: Changes in labour productivity are calculated by regional real value added.
Source: MNB calculation based on Eurostat data.

In addition to the expansion in manufacturing, the performance of the Central and Western Transdanubia and the Northern Hungary regions was determined by the strong growth in the employment rate. Following the labour market reforms that started in 2010, the number of people in employment rose in all three regions, despite the unfavourable developments in the underlying demographic trends. In Northern Hungary, the Southern Great Plain and the Central Transdanubia regions, productivity also made major contribution to the convergence of the regions (Chart 1-25).

Chart 1-25: Decomposition of growth in GDP per capita by regions, 2012–2017



*Note: the working age population includes the 15–64 age group. GDP/total population = (GDP/employees) * (employees/working age population) * (working age population/total population). The analysis included the internal migration processes; no separate calculation was performed for this.*
Source: MNB calculations based on OECD.

1.5 Structural factors determining productivity

Of the structural factors determining productivity, first we examine to what extent the productivity growth of the SME sector can be related to the degree of the sector's embeddedness in the Hungarian economy. Secondly, we examine the role of capital investments, focusing on the roles of sector-specific capital-labour substitution. Thereafter, we shed light on the human resource aspect of productivity, relying on the results of a new survey. Based on results, we can find an answer to the rarely asked question as to which human capabilities influence productivity. The analysis touches upon exposure to automation and also covers the relation between the maturity and productivity of enterprises, taking into consideration the specific features of the sectors. Finally, the last subsections examine the role of the external trade activity (particularly of exports) and research and development in respect of productivity. (The efficiency of R&D and innovation is examined in the next section).

1.5.1. Relation between embeddedness and productivity

The production of corporations may be determined by the production function based on the classic factors of production or with the use of the corporate input-output relations. Compared to the classic production function, the advantage of accounting based on productive inputs and the relation describing it is that the impact of the changes affecting certain enterprises can be also estimated for the enterprises in a commercial relationship with the given company. Productive inputs include products and services purchased from other enterprises (sectors), but do not include capital goods (investments). The specialist literature refers to the production model as the Leontief production function.[11]

Box 1-3: Input-output tables

The analyses in this section rely strongly on the input-output tables. The biggest advantage of the input-output tables is that they reveal not only the direct relations of certain sectors, but – due to the mutual relations – even supplier relations of any level can be estimated, and due to this it is also possible to calculate the Leontief production function.[12] With the table, after performing the appropriate transformations, multipliers can be calculated, which help determine the degree to which individual sectors' production relies on domestic resources (on goods and services in this model framework).[13] In this subsection, we present one of the many possible uses of the Leontief model. Other manners of use are presented by Koppány (2017) or the UN (2018), for example. Since the compilation of such macro-level databases requires numerous data sources and expert estimations, the European statistical offices compile tables suitable for this only every 5 years.[14] In Hungary, the HCSO also prepares such a table, entitled Balance of Sectoral Relations, while the international specialist literature usually refers to it as a (symmetric input-output, IO) IO table. In this subsection, the calculations are performed on the basis of the latest (2015) input-output tables (Chart 1-26).

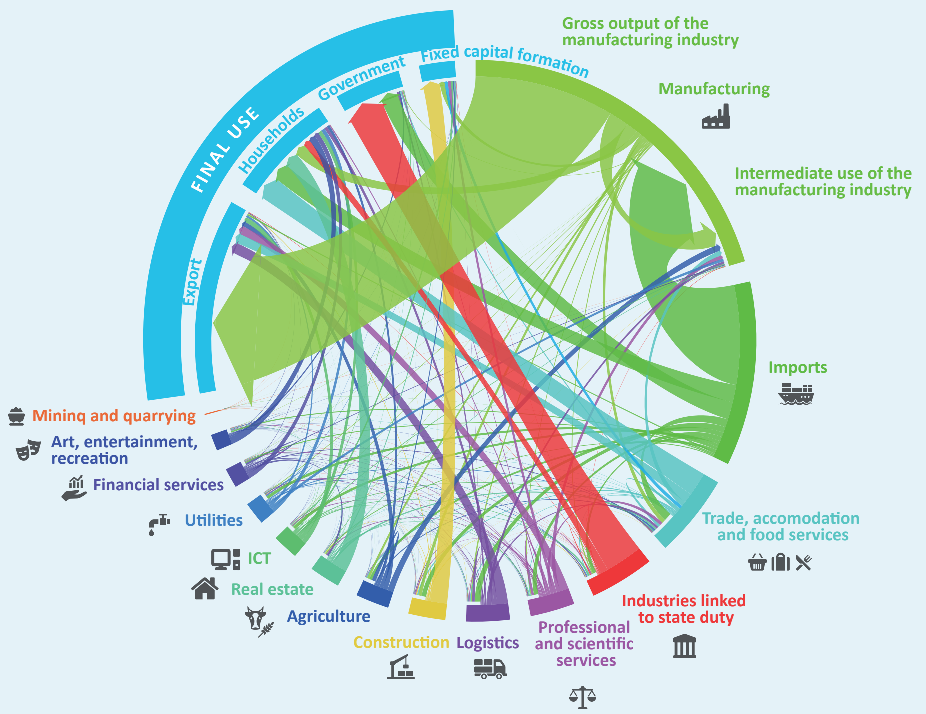
11 Apart from the foregoing, what distinguishes the Leontief model from Cobb-Douglas functions is that the factors of production (i.e. inputs re-quired for intermediate consumption) are not interchangeable, i.e. the technology is constant.

12 In this section we present only the demand side (Leontief) multipliers, but it is also possible to calculate from the tables supply side multiplier (Ghosh multiplier).

13 It is possible to calculate multipliers due to the mutual relations. In the input-output tables, the outputs of sectors come to same amount in the direction of column (intermediate consumption) and line (supply and end use), and due to this the model is symmetric.

14 For the sake of accuracy, it should be noted here that the resource and use tables containing the industry and sector resource-use data are prepared annually, but these also only come about with a lag of 3 years.

Chart 1-26: Scaled presentation of the Hungarian economy's industrial and sectoral relations in 2015 based on input-output tables



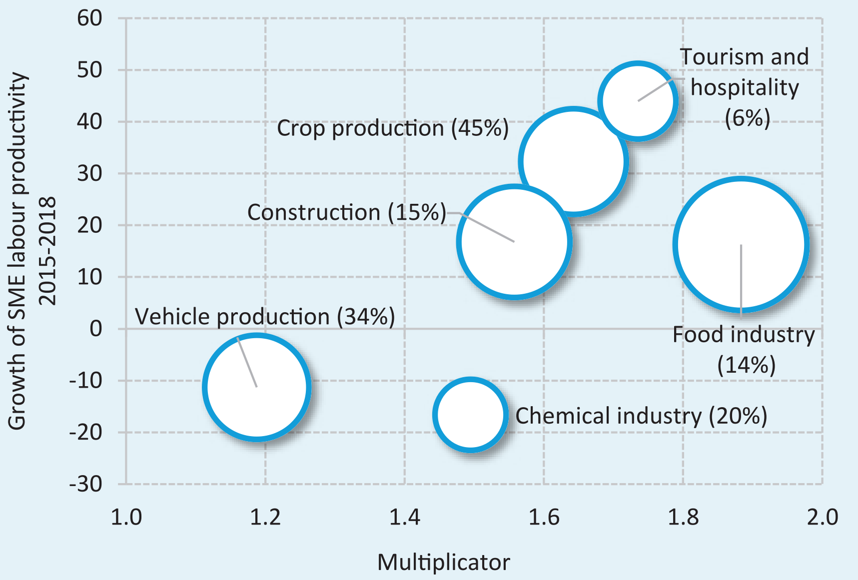
Source: MNB based on HCSO (prepared with Circos Online software).

Based on the input-output tables, compared to the size of the sector itself it is the engineering sectors (primarily vehicle manufacture, electronics) of manufacturing that have the fewest domestic relations, while the market service sectors have the largest partner network. Accordingly, the first group's demand side multipliers are typically low, while those of the latter are higher.

The hypothesis examined is that the more typical it is for a sector that based on its intermediate consumption it is well embedded in the domestic economy, the more likely it is that through mutual supplier relations the productivity of SMEs increases, reinforcing each other (multiplier effect). The horizontal axis of Chart 1-27 shows the demand multipliers. For example, if we increase the output of construction by 1 unit, it results in further output of 0.78 unit (i.e. in addition to the original increase of 1) in the economy. To support this assertion, we would need data showing the relations between enterprises in full; however, no such database is available to us. Accordingly, a validity check from the data of the input-output tables was performed for those sectors that have significant weight in domestic trade for production purposes. Seven industries were selected.[15] The criteria of the analysis was the real productivity increase of SME in pairs with the multipliers calculated from the input-output tables. We omitted the trade sectors (wholesale trade, retail trade, vehicle trade) from the analysis, since these mostly act as intermediaries between the individual industries and sectors.

15 The HCSO prepares the industry aggregation for 88 industries, grouped in 64+1 sectors in line with the Eurostat recommendations.

Chart 1-27: Real productivity growth of SMEs and correlation of sectoral multipliers



Note: The ratio of trade within the industry as a percentage of the total domestic intermediate consumption is shown in brackets. The size of the circles indicates the extent of the sector's domestic supplier relations.
Source: MNB calculations based on HCSO.

In recent years, tourism – which operates with low import intensity (with high domestic use) – and cultivation exhibited considerable productivity growth in the SME segment, i.e. their multiplier effects were able to succeed. By contrast, the productivity of vehicle industry – producing with high import use – decreased. In line with our preliminary expectations, the identified statistical relation highlights the importance of domestic relations in the productivity of small and medium-sized enterprises (Chart 1-27).[16]

The manufacture of transport equipment deserves special attention, since its weight in GDP is almost 5 percent, but its growth contribution – together with the second-round spillover effects – was much higher than that, about 18 percent in the past 6-7 years. The high import intensity of vehicle manufacturing (over 65 percent) implies that the share of domestic supply is still very low. The productivity of the sector is high, but in terms of its dynamics, the productivity of not only the SMEs but also of the large corporations declined between 2015 and 2018. In the sector, the large company segment increased its number of employees by more than 16,000 persons in the period under review, which implies that during the decline in productivity between 2015 and 2018 the sector was in an extensive growth phase (which inevitably undermines productivity), and thus no decline in performance occurred.

The performance of the sectors presented in Chart 1-27, which are characterised by higher multipliers, is mainly explained by the expansion in domestic use registered in the past two years. In 2017 and 2018 (as well as in 2019), the growth contribution of domestic use items (consumption, investment) exceeded 100 percent, and within that households' growth contribution was close to 50 percent. Dynamic household consumption may have made its effect felt mostly in tourism (and in trade, not included in the chart), and this sector may have also provided additional demand for food industry products.[17] Apart from the macroeconomic factors, government measures may have also had major effect on the sectors under review (e.g. cutting the VAT on housing, EU grants, FGS).

16 We also performed the calculation for 49 sectors, and the correlation disappeared. Disappearance of the correlation is influenced by the size of the sectors and also by the fact that for the smaller sectors many missing data are based on own estimates.

17 Naturally, the surplus in consumption in the past 2-3 years was felt not only in the accommodation and catering sectors. Partly in line with the housing market cycle, and partly due to the rebound in the previous consumption trend, purchases of consumer durables increased significantly. At the same time, these products generate little demand for the economy since they are typically import goods, and thus the multiplier could be interpreted through the trade sector. Since the sector's activity is not a productive activity in the classical sense but rather intermediates between the industries and sectors, we left it out from the analysis.

1.5.2. Capital-labour substitution

Industry trends

One way of raising productivity is to increase capital intensity, which may also be suitable for substituting physical labour. The general opinion that part of human activities can be substituted by mechanisation became an inseparable consequence of the industrial revolutions, which ultimately resulted in higher welfare at the economic level, partly due to the growth in productivity. The jobs that may be substituted by mechanisation are usually of medium productivity. On the other hand, when the technology introduced requires high qualification, the productivity of these employees rises since the advantages stemming from the new technology are enforced by qualified workers in the production process. In service sectors with low productivity, it is difficult to substitute labour with mechanisation (robotisation), which is partly attributable to the complex communication skills necessary for the rendering of services (MNB, 2017). As a result of the foregoing, technological changes reorganise the labour market in a specific way. Demand for skilled labour performing the supplementary work for the technology increases, but the labour supply appears to be limited in these special fields, and thus the process has a wage-increasing effect. Therefore, the increased productivity generates surplus income, which – as a spillover effect – increases demand for services, and through that labour demand for employees rendering the services. Consequently, wages in the service sectors also grow, which gives rise to labour force migration from the fungible sectors of medium productivity. Ultimately, the ratio of employees in the middle of wage distribution, performing routine tasks, declines in the labour market until such time as their wages are raised significantly.

Capital deepening supported growth in labour productivity in the vast majority of domestic industries (Chart 1-28). Labour productivity increased to the largest degree in manufacturing in the period 1995–2017, supported by major capital deepening (in the period under review, the capital-to-labour ratio rose by more than 230 percent). In 2017, employment in industry is almost the same as 25 years ago. Employment trends in construction show cyclicality. In this sector, the capital-to-labour ratio rose together with employment.

Chart 1-28: Changes in capital-labour ratio, labour productivity and employment over time (1995–2017)

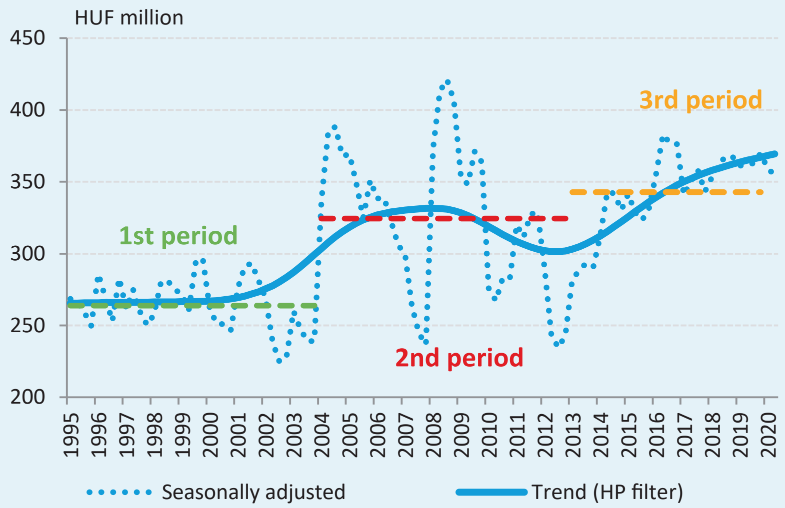
	Capital-labour ratio	Labour productivity	Employment
Manufacturing	+233.7	+1114.3	-5.4
Construction	+31.4	+201.9	+37.4
Wholesale and retail trade	+70.5	+72.9	+36.3
Transportation and storage	+32.3	+108.9	-9.6
Accomodation and food service activities	+22.4	-25.5	+46.9
ICT	-57.3	+194.8	+100.4
Agriculture	+77.1	+384.3	-41.7

Note: Capital stock is the net value of machine stock.
Source: MNB calculations based on Eurostat and HCSO.

Naturally, the role of labour in production is greater in services. The specific physical capital requirement is substantially lower compared to industry. Trend growth in employment can be observed in the trade sector; however – just like in construction – productivity may improve along with this as well, if the profit margin of the sector increases or profit margin improves. The sector operated with a capital-to-labour ratio exhibiting trend growth, and was able to increase its productivity at the same proportion. In the transportation and storage sector, the capital-to-labour ratio rose dynamically in conjunction with increased capital raising between 1995 and 2017, while the number of employees in the sector declined. This field is particularly affected by the automation megatrends: at present, machines are able to perform in full or in part even the non-routine work processes (e.g. Amazon also uses robots for warehousing). Accordingly, capital-labour substitution was realised in the logistics sector as well, but the degree thereof fell short of that observed in manufacturing. Major efficiency increasing potential can be identified in the accommodation and catering sector, indicated by decreasing labour productivity in addition to the capital and labour expansion. In contrast to the service sectors mentioned before, there is a special phenomenon in the infocommunication area: the productivity of this sector increased with rising employment and decreasing capital intensity. This is attributable to the fact that information technology prices have declined significantly. Thus, the sector was able to sharply increase its human capital stock while at the same time reducing the unit costs of its asset requirements.

Agriculture was characterised by capital-intensive efficiency growth. Similarly to manufacturing and transportation and storage, capital per employee rose in the sector in parallel with labour productivity, while employment fell by more than 40 percent. The volatility of production in the sector declined, while profitability increased from 2013 (Chart 1-29). Growth in mechanisation may have also been substantially supported by the FGS loans starting from 2013.

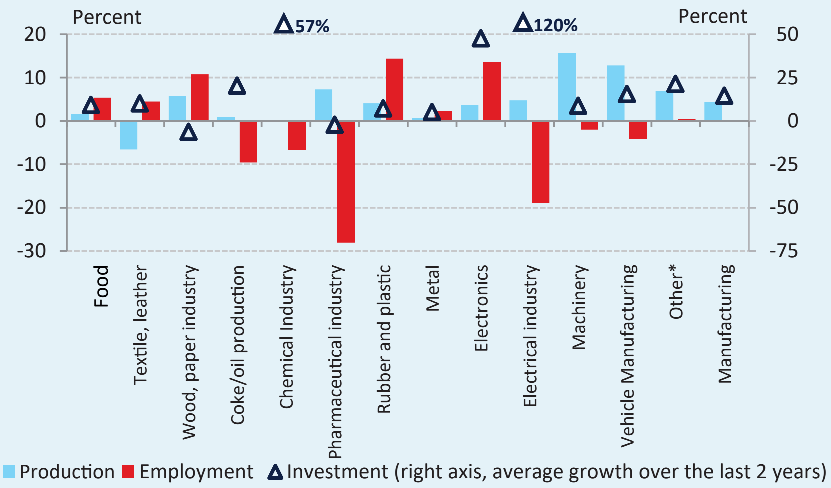
Chart 1-29: Real value added of agriculture at constant prices (2005)



Note: The dotted line indicates seasonally adjusted data.
Source: MNB calculations based on HCSO.

In 2018–2019, capital intensity growth accelerated, which was reflected by the investment ratio reaching a high level. The investment ratio was 25.2 percent in 2018 and 28.6 percent of GDP in 2019, putting Hungary in the vanguard of the European Union. In addition to the favourable prospects, the increase in capital intensity was caused by the tightness of the labour market and almost full employment. This was particularly the case, for example, in the chemical industry, electric industry and in the manufacture of machinery and transport equipment (Chart 1-30).

Chart 1-30: Annual change in production factors in manufacturing (H1 2019)



Note: Other category contains Manufacturing of furniture, machine repair, other manufacturing.
Source: MNB (2019b): Inflation Report, December 2019.

Thus, on the whole, the substitution of labour force by capital was most characteristic in agriculture. At the same time, capital intensity deepened significantly in a wide range of sectors. Productivity growth typically fell short of this, confirming the lower level of capital's production elasticity. Looking ahead, developments in the labour substitution process will depend on labour force supply conditions and the exposure of the respective industry to automation trends. In the next subsection, we analyse the latter, primarily examining this question in terms of human capabilities and jobs.

Automation and robotisation

Over the longer term, technological progress may also significantly change the level of productivity through robotisation and automation. In recent years, increasing numbers of attempts have been made to quantify the specific effects of automation. The main question examined by researchers is: Based on present structure of the labour market, which jobs (and consequently which industries and countries) are exposed to technological changes? (The efficiency of digitalisation and the importance of automation are dealt with in Section 3).

Calculating the impact of automation for the US labour market was first attempted by Frey and Osborne (2013): they came to the conclusion that 47 percent of the occupations are exposed to negative effects stemming from automation in the next one or two decades. Going beyond the earlier mainstream opinion of researchers, Frey and Osborne postulated that new technologies (e.g. machine learning) permit the programming not only of routine tasks but that tasks can be automated even beyond that. They assigned the skills that will not be replaceable by machines in the foreseeable future to three categories: manipulative and perceptive tasks, tasks requiring creative intelligence and tasks requiring social (emotional) intelligence. The authors determined how susceptible certain jobs are to automation and concluded that the repetitive routine occupations are exposed the most to the risk of termination (telemarketing operators, data entry clerks, repairers of watches, etc.), while technical controllers, nurses and recreation organisers are exposed to the least risk in the private sector (Frey-Osborne, 2013).[18]

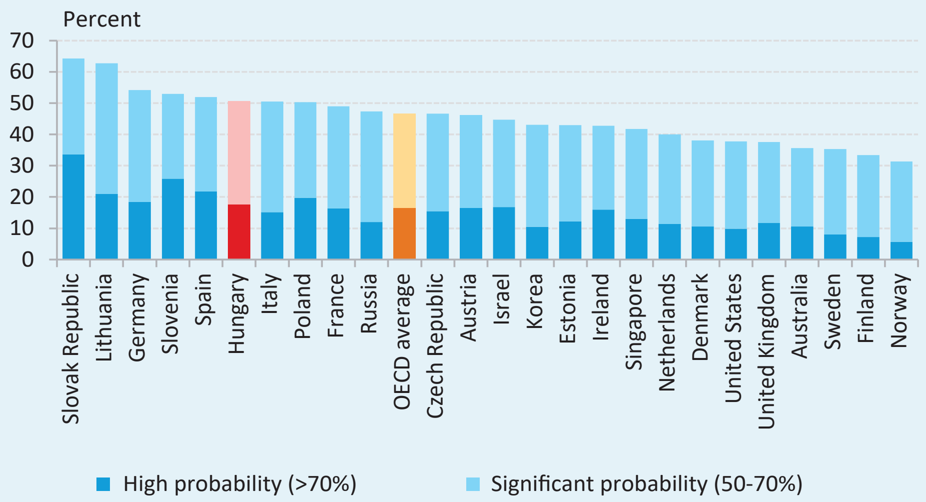
In their 2017 study, analysts at McKinsey came to the conclusion that roughly 60 percent of occupations can be automated to a degree of at least 30 percent. In their estimation, in the USA 46 percent of the working time could be saved with the use of already existing technologies. They estimated the hourly wage of applying the new technologies at USD 20/hour. An important inference they made is that it is not possible to take the simplicity of the jobs as the basis when examining exposure to automation, since even simple jobs may be complex for a robot.

18 It should be noted here that the occupation-based analysis (as the one also conducted by Frey and Osborne) carries risks, since occupations (particularly the larger groups, e.g. office and administrative support) may vary significantly even within the same occupation code, and thus the best results can be clearly achieved by analysis at the fundamental level.

Arntz et al. (2016) concluded that at present in the developed world one third of employees have complex problem-resolution skills. The OECD conclusion in this respect is that the better teaching of basic IT skills alone is not sufficient for labour market adjustment and it is equally important for IT professionals to be able to become specialists in certain fields (Arntz et al., 2016). The PIAAC (Programme for the International Assessment of Adult Competencies) database provides an excellent opportunity for panel analysis of the exposure of countries to automation for two reasons. On the one hand, with the use of this database conclusions with regard to the possibility of automation can be drawn not only based on the classification of jobs by nomenclature methodology, but also based on the specific content of jobs. On the other hand, due to this the different features of the same jobs can be identified from country to country. This is necessary, because even those performing similar office jobs work in different work cultures depending on which country they are in, and this circumstance also influences the possibility to automate. In the aforementioned research, performed in 2016 for the OECD, the authors note that in the United States the performance of work is built more strongly on personal interactions than for example in the United Kingdom or the Czech Republic, and thus cultural differences also exist between countries.

According the PIAAC data, Hungary is among the leaders in the OECD countries in the sense that most probably it will be possible to automate half of the jobs in the future (Chart 1-31). It should be noted that this ratio does not correspond to the number of jobs "disappearing" from the labour market, i.e. it does not necessarily represent capital-labour substitution. The ratio should rather be interpreted such that half of the employees will be faced with challenges posed by automation. In practice, this means that many routine tasks will be automated at certain employees, but human presence will remain necessary for some duties. Even so, certain jobs may disappear. Manufacturing may be the sector which is most exposed.

Chart 1-31: Ratio of jobs with high or significant probability of automation (2018)



Note: In Hungary, 17.6 percent of the jobs can be automated with high probability and 33 percent of them with statistically significant probability.
Source: Estimated based on OECD PIAAC, Nedelkoska, L. – Quintini, G. (2018).

It is worth examining the exposure of the V4 states, and particularly the results for Hungary, Slovakia and the Czech Republic, where manufacturing competitiveness is a fundamental aspect. The possibility of automation varies substantially, despite the fact that the size of manufacturing is similar in the three countries. Germany, also a highly industrialised country, is among the leaders in the list, preceding e.g. Hungary and the Czech Republic, i.e. the countries receiving a major part of German manufacturing FDI and, a large part of the outsourced work usually belongs to the "possible to automate" category (e.g. assembly). Of the states that joined the EU in 2004, only Estonia's exposure is below the OECD average.

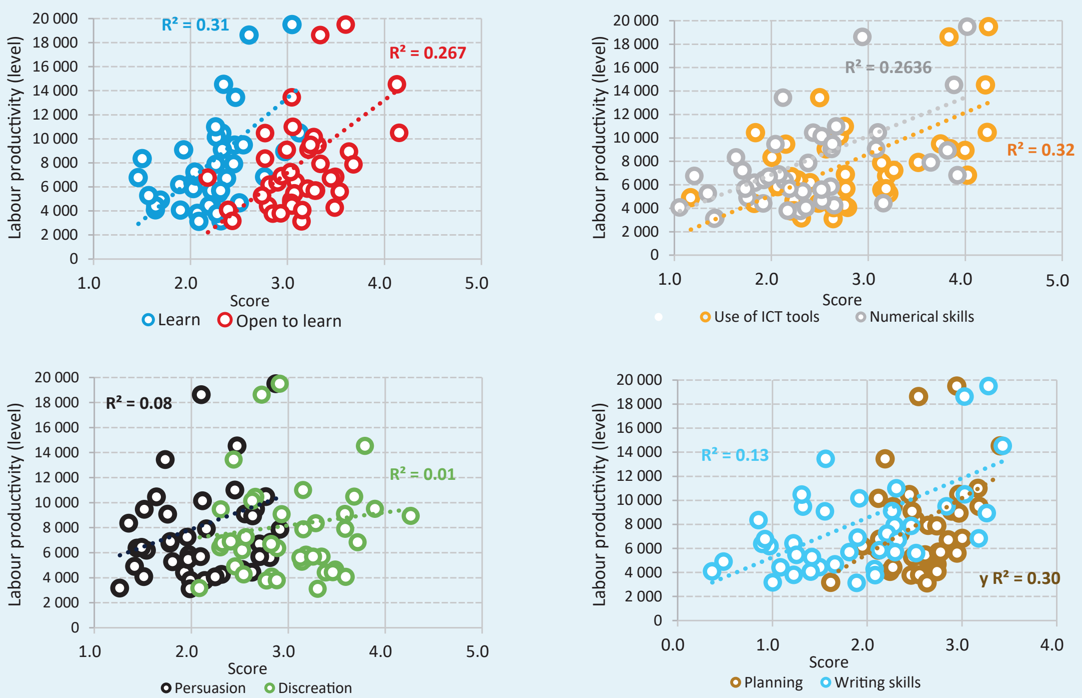
On the whole, it can be stated that automation may strongly affect Hungary, opening up two possible prospects in terms of productivity. On the one hand, as a result of automation, productivity will rise significantly in some industries (particularly in manufacturing), and on the other hand, the redundant labour force will have to find jobs in other sectors. It is the responsibility of economic policy to efficiently support the impending transformation of the labour market, primarily from the SME side.

1.5.3. Skills

The level of and growth in productivity is closely related to human capital. The rapid technological changes in the 20th century significantly increased demand for labour force with high cognitive skills. Technology has fundamentally changed even traditional jobs. However, the degree of the use of technology in similar jobs varies substantially by companies or countries. Accordingly, it is not possible to estimate productivity efficiently purely based on data coming from occupation nomenclatures.

The more skill-intensive an industry is, the higher its productivity. The first research assessing adult competencies was prepared by the OECD (OECD-PIAAC), which provides results for the comparison of certain skills and attitudes in a new perspective. As shown in Chart 1-32, the categorical variable measuring the learning level correlates positively with an industry's productivity level. Propensity for self-development is the most important driver of productivity, which has the strongest presence in the infocommunication and scientific research sectors. The application of conviction and discretion, as typical managerial skills, has the weakest connection to productivity. This may depend on the ratio of employees in management positions in the individual sectors. The use of ICT tools and the application of numeric skills increase productivity. Significant variance can be identified between sectors in respect of both variables. Employees use numeric skills mostly in the financial sector; within manufacturing, the pharmaceutical sector stands out in this respect. The use of writing and reading skills also has positive influence on productivity. Scientific research stands out in respect of both variables, while within manufacturing only in the pharmaceutical sector. The aforementioned facts clearly indicate that education and vocational training policy aimed at the improvement of general skills may increase productivity. Nevertheless, productivity also depends strongly on sector-specific factors, which we do not deal with here.[19]

Chart 1-32: Usage of skills in certain sectors, and productivity level (2018)



Note: The sample only includes sectors employing at least 20,000 persons. 44 sectors in total.
Source: MNB calculations based on OECD PIAAC.

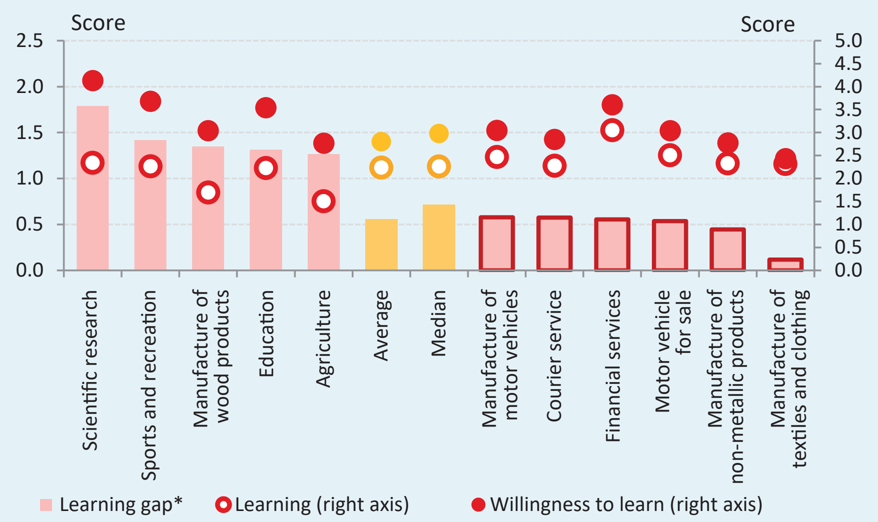
Based on the Hungarian figures, the labour force is prepared to learn and develop in most sectors (Chart 1-33). The question is whether, in addition to the opportunities, employees have adequate capacity to improve. Based on the scoring in the dimensions 'openness to learn' and 'on-the-job acquisition of knowledge and skills', we calculated the difference, which can

19 It is striking that the use of ICT tools is similarly typical for financial activity, infocommunication services and scientific researches, while the productivity of the financial sector is one third higher than that of the scientific research sector and exceeds the productivity of the infocommuni-cation sector by 85 percent.

be interpreted as a utilisation indicator. This indicator is referred to as the learning gap, which illustrates[20] how much human capital the employees of a specific sector gain compared to the degree they wish to gain. (On the other hand, the learning gap also implicitly includes employees' satisfaction with the learning opportunities.)

The attitude of the textile and clothing industry employees to the acquisition of new competences may be deemed inflexible, and employees in vehicle manufacture and financial activities are similarly reserved. At the same time, in the latter sectors the qualification level exceeds the national economy average. Substantial development potential can be identified in the sectors dependent on government orders, such as scientific research, sports and recreation, and education. At the same time, for these activities the larger learning gap is also a natural phenomenon of the sectors, as the scientific research and development and education sectors are driven by the "thirst for knowledge".

Chart 1-33: Unutilised human resource potential: difference in the willingness to learn and learning scores



*Note: *Difference between openness to learn and learning score.*
Source: MNB calculations based on OECD PIAAC.

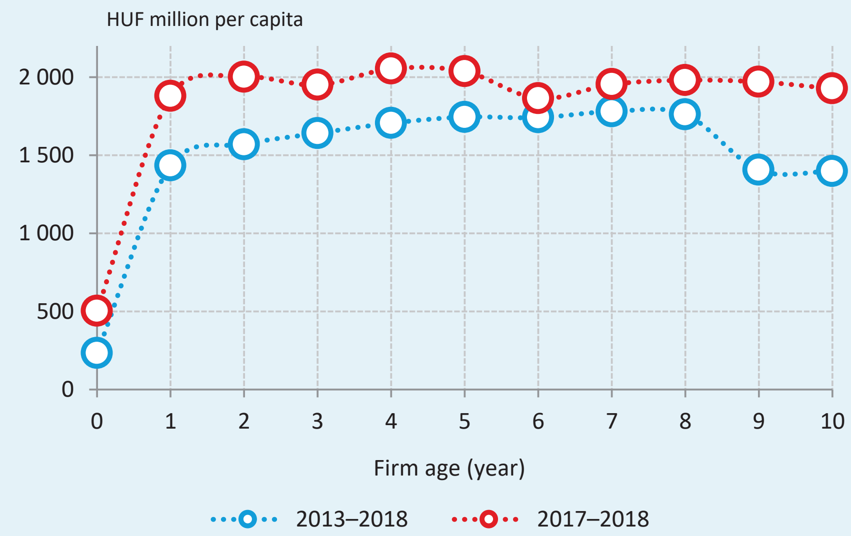
1.5.4. Relation of corporate maturity and labour productivity

In addition to the human capital and technology applied by the enterprise, the age (maturity) of the enterprise may also substantially influence productivity. With the availability of appropriate data, the age and "life expectancy" of enterprises alone permit the preparation of special analyses. In addition, the relations identified between the corporate demographic data and real economy indicators may open new prospects for corporate support and funding programmes. Correlation between the levels and changes must be always assessed and considered when performance is to be analysed based on the age of the enterprise.

According to Bauer – Endrész (2018), young enterprises are mostly micro enterprises, they grow rapidly, but at the same time the ratio of liquidated companies is higher among these firms and their productivity is lower than that of older firms. Although the share of young companies is low in aggregate output, their contribution to aggregate growth is significant and their productivity growth is extremely high.[21] This dynamism is mostly attributable to their young age, rather than to their size. The authors point out the dichotomy of the creation of value added and growth along with age. Their results show that the contribution to aggregate growth declines in parallel with the ageing of the enterprise. The most striking fact is that although the age group of 1–4 years produced merely 7 percent of the total value added, 70 percent of the growth is attributable to this group. By contrast, the firms aged 15 years created roughly half of the total value added, while their growth contribution was negligible.[22]

20 The gap indicator captures the relative relation between sectors, and thus it can be used for determining that between the employees of two sectors in which sector the potential employee human capital may be increased to a larger degree. This is an absolute scale, and thus the potential can be interpreted within industries, as the desire to develop (willingness) and the possibility to acquire knowledge differs by sectors and even by jobs.
21 Benk – Morvay – Telegdy (2018) examine the impact of enterprise age on job creation.
22 This is partly attributable to the fact that in practice these companies reached the limit of their production potential.

Chart 1-34: Labour productivity by enterprise age (2013–2018)



Source: MNB calculation based on tax and firm registry data.

Median labour productivity rises up to the age 3 for enterprises, followed by stagnation until the age of 6-7 years in the comparison of age profiles (2013–2018). Typical enterprises aged 8 years have the highest productivity, and then the older domestic companies (aged 9-10 years) once again operate with somewhat lower productivity (Chart 1-34). The domestic analyses examined the relation between age and value added (Bauer and Endrész, 2018), and between age and employment (Benk – Morvay – Telegdy, 2018) separately. Both analyses come to the following conclusions: young companies are typically small in size, and the probability of liquidation of small companies is higher, but those that survive grow faster than large enterprises, and finally, there is positive correlation between age and size. Bauer and Endrész (2018) decomposed growth between 2001 and 2015 by age groups. They found that newly established enterprises are not only small, but also extremely dynamic; they achieved high growth rates in the first few years after their establishment. For example, in the period under review, enterprises aged 3 grew by 20 percent annually on average. After the 5th and 6th years (the life cycle analyses often identify this age with the maturity of the enterprise, when companies start to slow down) the growth rate falls off significantly below 5 percent, while enterprises over the age of 10 years hardly realise any growth (max. 1-2 percent). Analysing a similar period (2000–2015), Benk, Morvay and Telegdy (2018) conclude in their assessment of age and employment that for enterprises existing for at least three years, employment in more than half of the cases (57 percent) stagnates or decreases compared to the first year. That is, only less than half of the enterprises surviving until the age of three are able to employ substantially more persons. However, growth in their case was significant: in three years they increased – their typically low – headcount by two and a half times on average. They also concluded that firms older than three years suffered an average of 1-4 percent loss in headcount in the period 2000–2015. As regards the output of enterprises, in line with the results of previous analyses, young enterprises (0-3 years) increase at a high rate. Only a few enterprises reach the age of 8-10 years. Nevertheless, the productivity of these enterprises is the highest compared to the efficiency of younger enterprises.

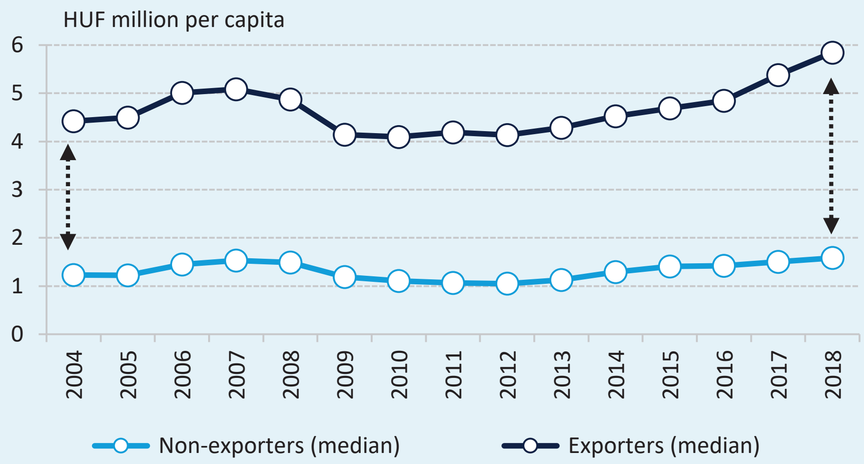
1.5.5. External trade activity

Several studies highlighted the fact that participation in external trade entails higher corporate employment, labour productivity and technological quality, and exporter and importer companies are more competitive both in foreign and domestic markets. (Bernard és Jensen, 1999; de Loecker, 2007; van Biesebroeck, 2005).[23] In the following, we present the difference between the exporter and importer companies, and discuss further findings with regard to certain sectors.

23 Section 6 of the MNB's 2018 Growth Report also dealt with the importance of external trade (MNB, 2018).

Based on individual enterprise data, the productivity of a typical exporting SME has been steadily rising since 2013, whereas after 2016 the productivity advantage of small and medium-sized exporting firms increased steeply compared to non-exporting companies. While in 2004 the difference between the exporter and non-exporter SMEs was HUF 3.2 million/person in favour of the exporting companies, by 2018 this advantage already exceeded HUF 4 million (Chart 1-35).

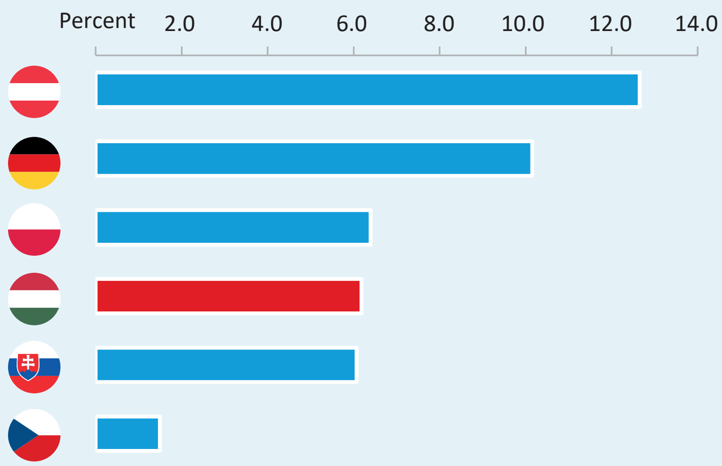
Chart 1-35: Median SME productivity by export activity (2004–2018)



Source: MNB calculation based on tax registry data.

The external trade performance of Hungarian SMEs is high in a regional comparison, but lags behind that of the Austrian and German companies of similar size (Chart 1-36). The empirical results help to answer the question of whether export market activity is conditional upon higher productivity, or it is the exports that affect productivity. According to the data, prior to entering the export market, the productivity of an SME exporting goods or services hardly falls short of the productivity of an already exporting company (by 2-3 percent) (MNB, 2018). Accordingly, exporting necessitates higher-than-average initial productivity from the outset, and the productivity advantage increases significantly further when entering the external market. The largest growth was achieved by exporters of services. Accordingly, the ratio of Hungarian exporter SMEs can grow, if – prior to entering the external market – as many enterprises as possible increase their productivity.

Chart 1-36: Share of exporter SMEs within all SMEs (2017)

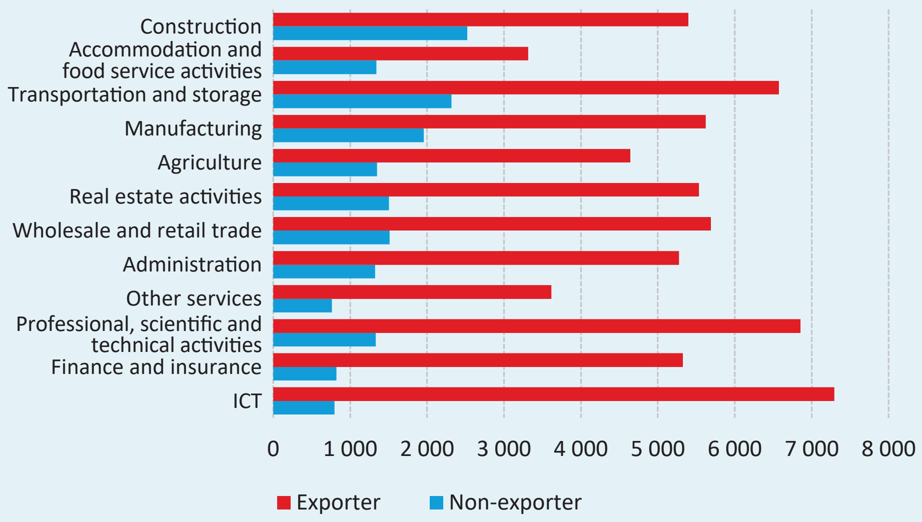


Source: MNB based on Eurostat (SBS survey).

When examining the industry data, it is apparent that there are large gaps even within industries (Chart 1-37). The productivity of a typical exporter SME was 9 times higher in the infocommunication sector than of a non-exporter SME.

The difference appears mainly in the micro and small enterprise size category. There is no significant difference between exporter and non-exporter enterprises among the medium-sized and large companies. In the external trade-oriented manufacturing, there is an almost three-fold difference between the labour productivity of the typical non-exporter and exporter SMEs. The productivity gap disappears in this sector as well for medium-sized and large firms. In the professional scientific activities and in the trade sectors, large productivity differences can be identified even in the large corporate category.

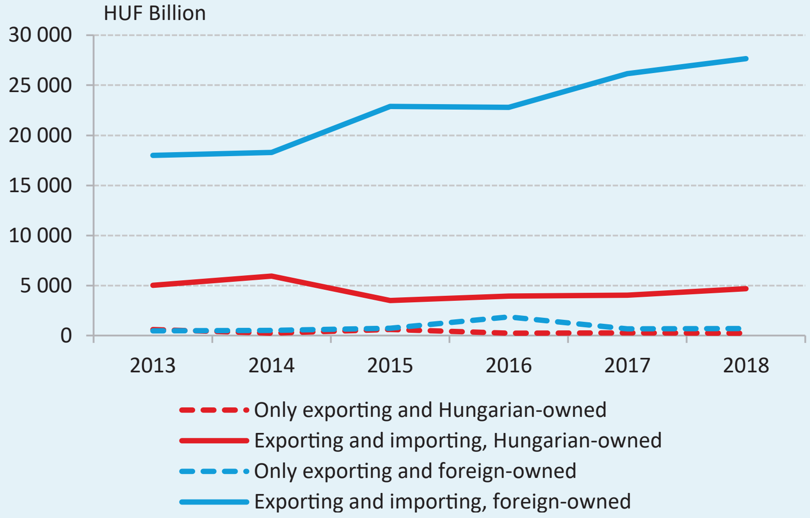
Chart 1-37: Median SME productivity by export activity (2018)



Note: based on median values.
Source: MNB calculation based on tax registry data.

Despite the fact that the recent global economic events point to a decline in world trade, the tight positive correlation with productivity is unlikely to disappear. Although over the past few years multilateral trade agreements have been undermined by a number of events in world politics, the changes are less relevant for SMEs, since SMEs usually sell to closer export markets. In the past 10 years, owing to its participation in global value chains, the export performance of the Central European region was able to grow particularly rapidly. No direct micro data sources are available with regard to the participation in such value changes. However, the productivity of enterprises with two-way external trade activity is higher than of those that only import, but do not export (CompNet, 2020). In Hungary, it is mostly the foreign-owned enterprises that are able to increase their participation in two-way external trade (Chart 1-38).

Chart 1-38: Turnover of exporter companies



Source: MNB calculation based on HCSO.

Although the export share of Hungarian companies in Hungary's total exports remains low, in the case of Hungarian-owned enterprises the contribution of SMEs increased in the period under review, as a result of which exports became less concentrated. In 2013, among the corporations engaged both in exports and imports, 54 percent of the turnover was generated by large corporations. However, over the span of 5 years, the share accounted for by large corporations rose to 60 percent. Over the same horizon, the number of Hungarian-owned enterprises generating bi-directional turnover rose by 5,000 companies, while no significant change occurred in the number of large corporations. The more balanced export performance may have contributed to the SME segment's outstanding productivity growth registered in recent years.

References

Andrews, D. – Criscuolo, C. – Gal, P. (2015): *Frontier firms, technology diffusion and public policy: micro evidence from OECD countries,* OECD Productivity Working Papers No. 2.

Arntz, M. – Gregory, T. – Zierahn, U. (2016): *The Risk of Automation for Jobs in OECD Countries: A Comparative Analysis*, OECD Social, Employment and Migration Working Papers, No. 189, OECD Publishing, Paris, Download link: https://doi.org/10.1787/5jlz9h56dvq7-en

Bauer, P. – Endrész, M. (2018): *Vállalati dinamika és aggregált növekedés Magyarországon* (Firm Dynamics and Aggregate Growth in Hungary). Hitelintézeti Szemle (Financial and Economic Review), Vol. 17 Issue 2, June 2018, pp. 68–98, Budapest. Download link: http://doi.org/10.25201/HSZ.17.2.6898

Benk, Sz. – Morvay, E. – Telegdy, Á. (2018): *KKV-k és nagyvállalatok: hogyan járulnak hozzá a munkahelyteremtéshez?* (SMEs and large corporations: how do they contribute to employment creation? Download link: https://www.mnb.hu/letoltes/benk-morvay-telegdy-kkv-k-es-nagyvallalatok-hogyan-jarulnak-hozza-a-munkahelyt-mnb-honlapra.pdf

Bernard, A. – Jensen, B. (1999): *Exceptional exporter performance: cause, effect, or both?,* Journal of International Economics 47 (1999) 1–25.

Bianchi, F. – Comin, D. – Kung, H. – Kind, T. – Matusche, A. (2019): *Slow recoveries through fiscal austerity: New insights in the effects of fiscal austerity,* ZEW policy briefs 2/2019, ZEW - Leibniz Centre for European Economic Research.

Bloom, N.C. – Van Reenen, J. – Webb, M. (2017): *Are Ideas Getting Harder to Find?,* NBER Working Paper w23782.

CompNet (2020)*: Firm Productivity Report,* OECD, Download link: https://www.comp-net.org/fileadmin/_compnet/user_upload/Documents/Productivity_Report_FINAL-.pdf

De Loecker, J. (2007)*: Do Exports Generate Higher Productivity? Evidence from Slovenia,* Journal of International Economics, 73, September, 69–98.

European Central Bank (2017): Economic Bulletin (2017) Issue 6 / 2017 – *Box nr. 1: Investment dynamics in advanced economies since the financial crisis*. https://www.ecb.europa.eu/pub/pdf/other/ebbox201706_01.en.pdf

Frey, C. – Osborne, M. (2013): The Future Of Employment: How Susceptible are Jobs To Computerisation?, Oxford Martin Programme on Technology and Employment. Available at: https://www.oxfordmartin.ox.ac.uk/downloads/academic/The_Future_of_Employment.pdf

Gordon, R. (2018): *Why Has Economic Growth Slowed When Innovation Appears to Be Accelerating?,* NBER WorkingPaper No. w24554

Hoekstra, R. (2019): *Replacing GDP by 2030.* Cambridge University Press.

Kiss, Á. – Szilágyi, K. (2014): *Miért más ez a válság, mint a többi? Az adósságleépítés szerepe a nagy recesszióban* (Why does this crisis differ from the others? Role of deleveraging in the great recession.) Közgazdasági Szemle (Economic Review), Vol. LXI, September 2014 (pp 949–974)

Koppány, K. (2017): *Makrogazdasági és regionális hatáselemzés multiplikátor modellekkel* (Macroeconomic and Regional Impact Analysis with Multiplier Models), Széchenyi István University. ISBN 978-963-06-4385-6

Matolcsy, Gy. (2015): *Egyensúly és növekedés – Konszolidáció és stabilizáció Magyarországon, 2010–2014* (Economic balance and growth. Consolidation and stabilisation in Hungary, 2010–2014), Kairosz Kiadó, 2015, Available at: https://www.mnb.hu/kiadvanyok/mnb-szakkonyvsorozat/egyensuly-es-novekedes

Matolcsy, Gy. – Nagy, M. – Palotai, D. – Virág, B. (2019): *Az infláció mibenléte – ideje a mérőrendszereinket újragondolni* (The nature of inflation - time to rethink our measuring systems), Download link: https://www.mnb.hu/kiadvanyok/szakmai-cikkek/inflacio/matolcsy-gyorgy-nagy-marton-palotai-daniel-virag-barnabas-az-inflacio-mibenlete-ideje-a-mero-rendszereinket-ujragondolni

McKinsey Global Institute (2017): *A Future That Works: Automation, Employment, and Productivity,* Download link: https://www.mckinsey.com/~/media/McKinsey/Global%20Themes/Digital%20Disruption/Harnessing%20automation%20for%20a%20future%20that%20works/MGI-A-future-that-works_Executive-summary.ashx

Magyar Nemzeti Bank (2016): *Growth Report,* Magyar Nemzeti Bank, Chapter 1, https://www.mnb.hu/letoltes/novekede-si-jelentes-2016-hu.PDF

Magyar Nemzeti Bank (2017): *Growth Report,* Magyar Nemzeti Bank, Chapter 4, https://www.mnb.hu/letoltes/novekede-si-jelentes-2017-hu-web.pdf

Magyar Nemzeti Bank (2018): *Growth Report,* Magyar Nemzeti Bank, Chapter 6, https://www.mnb.hu/letoltes/novekede-si-jelentes-2018-digitalis.pdf

Magyar Nemzeti Bank (2019a): *MNB's Competitiveness Programme in 330 points,* Magyar Nemzeti Bank, https://www.mnb.hu/letoltes/versenykepessegi-program.pdf

Magyar Nemzeti Bank (2019b): I*nflation Report,* Magyar Nemzeti Bank, December 2019.

Nedelkoska, L. – Quintini, G. (2018): Au*tomation, skills use and training*, OECD Social, Employment and Migration Working Papers, No. 202, OECD Publishing, Paris, https://doi.org/10.1787/2e2f4eea-en

OECD (2019): *Skills Matter: Additional Results from the Survey of Adult Skills,* OECD Skills Studies, OECD Publishing, Paris, https://doi.org/10.1787/1f029d8f-en

Szigeti, C. (2015): *Az ökolábnyom és egyéb fenntarthatósági indikátorok mérési tartományának értelmezése* (Interpretation of the measurement range of the ecological footprint and other sustainability indicators), Journal Of Central European Green Innovation 3 (1063-2016-86232), pp. 49–68

Szoboszlai, M. – Bögöthy, Z. – Mosberger, P. – Berta, D. (2018): *A 2010–2017 közötti adó- és transzferváltozások elemzése mikroszimulációs modellel* (Assessment of the tax and transfer changes in Hungary between 2010 and 2017 using a micro-simulation model), MNB Occasional Papers, No 135

UN (2018): Handbook on Supply, Use and Input-Output Tables with Extensions and Applications, Handbook of National Accounting. United Nations, New York. eISBN: 978-92-1-0

Van Biesebroeck, J. (2005): *Exporting Raises Productivity in sub-Saharan African Manufacturing Firms, Journal of International Economics,* December, 67(2): 373-391.

Virág, B. (ed.) (2019): *A jövő fenntartható közgazdaságtana* (Long-term Sustainable Econo-mix), Magyar Nemzeti Bank, Budapest, Subsection 2.3. ISBN: 978-615-5318-28-3, Available at: https://www.mnb.hu/kiadvanyok/mnb-szakkonyvsorozat/a-jovo-fenntarthato-kozgazdasagtana

Virág, B. (ed.) (2020): *Trianon 100 – Tízszer tíz év számokban* (Trianon 100 – 10 x 10 Years in numbers), Magyar Nemzeti Bank, Budapest. ISBN: 978-615-5318-37-5, Available at: https://www.mnb.hu/kiadvanyok/mnb-szakkonyvsorozat/trianon-100

2 Efficiency of innovation

The relationship between productivity and innovations has a long history in economic literature. The growth models appearing in the 1990s highlighted the fact that the efficiency of the innovation system may also change both in time and space. The efficiency of the innovation system is meant to indicate how efficiently R&D expenditures and researchers are able to create new knowledge, new patents and new studies. Our analysis points out that the Hungarian innovation performance is implemented with low returns in parallel with continuously increasing expenditures, and thus the efficiency of the innovation system is low in an international comparison.

As regards changes in innovation expenditures over time, the picture is basically favourable, i.e. the expenditure figures are mostly increasing. On the output side, the trend is less favourable compared to expenditures: the ratio of innovative enterprises shows a declining trend and, in parallel with this, the registration of intellectual property rights is also decreasing. However, considerable improvement was achieved in the science citation index and in the number of business intellectual property protections (trademark, design patent). The gazelle index capturing fast-growing enterprises also reflects favourable trends.

Comparing Hungarian innovation efficiency internationally, a substantial deficit can be identified compared to the EU average. On the one hand, the increasing research and development expenditures result in a decreasing number of patents, and thus the Hungarian ratio is below the V3 average and substantially falls short of the EU average. Although the number of design patents and trademark protections, as an indicator which captures market innovation, appears to be catching up (we compared the submissions with knowledge-intensive employment), Hungary's lag compared to the V3 and EU average remains substantial. Nevertheless, positive trends can be also observed: as regards the citation indices, mostly due to life sciences (primarily to medical sciences), Hungary reached the EU average in recent years, elevating Hungary's performance to first place in the Visegrad region. Within Europe, there is still a large gap between the leader innovators and follower countries. Hungary's region belongs to the latter group, while the Scandinavian states and the Netherlands have been in the vanguard for many years.

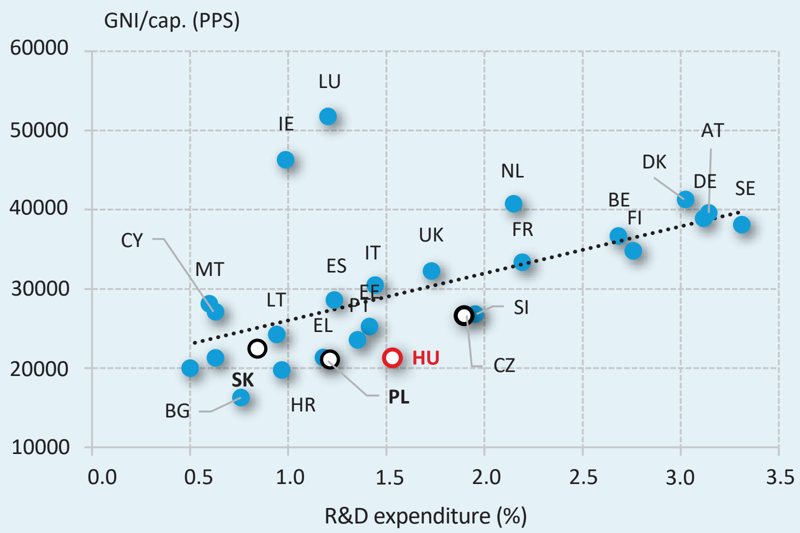
We also qualified the shortfall in an international comparison separately, with a non-exhaustive list of factors. The most important hindering factor is the fragmentation of the innovation system. Fragmentation can be observed in the relatively weak relations of production between knowledge-generating sectors and other sectors as well as in the high ratio of knowledge import in production. Trends are also deteriorating in the number of co-operations. No innovation premium can be identified at foreign-owned companies, which are responsible for the core of Hungary's innovation performance, which also reduces systemic efficiency. In addition, SMEs' low innovation performance is also a systemic hindering factor.

2.1 Introduction

Economics regards innovation as one the most important explanatory factors (driver) of productivity. The relationship between productivity and innovation has a long history in the economic literature. Economic history first links the recognition of the importance of innovation to Joseph Schumpeter, who – contrary to the then-mainstream neoclassic economic theory – explained economic cycles with the endogenous role of innovation (Schumpeter, 1939). Griliches (1979) was the first to deal with functions formalising knowledge generation, but the real breakthrough was achieved with the model of Romer (1990), where the increasing return characterising the R&D sector resulted in an endogenous growth path in the economies. Based on the time series analysis of Jones (1995), diminishing returns are typical also in the R&D sector, as evidenced by the latest research as well (Bloom et al., 2017). Slightly amending Romer's model, Jones (1995) concludes that although the results of innovation are important and the role of innovation can indeed be identified in the time series data, over the longer term the growth rate can be mostly explained by the exogenous indicators, such as the growth in population. Accordingly, the efficiency of research and development is critical for the long-term dynamics of the economy. It is also worth capturing knowledge in the spatial aspect. Varga (2009) analyses the importance of this, setting out from the assumption that knowledge is limited in space, and thus the spatial structure become a fundamental factor of innovation. Varga also points out that the nature of innovation and the entity implementing it as well as the industry delimits the penetration of innovation.

The impact of innovation on corporate performance was examined on Hungarian data by Halpern and Muraközy (2010), confirming that there is a causal relationship between the two processes (Halpern–Muraközy, 2010). Based on their research using corporate micro data, innovative enterprises are more productive, and are more likely to participate in external trade and export to more countries. Valid results for micro data can also projected on macro data: the more developed an industry or economy is, the more likely it is to spend more on innovation (see e.g. the summary by Griffith (2000)). Chart 2-1 presents the EU countries in this regard. Apart from two economies in special position, i.e. Ireland and Luxembourg, this correlation is also valid in relation to the EU Member States. In Hungary, and typically in the other V4 countries, enterprises spend more on R&D than would be justified by their level of development.[24] At present in Hungary, 1.5 percent of GDP is spent on R&D, which exceeds the average of the Visegrad region, but falls short of the EU average of 2.2 percent.

Chart 2-1: Ratio of R&D expenditures and GNI per capita (2018)

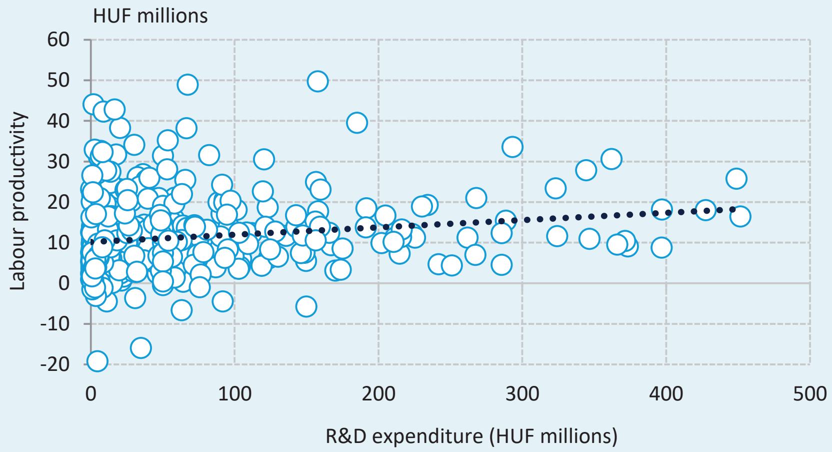


Note: Gross national income (GNI) per capita calculated at purchasing power parity (PPS).
Source: MNB based on Eurostat data.

The impact of R&D on productivity depends on the efficiency of the system, rather than on how large the amounts are. Based on Canadian data, Tang and Wang (2019) found that R&D improves (multifactor) productivity, but the actual effect depends on the efficiency of R&D, rather than on the amount spent on development. Accordingly, it is not surprising that the larger a company is the more it can spend on R&D, but not all companies are able to achieve results with the same efficiency. Based on the foregoing, a moderate positive relation between productivity and R&D appears to be logical, which we can also prove using Hungarian data on Chart 2-2. The result is in line with the international micro analysis experiences (e.g. Ugur et al., 2016 or Baumann – Kritikos, 2016).

24 One obvious reason for this is the gap between the income produced and received, i.e. the GNI/GDP ratio, which is typically below 1 in the Member States that joined the EU from 2004. The outflow of income may be related to FDI income. Another interesting point is that in these countries foreign companies spend the most on research and development, i.e. the very companies that are also responsible for a large part of the GDP-GNI gap.

Chart 2-2: Business R&D expenditures and labour productivity (2018)



Note: Outliers are excluded. R&D expenditures are based on data provided by the National Tax Authority (NCTA, tax base deductions for R&D items).
Source: MNB calculations based on data from NTCA reports.

In this section, first we review the performance and efficiency of the Hungarian innovation system based on times series, and then compare the Hungarian results with similar data from the region. In the second part of the section, we provide a supplementary explanation with regard to the trend processes. Our results show that Hungarian innovation efficiency currently lags substantially behind the EU average, but this also applies to the entire region. Fragmentation of the innovation processes is one of the important explanations, which appears mostly at enterprises and particularly in relation to cooperation between enterprises.

In 2018, the estimated number of corporate research centres was around 2,000 in Hungary, with innovation performed by roughly 10,000 enterprises. Innovation was performed by about one quarter of the enterprises with more than 10,000 employees, while only 5 percent of them pursued research.[25] In parallel with increasing company size and more active exports, firms are more likely to pursue development and/or innovation activity. Moreover, pursuing innovation is more common among foreign-owned companies (Halpern – Muraközy, 2010).

2.2 Differentiation of the innovation procedure

Innovation is a multifaceted process, which can include many activities ranging from creating the basic correlations of knowledge to implementing new organisational structures. As such differentiation is overly wide-ranging based on too many criteria both for the purposes of analysis and policy planning, research, development and innovation are usually separated in practice and their efficiency is also interpreted separately. In the earlier, traditional approach to R&D, research precedes or advances innovation. Research and development is one of the most important value-creating phases leading to innovation, essentially characterised by utilisable results obtained by using scientific methods (MNB, 2018: 128). The internationally agreed guidelines of the OECD were also transposed into the legislation of all European countries, and thus Act CXXXIV of 2004 on Research and Development and Technological Innovation differentiates the following areas of research and development;

- basic research: experimental, empirical, systematising or theoretical work undertaken to expand scientific knowledge related primarily to the essence of phenomena and observable facts;
- applied (or industrial) research: original investigation undertaken to acquire new knowledge primarily for a specific practical objective;

25 In order to estimate the number of innovating enterprises, we used the HCSO's enterprise database for 2018 as a basis, in which the projection base included enterprises with more than 10 persons. According to the statistical office's website, the ratio of enterprises pursuing innovation is 25.5 percent within the total sample, and thus the figure of 9,620 enterprises is obtained from a total of 37,722 enterprises.

- experimental (or pre-competitive) development: an activity drawing on existing knowledge gained from research and/or practical experience, with the aim to produce new materials, products, processes, systems, services or to substantially improve existing ones.

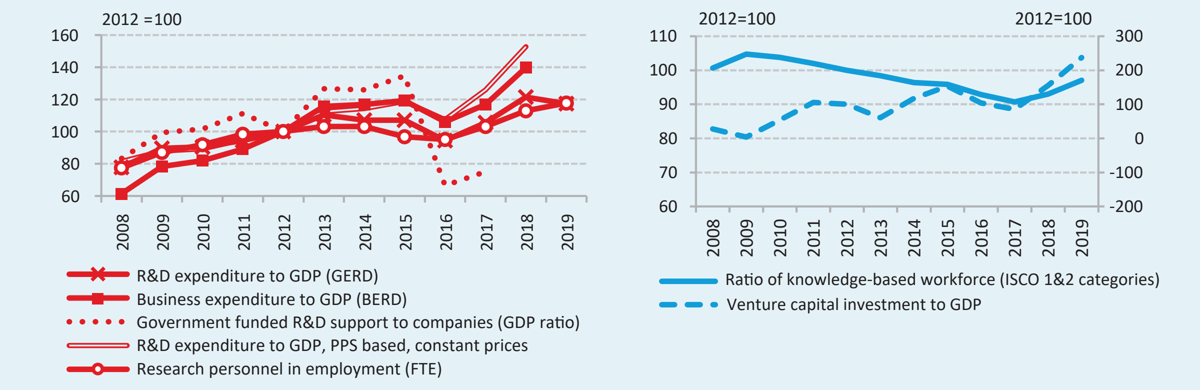
Based on the list above, not all R&D activities are aimed directly at the creation of finished products, registration of patents or the subsequent utilisation of such. In creating the ratios measuring innovation efficiency, it should be ensured that the time series used as the input and output indicator capture – as far as possible – the same phase of the innovation process. Basic research is clearly driven by the research mindset, while experimental development is fostered by the hope of later bringing the product to market (while applied research is a transition between the two activities). Compared to R&D, (market) innovation – both in legislative and economics terms – covers a broader conceptual scope, which also encompasses organisational and market innovations. The dividing line between experimental development (i.e. the last phase of R&D) and innovation is represented by market introduction: while for experimental development, market utilisation is not part of the process, this forms an integral part of product and technological innovation. Hereinafter innovation shall refer to both R&D and market innovation, but where appropriate, we indicate separately which phase we mean.

2.3 Efficiency of the innovation process in Hungary

Significant differences can develop between innovation expenditures and output results. In this subsection, we analyse the Hungarian performance based on time series, relying on several indicators, thus obtaining a view of expenditures and outputs separately. The international comparisons are included in the next subsection. Chart 2-3 contains the time series of the expenditure group, while the time series for the output indicator group are included in Chart 2-4. Time series related to R&D processes are marked in red, while those related to innovation are marked in blue.

Overall, on the expenditure side, both the R&D and the innovation indices show an increasing trend in the period under review. Based on Chart 2-3, most of the input indicators exhibited considerable growth in the period after 2004, and particularly from 2016.[26] The degree of R&D expenditures as a percentage of GDP or in real terms, and the ratio of staff employed as researchers has expanded by at least 40 percent since 2008 and at least by 20 percent since 2012. The only exception to the upward trend was seen in state aid. It is worth mentioning two factors in this regard: on the one hand, transitions between EU programming periods caused temporary shortfalls in funding, and on the other hand the significant reduction in corporate income tax also decreased the level of available aid. The temporary exhaustion of state aid disbursed to corporations made its effect felt in 2016, as in those two years many input indicators stagnated or even decreased. However, the retrenchment in 2016 did not cause the trend to decline: on the contrary, R&D and innovation inputs rose at an accelerating rate.

Chart 2-3: Expenditure figures related to R&D (red) and innovation (blue)



Note: All time series are available from 2012.
Source: MNB calculations based on HCSO data.

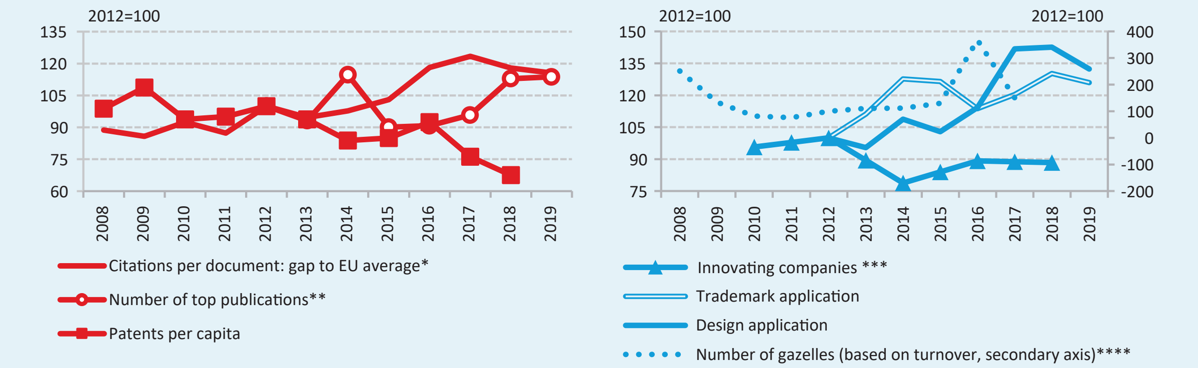
The ratio of those employed in knowledge-intensive jobs decreased during the economy's extensive growth phase, but has been rising since 2017. The decrease before 2017 was mostly attributable to the composition effect. To a large degree,

26 For some of the indicators we use, the price effect may have influenced the change in the indicator, but no appropriate data are available to state this unequivocally. Indicators that potentially may be exposed to price effect include the GERD and BERD indices as well as the ratio of public expenditures.

the government's labour market reform measures from 2010 supported the employment of people previously detached from the labour market. Within this group, the ratio of employees who can be employed in knowledge-intensive jobs (the first two main groups according to the Hungarian Standard Classification of Occupations [FEOR][27]) is low. Thus, although the number of knowledge-intensive employees rose, the total number of people in employment increased to an even larger degree, and the ratio of the former decreased. The most spectacular growth was seen in venture capital investments, but it should be noted here that their ratio is less than 0.1 percent of GDP.

In the case of the R&D indicators, the science citation figures have improved substantially since 2015, but there was a gradual decrease in the number of patents (Chart 2-4).[28] Citations of Hungarian research in the world's leading publications have surged in the past 2 years.

Chart 2-4: Output measures determining R&D (red) and innovation (blue)



*Note: * Hungarian to EU average by the issuance year of the document. EU average is weighted by the number of documents (source: ScimagoJr, Scopus data). ** Publications in the top 10% of all publications in the domain (source: EC, EIS indicators). *** Methodological break in 2016-2018. **** For 2008-2012, MNB estimates based on HCSO data.*

Of the measures of innovation performance, the most important measure, i.e. the ratio of innovating enterprises, shows a declining trend.[29] While in 2012 one third of the enterprises innovated in Hungary, according to the latest survey (2016–2018) this ratio fell to 28.7 percent. The Hungarian figure is in line with the regional average, but falls short of the EU average, where half the enterprises can be deemed innovative. Following robust growth in 2012–2014, the number of trademark applications is practically stagnating, while a substantial increase was observed in design patent applications in 2015–2017. The trends in the number of fast-growing, gazelle enterprises indirectly approximate innovation performance and paint a positive picture overall.[30] This is the indicator that is capable of best capturing the number of innovative enterprises through business data. However, market activity influences the results significantly. The number of gazelles fell to a low in Hungary during the global financial crisis, followed by a strong rise. After an outstanding year in 2016, the number of gazelle enterprises was once again characterised by trend growth from 2017, and in 2017 the number of gazelle enterprises was 2-2.5 times higher than in 2010. In terms of numbers, Hungary has almost 600 gazelle enterprises, which is higher than in the Czech Republic (500 enterprises). The interesting thing about this is that the number of gazelle enterprises is not necessarily connected to the size of the individual economies. This is well demonstrated by the fact that in Lithuania, which has 2.8 million inhabitants, more than 500 gazelle enterprises can be identified based on the sales revenue figures every year since 2014, almost as many as in the Czech Republic which is four times larger.

Taken together, the dynamics of output indicators is not in line with the typical trend growth of input indicators, which signals a decrease in innovation efficiency. On the other hand, it is an interesting development that in 2016, the year

27 The FEOR classification is in line with the ILO's ISCO-08 international classification.

28 There are numerous patent statistics. International data with regard to Hungary are published by WIPO, Eurostat, the OECD and also by the HCSO. Patents can be differentiated by the date of application and of granting the application; the data of which patent offices are examined can also influence the time series and also whether we take into consideration data by the country of the inventor or the applicant. It is a common feature of most time series that no material change was observed until 2016. Then, from 2016, the trend in patents started to decline. There is one exception to the phenomenon. In the time series compiled based on the country of submission of all patents registered by the OECD (IP5), a gradual decrease was observed from 2012. In choosing the WIPO time series, the guiding principle was that this statistic examines patents with the broadest possible focus, and publication of the data is faster compared to other institutions. Furthermore, the time series practically corresponds to the number of patent applications of Hungarian origin registered by the HCSO. This section does not deal with other types of industrial property rights (utility model applications, trademark applications).

29 It should be noted that the survey related to 2016–2018 was prepared using a different methodology than before, and thus its comparability is limited.

30 In line with Eurostat recommendations, gazelle enterprises are those that have completed at least 5 business years, have sales revenue growth higher than 20 percent in their last 3 years and had at least 5 employees at the start of the period.

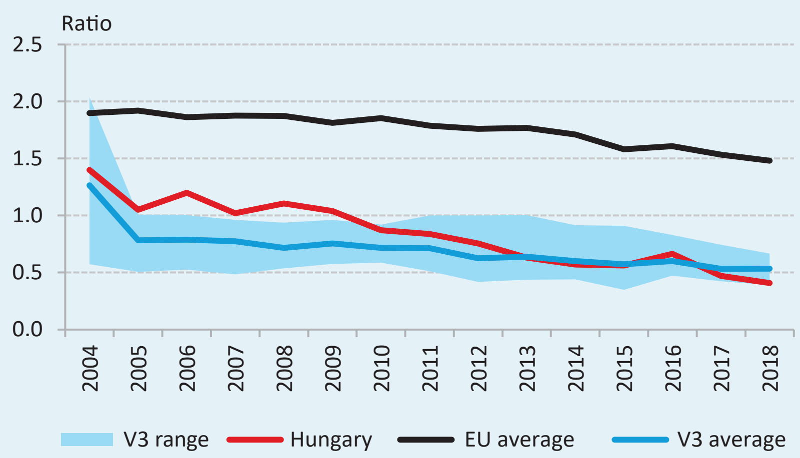
which was characterised by lower expenditures, strong growth can be observed in the R&D output time series. This raises the question of the direction of funding. However, the role of the state in the innovation processes cannot be assessed purely on a financial basis. The main reason for this is that much of the basic or applied research work is carried out for an expressly social objective, which in practice is inconceivable without public funding. The impact analysis of these aspects falls outside the focus of this publication. Nevertheless, we deal with some of the factors in the next subsection.

2.4 Innovation efficiency in an international comparison

The efficiency of R&D has been declining globally, and the Visegrad region's lag remains substantial. Bloom et al. (2017) point out that raising productivity requires higher and higher research expenditure; in other words, the efficiency of innovation is decreasing globally. The global drop in efficiency can be also observed in the Visegrad region, mostly in relation to patent efficiency, citations and trademark activities. In this subsection, we examine the indicators which are internationally comparable, both in terms of data availability and the stability of the time series. In the interpretation of ratios, we separately analyse the numerator (output) and denominator (input) in each case. Chart 2-5 shows the number of patents per real R&D expenditure.

The decreasing R&D efficiency is primarily reflected by the fall in the number of patents (between 2012 and 2018 the indicator declined to one third), while the more developed countries spend a larger part of the national income on development expenditures. The declining patenting activity observed across the world also exists in the region, and thus the phenomenon is seen in Hungary as well. The downtrend can be observed despite the fact that R&D expenditures in Hungary are continuously increasing, and the ratio of experimental development within R&D activities is higher and higher (while 45 percent of R&D expenditures was related to experimental development in 2010, this ratio was close to 60 percent in 2018).

Chart 2-5: Patents in the ratio of R&D expenditures



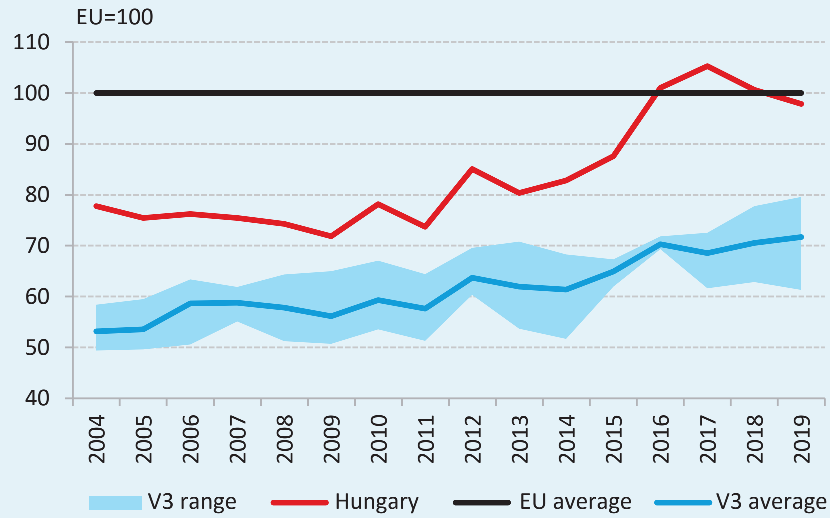
Note: R&D expenditures are PPS based.
Source: MNB calculations based on Eurostat and WIPO.

As regards the entire period, scientific performance of Hungarian journals exceeded the average of the other Visegrad countries and in 2016–2018 it outstripped even the EU-28 average. The R&D performance may be also captured by citation indices. It is normal that the citation of a new publication is lower than of a work published several decades before. Accordingly, if we only examine the raw series of citation, we would see a decreasing trend for all countries. It is similarly not practicable to examine the number of publications separately, since in parallel with the rise in the number of researchers and research centres these also increase, but the higher volume is not necessarily coupled with widely-accepted scientific quality. Based on these considerations, we compared citations by papers to the EU average (Chart 2-6). It should be noted here that the Scopus database (Elsevier B.V.) performs the ranking by the parent country of the scientific journals, and is thus only able to capture the performance of Hungarian researchers to a limited degree.[31] In 2019, the performance

31 Based on the HCSO table measuring the issued publications, the ratio of foreign and Hungarian language publications is about fifty-fifty. However, the frequency of publishing foreign language papers in the Hungarian journals is not known.

of Hungarian journals was almost the same as the EU average. In addition to medical and physical science, the leading areas of the Hungarian scientific journals include the areas connected more broadly to chemistry and biology. In the ScimagoJr ranking, Hungary took 3rd place in medical sciences among countries with at least 1,000 studies. It should be noted here that the favourable citation indices are accompanied by a quality lag. When examining the list of the top publications in the world, Hungarian papers occur less frequently. The Hungarian index stands at half of the EU average in 2019 (European Innovation Scoreboard, 2019).

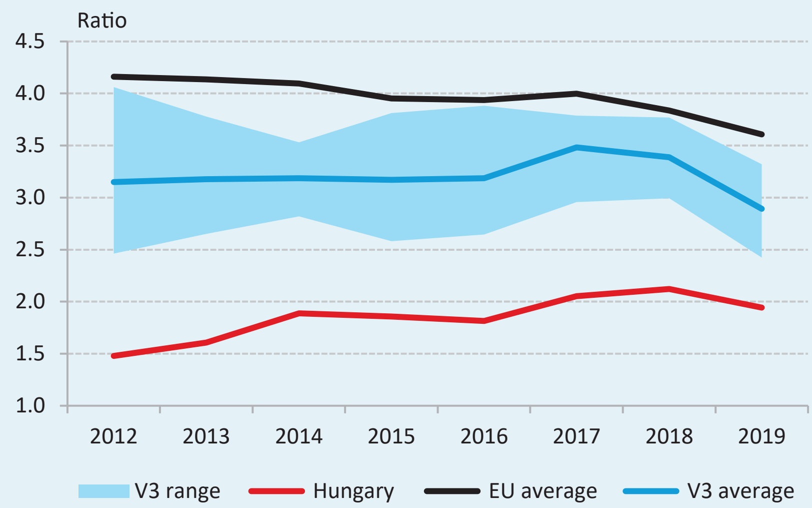
Chart 2-6: Average citation index per document by year of publication



Source: MNB calculations based on ScimagoJr, Scopus.

As the last efficiency indicator, we compared the number of design and trademark applications – a figure which broadly captures innovation performance – to the ratio of knowledge-intensive employees (Chart 2-7). From the group of patent rights (patent, trademark, design patent), we selected the latter two as they usually impact more enterprises than patent rights. Hungary lags behind both the V3 average and the EU average in this area of efficiency. In Hungary, the ratio of knowledge-intensive employment declined moderately, which was offset by the rise in patents, primarily between 2016 and 2018, and thus this period was characterised by improved efficiency. In 2019, patent and design patent registration activity declined, and thus the indicator did not rise further. The observation is also valid for the other countries under review.

Chart 2-7: Trademark and design patents per knowledge-intensive employee



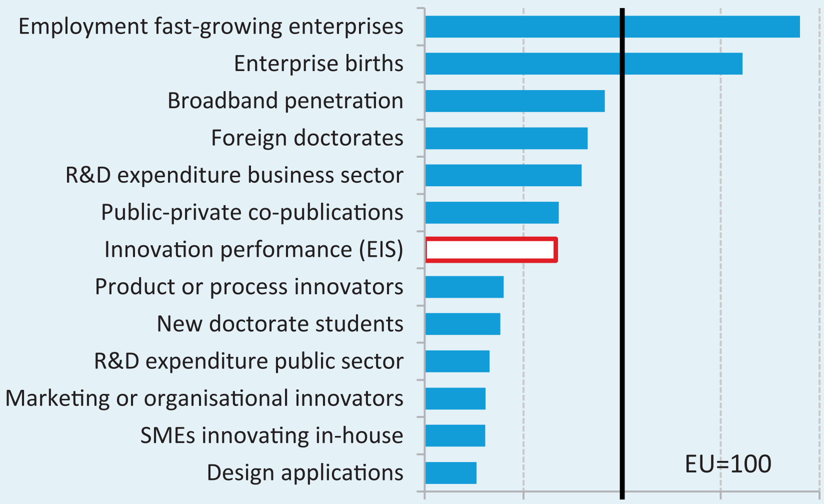
Note: The intellectual property rights were created using EIS data. Knowledge-intensive workforce is calculated as the ratio of the knowledge-intensive workforce to total employment.
Source: MNB based on Eurostat and European Commission (EIS).

Overall, apart from one or two years, Hungarian expenditures have been continuously increasing in the past decade. However, the output results were typically unable to keep abreast of the rise in inputs, and thus we see a decrease in efficiency. Hungary's innovation performance falls substantially short of the EU average; at the same time, this is a general phenomenon in the Visegrad region, and thus Hungary's innovation outputs reach the average of the region. The role of public funding until 2017, the period covered by the data, developed unusually, as efficiency rose even in parallel with lower funding. In the following, we examine a few underlying factors, which may help to understand the Hungarian trends.

2.5 Factors behind Hungarian innovation performance

In Hungary, the innovation activity of SMEs represents major growth potential. In the European Commission's European Innovation Scoreboard (EIS) indicator system, Hungary performs poorly on the expenditure (input) side in terms of the public sector's R&D expenditures and the number of doctoral students, while on the output side, Hungary's position is weak in the ratio of innovating SMEs and trademark acquisition activities. However, there are also positive results among the EIS indicators: both the number of high-growth enterprises and the number of newly-established companies imply favourable innovation trends (Chart 2-8). Notwithstanding, the corporate demographic data should be treated with reservation, as the changes in the time series are also influenced by the laws related to operating companies, which are usually independent of innovation efficiency. SMEs' innovation performance indicates tangible growth potential in respect of all EIS indicators, as the ratio of innovating enterprises within Hungarian SMEs is only 30 percent of the EU average. Nevertheless, the trend is developing favourably as this ratio was only 11 percent in 2012. There is unusual variance in the Visegrad region: while Czech SMEs are more innovative than the EU average, Polish companies are below 20 percent of the EU average, while Slovak SMEs are at 41.5 percent of the EU average. According to the latest comprehensive R&D&I country analysis ordered by the European Commission, the reason for the moderate Hungarian result is that SMEs' risk appetite is low, which fundamentally hinders commitment to innovation. The report notes that a number of development policy measures help SMEs increase their willingness to innovate (Dőry et al., 2018). The data also reflect that these support measures proved to be effective, as convergence accelerated between 2017 and 2018.

Chart 2-8: Lowest and best performing indicators of innovation performance in Hungary (2019)

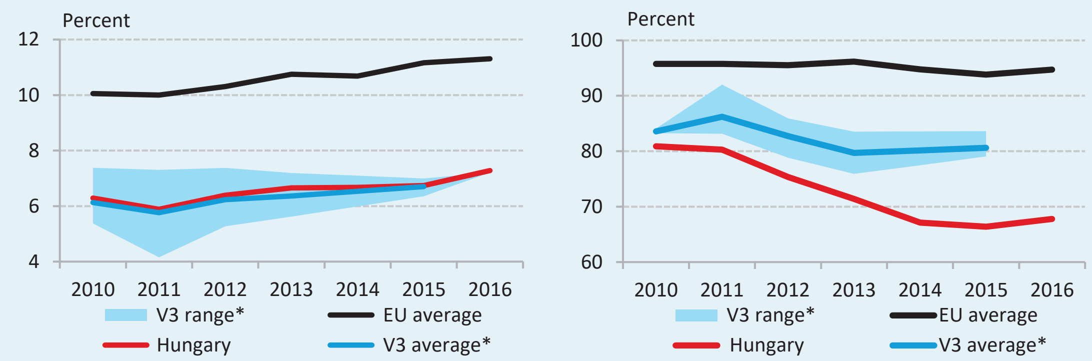


Note: We only included indicators that are directly relevant to innovation, meaning many context indicators for the general state of the economy were omitted. It is necessary to note that the performance of Hungary is typically better than the EU average in these indicators.
Source: MNB calculations based on European Commission (2020).

Fragmentation of the innovation framework complicates the process of knowledge transfer, and thereby the growth in innovation outputs. If innovation remains within the walls of research centres, i.e. has no spillover effect, aggregate innovation output will be also weaker. In practice, most innovations may be regarded as indoor innovations, and only the rarely emerging general-purpose technologies are exceptions to this. It may be expected that an innovation can exert its impact outside the research centres as well, if the industries producing the innovation are able to deliver in large volumes to other productive industries, or if innovation is performed jointly by the research centres and the various actors. We examined the first hypothesis by the input-output tables, and analysed the second one based on relevant indicators of EIS and NTCA data.

Although demand for knowledge-based services is gradually increasing, it still lags substantially behind the EU average. When selecting typically knowledge-generating sectors such as education, engineering or scientific R&D and examining how their related industry transactions have changed recently, trend growth can be observed. On the left side of Chart 2-9, we aggregated the intermediate consumption data of the industries listed above at current price (basic price).

Chart 2-9: (left) Output of knowledge-producing sectors for intermediate consumption within the total intermediate consumption of the national economy, (right) Share of knowledge-intensive purchase of services in domestic production (direct)



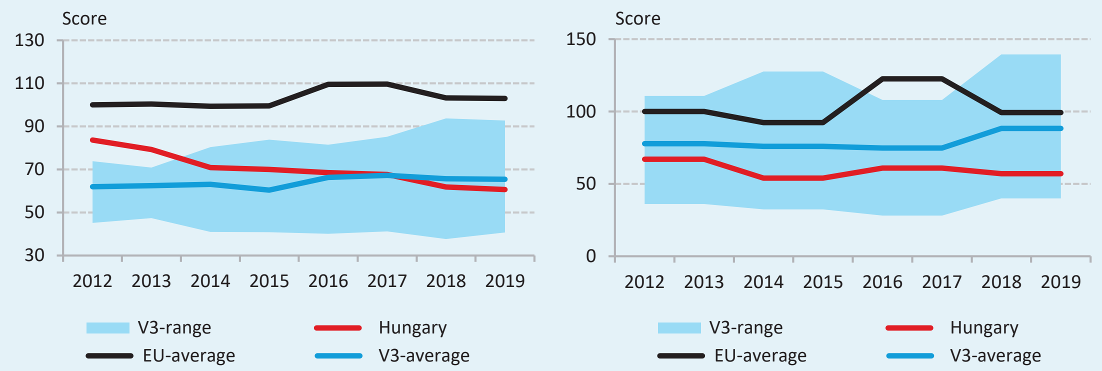
*Note: Output of knowledge-producing sectors for intermediate use in proportion to the total intermediate use of the total economy. Knowledge generating sectors: ICT services, professional, technical services, engineering, architectural services, R&D activities, education (NACE rev.2 69-72 and 85, respectively). * Data for Slovakia were interpolated between 2011 and 2014, and for Poland for 2014.*
Source: MNB calculation based on Eurostat data.

The ratio of domestically produced intermediate consumption within total knowledge consumption is extremely low (Chart 2-9, right). High imports may also indicate that the entire innovation value chain is not fully developed or that there are interruptions at certain points in the chain, which ultimately results in a deterioration in systemic efficiency. Among the knowledge-intensive sectors, it is primarily ICT services that are import-intensive. In Hungary, when enterprises purchase ICT services almost every second forint is spent on foreign services, while in the Czech Republic only every 3rd or 4th koruna directly increases imports. Direct and indirect segregation is also important, since the times series presented in the right panel of Chart 2-9 only include the imports generated directly by firms' orders; however, the production of the domestic ICT services is also import-intensive, and thus the import estimates presented above should be regarded as lower estimates.

Innovation cooperation is rare in Hungary and shows a declining trend. While in the Czech Republic, the ratio of projects implemented in the framework of public-private partnerships comes close to the EU average, Hungary's ratio is steadily decreasing; i.e. Hungarian SMEs tend to cooperate with each other and with the state in their research activity less and less, and they are also unable to increase the number of mutual co-operations (Chart 2-10) This is a valid finding even despite the fact that Hungarian enterprises are typically able to choose from a wide range of counterparties, as noted by the survey of Eurobarometer. Only 9 percent of the respondent SMEs believed that the absence of innovation partners hinders innovation. This is the lowest ratio within the Visegrad region, and is also below the EU average (Eurobarometer, 2020).[32]

32 Citing the absence of appropriate partners is much more frequent among start-up companies and family businesses. Enterprises mention the lack of funding as the main obstacle to innovation (every fourth SME mentioned this), while this corresponds to the EU average and is below the Visegrad countries' similar ratio.

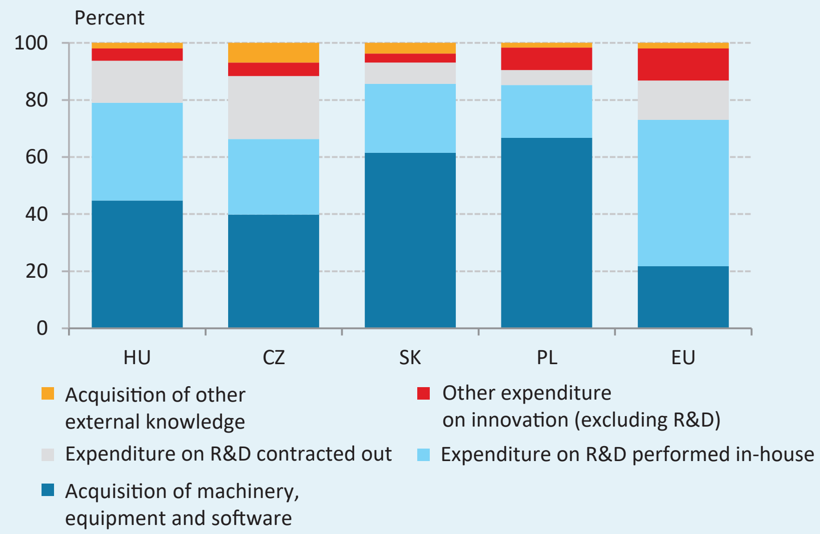
Chart 2-10: EIS survey composite indicators measuring public and private research cooperation (left) and cooperation between innovative SMEs (right)



Note: the EIS composite indicator on the left is based on three time series (number of companies cooperating with each other, number of joint publications of public and private institutes, private-public co-funding).
Source: MNB based on the European Commission (EIS).

The nature of the state aids may also impact the low number and deteriorating trend of co-operations, which is mostly dominated by asset financing instead of project financing, which may worsen willingness to cooperate. Similarly to the rest of the region, Hungarian enterprises mostly spend their R&D funds on asset purchases, in contrast to EU companies, where research centres typically try to post-finance their operating expenses (Chart 2-11). The asset-dominated cost structure of the Hungarian and V3 enterprises may be attributable to the fact that in the region public development funds strongly support the procurement of assets, and the respective tax environment is also favourable, and due to this enterprises are less dependent on project-based cooperation. In the core countries of the EU, in terms of external funding the best external finance alternative is typically represented by the central funds from Brussels (e.g. Horizon 2020), the award of which is conditional on cross-border cooperation. Due to this, it is possible that the results of innovation are also able to spread faster in the western EU Member States (the tenders usually also prescribe dissemination, and social challenges are strongly represented among the research topics, which by nature call for strong cooperation).[33] However, the nature of public funding is not the only explanation for the relatively weaker willingness to cooperate, as the expenditure structure in the Czech Republic is similar to that of Hungary, but there is still greater willingness to cooperate.

Chart 2-11: Structure of innovation expenditures at large enterprises (2016)

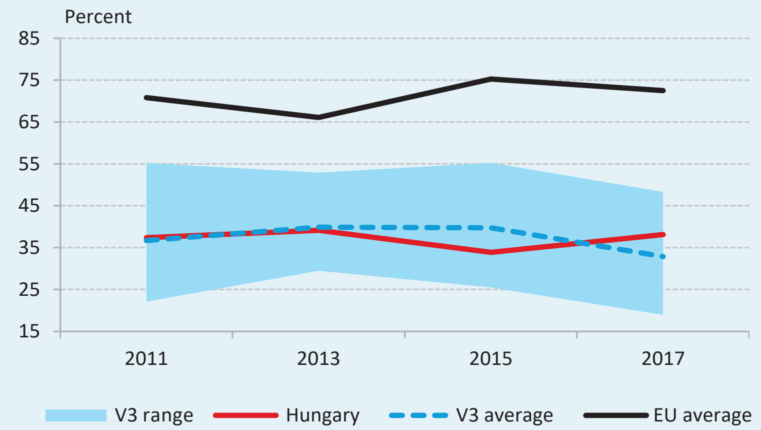


Source: Eurostat, European Commission, CIS survey.

33 It should be noted here that a number tender schemes and tax allowances in respect of R&D activities carried out in cooperation with the state are also available in Hungary. Upon the assessment of EU tenders, joint applications always represent an advantage, and in many cases this is a mandatory condition.

The weight of multinational companies within the economy and the process optimisation performed by them globally may be also related to the fragmented structure. Developments in R&D expenditures over time are not necessarily related to the local performance of multinational corporations (Halpern – Muraközy (2010) also came to a similar conclusion). In the corporate sector, a vast part of the innovation performance is created by a small group, which typically includes large manufacturing enterprises, which are typically controlled by non-residents. Hungarian-owned companies account for roughly 40 percent of R&D expenditures, while the remaining part is attributable to foreign-owned companies (Chart 2-12). This ratio differs substantially from the EU average, but this is not a unique phenomenon in the region. On the other hand, the trend improvement in Hungary between 2015 and 2017 reduces fragmentation, and it is assumed that the weight of Hungarian enterprises may have increased further by 2019.

Chart 2-12: R&D expenditures of domestically owned enterprises as percentage of total business R&D expenditures



Note: The EU average varies depending on the country composition.
Source: Eurostat.

The R&D expenditures of multinational corporations in Hungary do not increase productivity by positive yield and moreover, at certain enterprises the link between the two variables is weak. Foreign companies optimise their innovation activation globally, i.e. they may choose between their various production units in space and time. Relying on the corporate tax returns submitted to NTCA, we analysed R&D expenditures and the accompanying growth in value added of 20 multinational corporations operating in Hungary. Based on the results of the analysis, no innovation premium can be identified, i.e. the corporations' value added does not grow faster than their R&D expenditures incurred during the period under review (2012–2018). In order to clarify the relation, we should know the ratio between the corporations' internal (within the borders) and external R&D activities. This information is not disclosed in corporate reports. Based on supplementary information available from other sources, it can be assumed that a large part of the R&D expenditures is the result of the intragroup cost optimisations (see e.g. G7, 2018).[34]

In summary, Hungarian innovation performance is achieved in parallel with continuously rising expenditures with low return. The Hungarian trends are not unique, and with minor differences they are also valid for other countries in the region. The most important reason for this is the fragmentation of innovation, and this process is further strengthened by the nature of state aids. The innovation expenditures of foreign companies, accounting for a good part of Hungary's innovation performance, do not increase the productivity of these companies with positive yield. Moreover, the result of their innovation activity is likely to remain within the group without any spillover effect.

34 Enterprises have the option to recognise as cost also the R&D expenditures incurred from related companies, provided that the allowance is enforced only once.

References

Act CXXXIV of 2004 on Research, Development and Technological Innovation. Available at: https://mkogy.jogtar.hu/jogszabaly?docid=a0400134.TV

Baumann, J. – Kritikos, A.S. (2016): *The link between R&D, innovation and productivity: Are micro firms different?,* Research Policy, Elsevier, vol. 45(6), pages 1263-1274.

Bloom, N. – Jones, C. – Van Reenen, J. – Webb, M. (2017): *Ideas aren't running out, but they are getting more expensive to find.* https://voxeu.org/article/ideas-aren-t-running-out-they-are-getting-more-expensive-find. Download date: 15.10.2020

Dőry, T. – Csonka, L. – Slavcheva, M. (2018): *RIO Country Report 2017: Hungary,* EUR 29178 EN, Publications Office of the European Union, Luxembourg, 2018, ISBN 978-92-79-81343-6, doi:10.2760/190055, JRC111364. Download date: 26.10.2020

Eurobarometer (2020): *Flash Eurobarometer 486: SMEs, start-ups, scale-ups and entrepreneurship.* Download link: https://ec.europa.eu/commfrontoffice/publicopinion/index.cfm/survey/getsurveydetail/instruments/flash/surveyky/2244, download date: 08.10.2020

G7.hu (2018): *Magyarország a globális innováció segédmunkása, öt cég költi el az országos k+f felét* (Hungary is the handyman of global innovation; half of the national R&D is spent by five companies). Download link: https://g7.hu/kozelet/20180807/magyarorszag-a-globalis-innovacio-segedmunkasa-ot-ceg-kolti-el-az-orszagos-kf-felet/

Griffith, R. (2000): *How important is business R&D for economic growth and should the government subsidise it?* The Institute for Fiscal Studies. http://www.ifs.org.uk/bns/bn12.pdf

Griliches, Z. (1979): *Issues in Assessing the Contribution of R&D to Productivity Growth.* Bell Journal of Economics 10, 92–116.

Halpern, L. – Muraközy, B. (2010): *Innováció és vállalati teljesítmény Magyarországon* (Innovation and firm performance in Hungary). http://epa.oszk.hu/00000/00017/00169/pdf/01halpern-murakozy.pdf

Jones, C.I. (1995): *R & D-Based Models of Economic Growth.,* Journal of Political Economy, 103, 759–784. op. Available at: https://www.jstor.org/stable/2138581, download date: 24.09.2020

HCSO (2019): *Fund absorption tables, according to the 2019 methodology.* Available at: http://statinfo.ksh.hu/Statinfo/index.jsp, download date: 24.08.2020

Magyar Nemzeti Bank (2018): *Growth Report.* Available at: https://www.mnb.hu/kiadvanyok/jelentesek/novekedesi-jelentes/2018-11-08-novekedesi-jelentes-2018-november

Romer, P.M. (1990): *Endogenous Technological Change,* The Journal of Political Economy, 98(5, part 2), S71–S102.

Schumpeter J. (1939): *Business Cycles: A Theoretical Historical and Statistical Analysis of the Capitalist Process* (1-2, 1939)

Tang, J. – Wang, W. (2019): *Is R&D Enough in Improving Firm Productivity?,* International Productivity Monitor, Centre for the Study of Living Standards, vol. 37, pp. 120–143, Fall.

Ugur, M. – Trushin, E. – Solomon, E. (2016): *A firm-level dataset for analyzing entry, exit, employment and R&D expenditures in the UK: 1997–2012,* Greenwich Papers in Political Economy 15556, University of Greenwich, Greenwich Political Economy Research Centre.

Varga, A. (2009): *Térszerkezet és gazdasági növekedés* (Spatial structure and economic growth), Akadémiai Kiadó, 2009.

3 Digitalisation efficiency

In Hungary, the development level of the digital infrastructure is adequate. In terms of digital infrastructure, Hungary is in the upper mid-range of the EU countries. Based on the 2019 data, in Hungary the coverage of high-speed broadband internet connection is 90 percent, exceeding the EU average by 7 percentage points. The penetration rate of wired internet connection was extremely fast in recent years, as a result of which Hungary managed to work off its lag behind the Visegrad countries and approach the EU average. In 2019, this ratio was 86 percent in Hungary, while the EU average is 90 percent. All of this supports the penetration of digital technologies for both households and corporations.

Despite the adequate infrastructure, the efficiency of the Hungarian population's digital skills lags substantially behind the EU average. While the infrastructure conditions are available, the public's software and internet skills, such as word processing and internet browsing, are low. Hungary's efficiency ratio compared to the EU average and the average of the TOP5 EU countries is 68 percent and 55 percent, respectively. 51 percent of the Hungarian population has basic software skills, which lags behind the EU average of 61 percent and is substantially lower than the TOP5 EU countries' average of 76 percent. Public utilisation of digital infrastructure has also lagged behind the V3 countries in recent years as household internet awareness has not kept pace with the increase in internet coverage.

The corporate efficiency of digital technologies is low in Hungary in a European Union comparison. The countries with the highest corporate digital efficiency include Ireland, Belgium, Finland, the United Kingdom and the Czech Republic. Hungary's efficiency is about half of the EU average, while it is merely one third of the TOP5 EU countries. Based on the Digital Economy and Society Index (DESI), which is prepared by Eurostat and measures the digital integration of enterprises, Hungary is ranked 26th among the 28 Member States. According to the enterprise digitalisation sub-index, only a small portion of Hungarian corporations invest in digital technologies. The digital intensity index shows that 57 percent of enterprises only have minimal digital technology, which significantly exceeds the EU average of 39 percent. In the area of e-commerce, it is mainly small and medium-sized enterprises that perform poorly. Based on the ratio of enterprises with their own website, Hungary is included in the lower mid-range, while the participation rate in the online marketplace is decidedly low (2.5 percent).

The ratio of ICT specialists in employment in Hungary exceeds the average of the V3 countries and the EU Member States. In recent years, 81 percent of large enterprises and 27 percent of SMEs employ ICT specialists, which exceeds the EU average of 76 and 19 percent, respectively. Specialists equipped with digitalisation skills boost digitalisation efficiency, and thereby productivity. Accordingly, it is of the utmost importance to train experts with these skills in parallel with technological progress.

However, Hungarian ICT specialists are only able to digitise corporate processes to a relatively small degree compared to the V3 and EU countries, since the domestic enterprises employing ICT specialists tend to use modern enterprise resource planning and customer relation management software more rarely. The managers of SMEs often have no clear understanding of what hinders their digitalisation developments, e.g. their software investments. Based on the 2020 Eurobarometer survey, the level of information related to digital technologies is low in the Hungarian SME sector.

The digital maturity of the state in Hungary exceeds the V3 average, but lags behind the EU average. Based on the interconnectedness and interoperability indicators of Hungarian e-governance, digital developments are required to catch up with the other EU countries, as Hungary takes the 22nd place in the EU ranking. Hungary's lag is particularly large compared to the TOP5 countries, as the Hungarian ratio compared to them is 65 percent. The 5 most developed countries in terms of state digitalisation are: Malta, Estonia, Lithuania, Latvia and Portugal. The digital administration system can be used with smaller obstacles more widely, which would save time for the population and reduce the administrative burdens of corporations. With the development of e-governance, the operation of the state accelerates and becomes more cost-efficient.

3.1 Relationship between digitalisation and data revolution

Data is often referred to as the oil of our age, since in terms of its significance among resources it precedes the role of fossil fuel. Examining the corporate success stories of the last decade, we find the winners of digitalisation among the largest companies overshadowing the heavy industry and energy giants which previously enjoyed a hegemony.

Apple, Google, Microsoft, Amazon, Facebook – and so on – have mostly become leaders by putting profit generated from the data collected during their operations at the centre of their business model. This is exactly what digitalisation has made possible: data generation and data collection have appeared in all areas of life and the economy, data processing has become more efficient and systematised, and gaining information from and making decisions based on data have generated enormous business profits. Digitalisation and the data revolution go hand in hand. In the rest of this section, we present the development and efficiency of digitalisation, by analysing the three-step process of data revolution (Chart 3-1), supplementing it with the analysis of the digital efficiency of the state, which is discussed in Section 3.6.

1. Data generation and collection, which can mean both the transformation of everyday events into data or the analysis of industrial process, can take place in visual, audio or binary form,[35] but ultimately it is stored digitally. This is supplemented when the data of processes linked on networks, (e.g. stock exchange trading, broadcasting) are stored in more detail and when it is possible to connect them with other databases. In the early 2000s, 1.5 billion gigabytes of data was generated annually, more than 90 percent of which was stored on disks: by contrast, in 2017 this volume of data was created in merely half a day,[36] mostly through the internet. The existence of the necessary infrastructure is essential for data collection and transportation. While data collection in the individual sectors and subsectors takes place in unique forms (e.g. car industry, healthcare), we do not intend to present the efficiency of these in detail. However, it is easier to examine the basic conditions, i.e. the efficiency of digital infrastructures, which will be addressed in Subsection 3.3. This includes the penetration and utilisation of wired and wireless networks, the price of internet subscription or the penetration of smart devices connecting to the network among households and enterprises. This is supplemented by the fact that one essential condition of data generation is the population with digital skills, i.e. solid internet usage and software management skills, which is also discussed in Subsection 3.3.

2. The second step is the efficient processing of data, during which data are structured, sorted and linked. It is obvious that data collection is a necessary but not sufficient condition for the spread of digitalisation. The penetration of corporate digital solutions (procurement of software, use of broadband internet, purchase of hardware and portable equipment, installation of sensors, etc.) necessitates investments. While as a result of corporate investments in automation, simpler and more repetitive processes are digitalised and thus inevitably replace the low-skilled labour force, it is essential to train specialists experienced in information and communication technology (ICT). In terms of productivity, we examine the efficiency of corporations' digital integration and the efficiency of ICT specialists in Section 3.4.

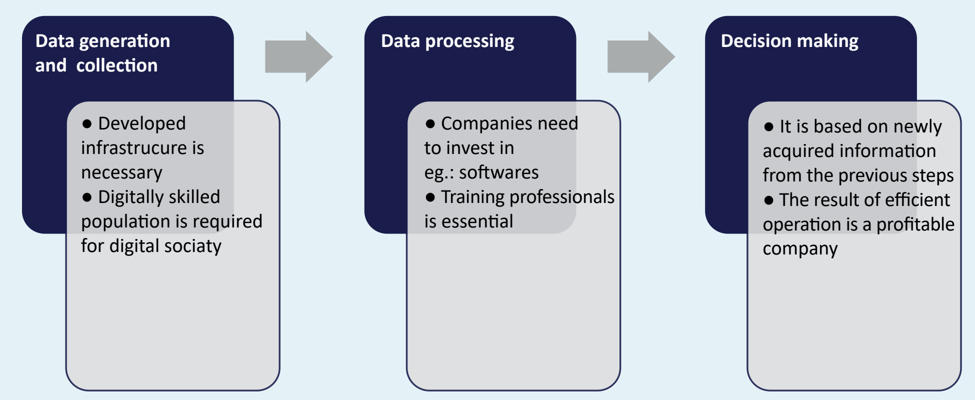
3. The processing and interpretation of data create new information, which accelerates decision-making and increases its efficiency, thus impacting corporate profitability. "Smarter" decisions may revolutionise our life in formerly unthinkable areas. In the course of machine learning and personalised financial or health consulting relying on artificial intelligence, the efficiency of the respective sectors may increase drastically, which may result in wealthier and healthier life. The principle of economies of scale is key to the penetration of digitalisation. The physical environment does not delimit digital innovation, and new solutions can reach millions of households and enterprises across borders at minimum cost. This means, for example, that a new user does not increase the expenses of social media operators, and that the business solutions of the new digital firms in the fintech world are highly scalable, and thus they can compete with banks with long operating histories. In its 2018 study, McKinsey points out that in Hungary there is a high ratio of jobs that can be automated,[37] and by adapting cost-efficient innovations Hungary may gain a competitive advantage in certain sectors (e.g. in manual labour-intensive manufacturing). On the other hand, the employment of the thus released labour force may call for active labour market policy. The profitability of digital investments is examined in Subsection 3.5.

35 Examples of these data sources and their use: traffic surveillance cameras function as a basis of smart cities, understanding human speech for voice instructions and individual financial consulting, customised marketing offers based on online search habits, e.g. at Amazon and Facebook.

36 Forbes (2013) provides a good summary of the history of the data revolution. According to the DOMO (2017) research, in 2017 the volume of data generated daily was roughly 2.5 billion gigabytes.

37 According to the McKinsey (2018) study, Hungary's automation potential (49 percent) exceeds the average of the European Union (44 percent)

Chart 3-1: Flow chart and necessary conditions of the data revolution



Source: MNB.

3.2 Relation between digitalisation and productivity

As a result of digitalisation, the total factor productivity ratio, which determines the technological development of the economy, increases. This means that if two companies employ the same number of employees and have the same volume of capital, the company applying digital technology is able to produce larger volume of goods and services, and thus has higher productivity. According to calculations, if the ratio of internet-user companies increases by 10 percent, over a period of five years this may increase the technological development level of average companies by 5.8 percent cumulatively[38] and thus boost productivity in the entire economy.

The multiplier effect of digitalisation on capital is greater than one. Digitalisation results in the emergence of capital-intensive economic processes and new enterprises. While increasing employment has an upper bound, corporate investments may be carried out without limitation, which is the basis of intensive economic growth. This process can be deduced by the following theoretical steps:

1. As a result of the capital intensive digitalisation investments, the economy's technological level increases, which has a positive external effect. For example, the introduction of digital payment technologies, such as payment by smart phone, not only increases the revenues of the respective company, but also encourages other companies to operate more efficiently.

2. Technological progress and operation with higher economies of scale increase the marginal product of capital, i.e. the return on capital.

3. This encourages enterprises to implement even more digital improvements.

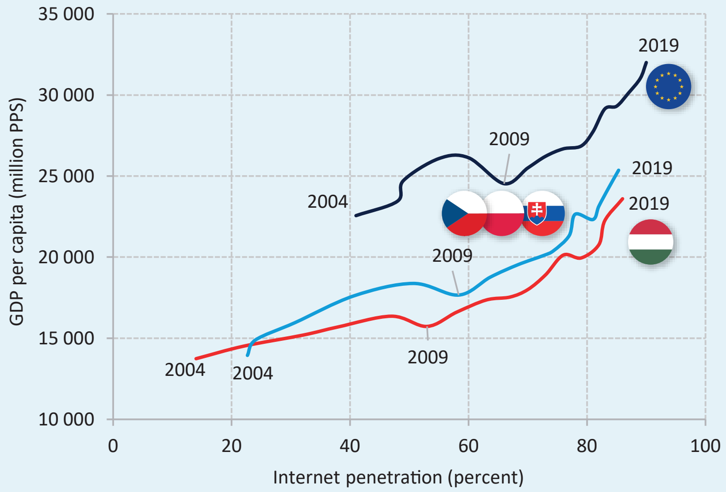
Efficiency of digital infrastructure and digital skills

The main means of digitalisation is the internet. By increasing internet coverage, users have more opportunity to connect to the world of the internet. While Hungary was well below the EU average in this respect (Chart 3-2) and lagged slightly behind its regional peers in 2004, by the end of the decade it had managed to work off this deficit. By 2009, almost half of the households already used the internet at home. Over the next 9 years the rise in the ratio of internet subscriptions followed a similar trend, and thus in 2019 Hungary was already on par with the average of the Visegrad Four, with a penetration rate of roughly 86 percent. In order to maintain growth, in the coming years the ratio of network coverage and particularly of the New Generation Access must be increased. The latter includes superfast broadband network technologies, which provide a minimum download speed of 30 Mbps. The National Digitalisation

38 Gal et al. (2019)

Strategy also serves this purpose,[39] which sets the goal that by 2030 all settlements in Hungary must have a superfast, optical backhaul network. In Hungary, the ratio of high-speed broadband internet access coverage is 90 percent, putting it in the mid-range of the EU ranking and exceeding the EU average by 7 percentage points.

Chart 3-2: Relationship between the penetration of internet and level of development (2004–2019)



Note: Internet penetration shows the percentage of households with internet connection. EU average internet penetration unweighted.
Source: MNB calculation based on Eurostat data.

The Digital Economy and Society Index (DESI) developed for monitoring the penetration of digitalisation can be used in the EU countries. In the EU 2019 digital ranking, prepared on the basis of DESI, Hungary is in the lower mid-range, ranked 21st of the 28 Member States, ahead of Slovakia and Poland.[40] The index covers the entirety of the digital economy. Its compilation necessitates accurate research annually, since it uses 35 indicators from the 28 EU countries. The composite index is compiled by weighting 5 sub-areas, which can be categorised as follows for the purposes of our analysis (Chart 3-3):

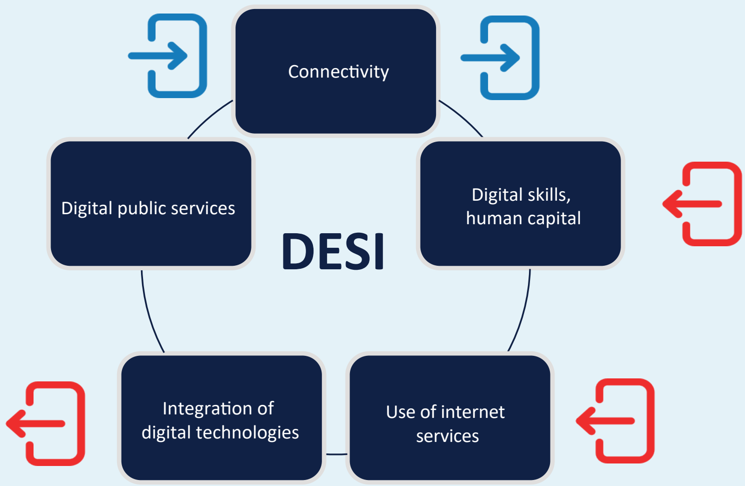
- connectivity (network infrastructure): appears on the input side of our productivity indicators;
- digital skills/human capital, use of internet services, integration of digital technologies: appears on the output side of our productivity indicators;
- digital public services: its sub-index is used as an indicator of maturity.

These indices consist of a combination of additional sub-indices; for example, the network infrastructure index contains the sub-indices related to the usage and penetration of broadband internet, mobile internet and internet prices. These indices serve as a good basis for measuring the digital efficiency of households, enterprises and the state.

39 The National Digitalisation Strategy will replace the National Infocommunication Strategy from 2021, "it will systematise, consolidate, update and supplement, as necessary, the judgement of the government documents prepared to date in connection with digitalisation…".

40 https://ec.europa.eu/digital-single-market/en/desi

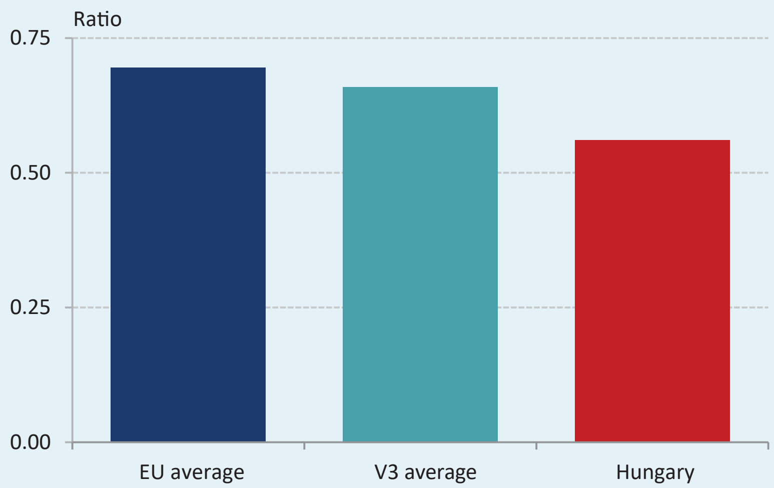
Chart 3-3: Sub-areas of the Digital Economy and Society Index (DESI)



Note: In our analysis, the network infrastructure (connectivity) index is on the input side of the indicators, and the following three indices (digital skills / human capital, use of internet services and integration of digital technology) are on the output side. One of the sub-indices of digital state is used as an indicator of maturity.
Source: Eurostat.

In 2019, utilisation of the digital infrastructure was lower in Hungary compared to the V3 and EU average (Chart 3-4)**.** While in recent years network infrastructure developed extremely rapidly, internet usage by households did not keep pace with this. The latter includes indicators that measure the ratio of regular internet users and indicators measuring online activity, such as e.g. frequency of online shopping (e-commerce) or internet bank usage. Hungary's lag is even more striking compared to the average of the TOP5 countries (e.g. Ireland and Cyprus), compared to which Hungary's efficiency was 66 percent in 2019. In order to reduce Hungary's lag, the frequency of internet usage by households should increase in the near future. There are numerous opportunities for this: diverting state bureaucracy to digital channels sets a good example for citizens and increases the trust of younger and older generations in digital technology. Measures reducing the usage of cash and the instant payment system serve as incentives to use online banking and increase the ratio of e-commerce users.

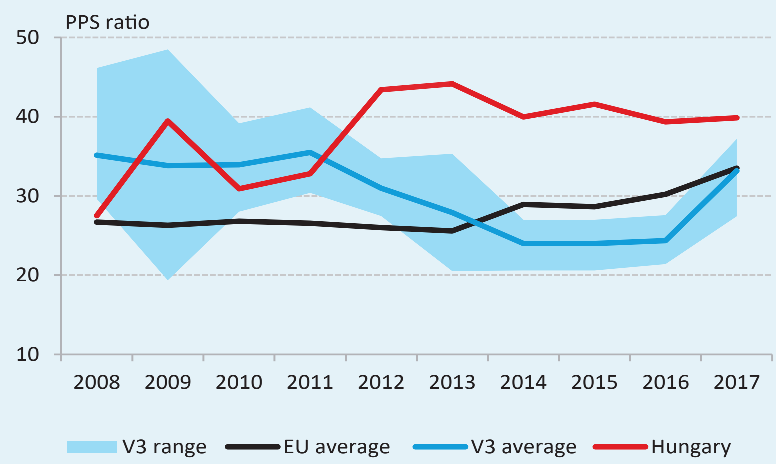
Chart 3-4: Utilisation rate of digital infrastructure by households (2019)



Note: Quotient of the usage of digital technology by households and the network quality (DESI indices).
Source: MNB calculation based on Eurostat data.

Internet usage by households may be also fostered by reducing the related costs, since in recent years the price of wired internet exceeds the average of the EU and that of the regional peers (Chart 3-5). While the penetration of basic-level wired internet networks is extremely high, changeover to new technologies, such as fibre optic network or 5G wireless network, represents ongoing investment and infrastructure costs for providers. The high internet prices hinder growth in internet utilisation by households. While in the Visegrad countries prices followed a downward trend, internet prices in Hungary on purchasing power parity basis stagnated at a price level which is almost 1.5-2 times higher.

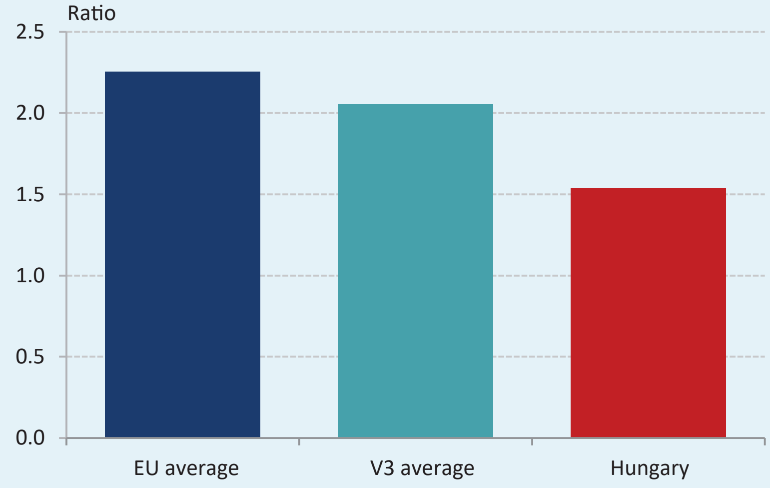
Chart 3-5: Price of wired internet for households at purchasing power parity



Note: Price of a medium wired internet package. The EU average is unweighted.
Source: MNB calculation based on ITU.data.

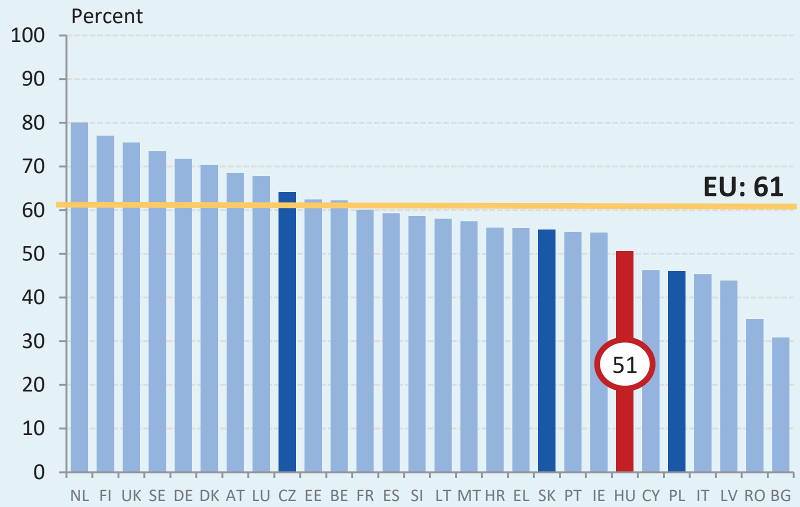
The efficiency of households' digital skills also fell short of the average of the EU Member States, and convergence is necessary at the regional level as well (Chart 3-6). Hungary's efficiency ratio compared to the EU average and the TOP5 EU countries (Finland, United Kingdom, Estonia, Ireland, Austria) is 68 percent and 55 percent, respectively. Hungary has good infrastructure conditions, but this is not utilised adequately by households. One reason for this is that the information search and communication habits of the average internet users, as well as problem solving capabilities in the digital world are below average. In addition, among other things, the index also includes the knowledge of word processing and presentation software and programming languages among households with above-average skills. 51 percent of the Hungarian population has basic software skills, which lags behind the EU average of 61 percent (Chart 3-7). The Netherlands has the highest value, where eight out of ten people are proficient in the use of a computer.

Chart 3-6: Households' digital skills and quality of infrastructure (2019)



Note: Quotient of digital skills and the network quality (DESI indices).
Source: MNB calculation based on Eurostat data.

Chart 3-7: Ratio of population with at least basic level software management skills in the EU (2019)



Note: This index is one of the sub-indices of the DESI human capital index.
Source: Eurostat.

3.3 Digital efficiency of the economy

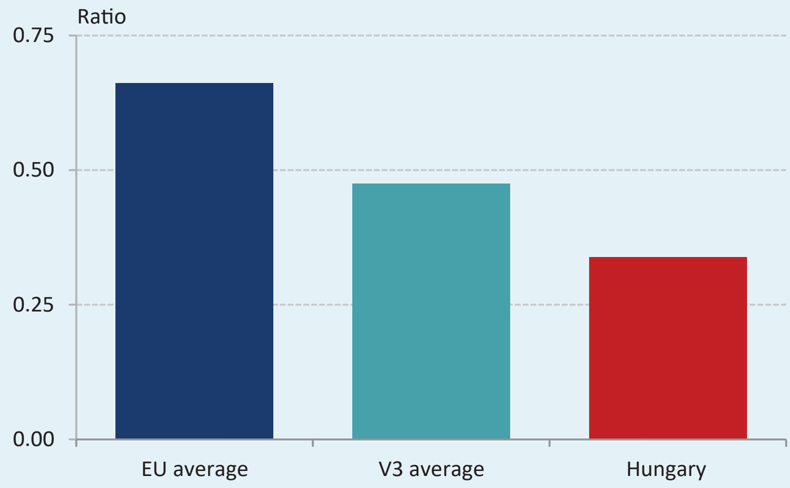
The corporate efficacy of digital technologies is low in Hungary in a European Union comparison (Chart 3-8). The countries with the highest corporate digital efficiency include Ireland, Belgium, Finland, the United Kingdom and the Czech Republic. Hungary's efficiency is about half of the EU average, while it is merely one third compared to the TOP5 EU countries. This may be attributable to the fact that corporations fail to exploit properly the advantages offered by the maturity of Hungary's digital infrastructure. Despite the availability of the necessary experts at the companies, presence on the internet, own website, database usage, cloud computing and e-commerce has not spread to the desirable degree.[41]

41 The applied DESI corporate digital integration index measures the sharing of electronic information, presence in social media, the frequency of using big data and cloud services and the degree of integration of e-commerce.

Based on the DESI indicator measuring the digital integration of corporations, Hungary is ranked 26th among the 28 Member States. According to the enterprise digitalisation sub-index, only a small portion of Hungarian corporations invest in digital technologies. The digital intensity index shows that 57 percent of the enterprises only have minimal digital technology, which significantly exceeds the EU average of 39 percent (Chart 3-9). Moreover, only a very low ratio of enterprises – roughly 6 percent – use big data for decision-making, which puts Hungary next to the last place in the EU ranking. By contrast, this value in Malta is 25 percent.

In the area of e-commerce, it is mainly Hungary's small and medium-sized enterprises that perform below the average in an international comparison. While based on the ratio of enterprises having their own website Hungary is included on the lower mid-range, the participation rate in online marketplaces is decidedly low (2.5 percent). Online marketplaces reduce information asymmetry for corporations and vis-à-vis consumers, which boosts competition among the actors.[42] This fosters the use of more cost-efficient solutions, which increase productivity.

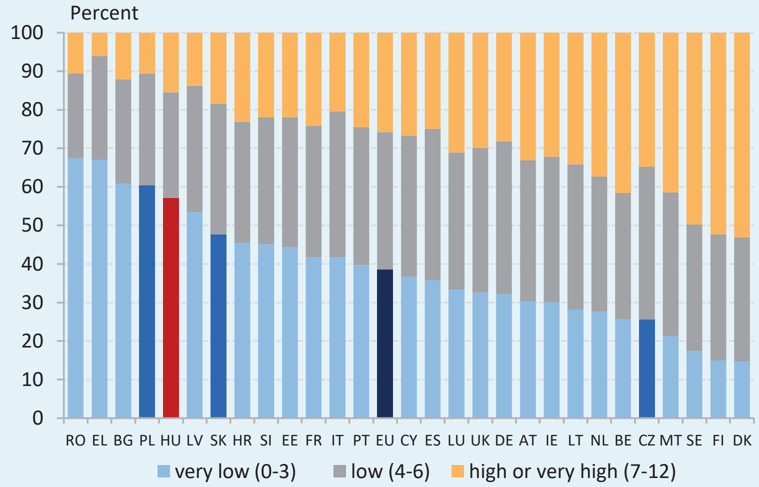
Chart 3-8: Utilisation rate of digital infrastructure by enterprises (2019)



Note: Quotient of the utilisation of digital technology by enterprises and network quality (DESI indices).
Source: MNB calculation based on Eurostat data.

42 For more information on this subject, see the 2019 Growth Report.

Chart 3-9: Distribution of enterprises based on the digital intensity index (DII) in the European Union (2019)



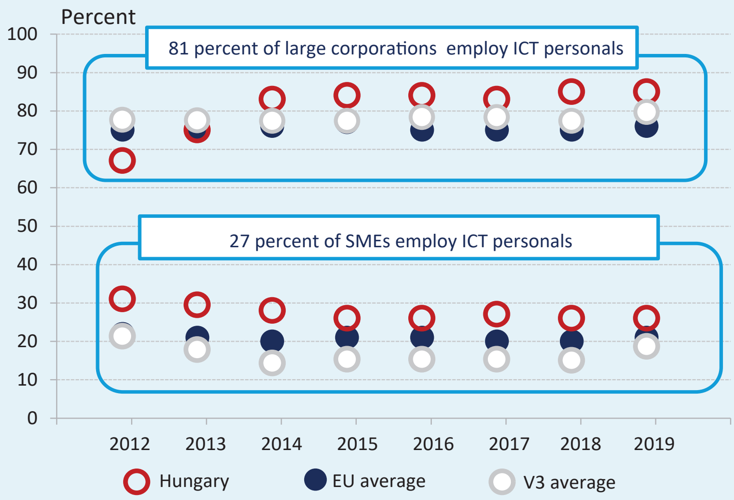
Note: To measure DII, companies had to select the methods used from a 12-item digitisation list, such as: use of ICT protection solutions, internet speeds up to 30 Mbps, use of social media, online commerce, presence of portable devices, value of electronic orders. Very low levels indicate companies using up to 3 digital technologies, low to 4-6, high and very high to at least 7. The figure shows percentages for all companies.
Source: Eurostat.

ICT specialists play a key role in the building of digitalised economy. Enterprises may decide to employ ICT experts or outsource the tasks to external partner companies. However, the continuous education of IT specialists is essential for the welfare of the country. This is evidenced by the fact that there is huge demand in the private sector for IT specialists and the average wage is also well above the national economy average.[43]

Larger enterprises have a better chance to maintain the required team of professionals and thus to employ ICT specialists. This is also confirmed by data: while in the period 2012–2019 on average 27 percent of SMEs employed ICT experts, this value was 81 percent for large corporations (Chart 3-10). Furthermore, large corporations registered strong growth, with the frequency of employment rising from 67 to 85 percent, while SMEs recorded a minor decrease. The Hungarian ICT employment indices exceeded the regional average in recent years, which has positive impact on the penetration of digitalisation.

43 In the infocommunication sector, the monthly gross average wage of full-time employees in 2019 was HUF 624,000, while the national economy average was HUF 368,000 (HCSO).

Chart 3-10: ICT specialists in employment in individual size categories



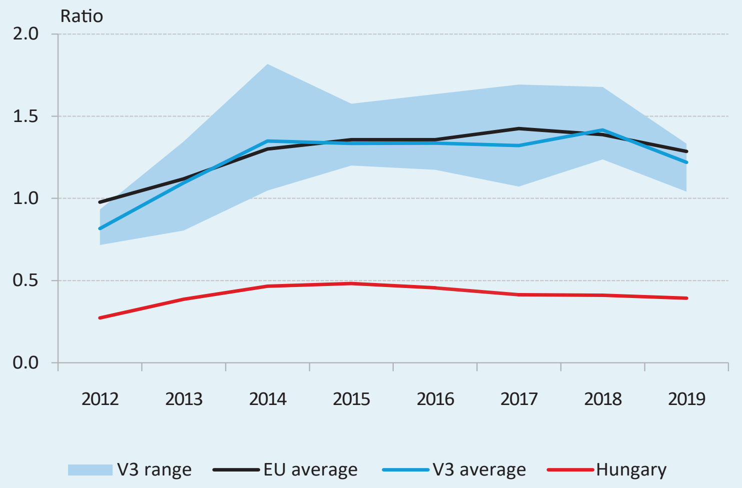
Note: Estimate for 2013, without SMEs and micro enterprises. Average values for the entire period. The EU average values are 76 and 19 percent, respectively.
Source: MNB calculation based on Eurostat data.

However, Hungarian ICT specialist are able to digitise corporate processes to a relatively small degree compared to the V3 and EU countries (Chart 3-11), since the domestic enterprises employing ICT specialists tend to use modern enterprise resource planning and customer relation management software more rarely (ERP and CRM software). One of the common measures of digital economy is the penetration of modern enterprise resource planning (ERP) software, which accelerate enterprises' administration, document and process management systems. ERP systems support the collection, storage, management, processing and interpretation of data generated in certain areas. The software monitors organisational resources, such as cash, inventories, base materials and human resources as well as liabilities, such as customer orders, sub-contractor orders and wage costs. Accordingly, it is of great help for medium-sized or even small enterprises. In addition, major productivity growth may be achieved through the application of customer relation management (CRM) software, since monitoring counterparties, suppliers and customers increases enterprises' adaptability. One of the reasons for the low penetration of modern enterprise resource planning software is the limited nature of domestic enterprise relations. The average small number of partner companies per enterprise (supplier and customer) determines the interconnectedness and complexity of the corporate network. Since the purpose of using ERP and CRM software is to systematise and accelerate enterprises' daily administration, the absence of such software is connected to enterprises' relationship structures.

One possible explanation for the low level of corporate digitalisation is that many Hungarian SME managers have no proper understanding of the obstacles to and opportunities of digital developments. In the 2020 Eurobarometer[44] survey, the topic of which was the willingness of SMEs, start-ups and scale-ups to invest, one of the questions was aimed at the obstacles related to digital developments. The results of the survey show that almost half (47 percent) of the respondent Hungarian SMEs see no obstacle to digital investments, while in the EU only 32 percent of the enterprises were of similar opinion.[45] In its own right, this is positive, but in light of the moderate IT investment activity, it implies that the level of information related to digital technologies is low in the SME sector.

44 Flash Eurobarometer 486 (2020)
45 Possible answers: 1) Uncertainty with regard to the future digital standards (9 percent); 2) Lack of financial resources (14 percent); 3) Legislative obstacles (10 percent); 4) IT security problems (7 percent); 5) Lack of qualifications, including the managers' skills (11 percent); 6) Absence of information technology infrastructure (8 percent); 7) Internal resistance to change (4 percent). It was possible to select more than one response (Flash Eurobarometer 486, 2020).

Chart 3-11: Efficiency of digital specialists

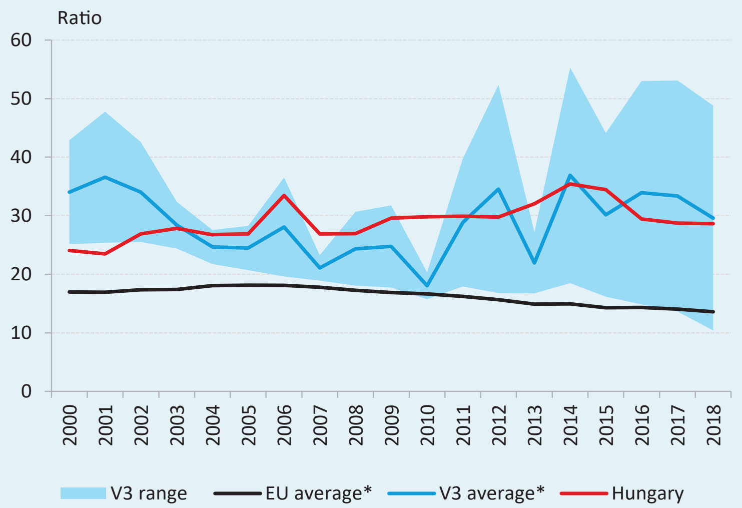


Note: Application of ERP and CRM software by computer-user companies divided by the corporate penetration of ICT specialists (ratio of enterprises employing ICT specialist).
Source: MNB calculation based on Eurostat data.

3.4 Return realised by digital economies

The profit on capital invested in one unit of digitalisation is higher in Hungary than the EU average (Chart 3-12). One reason for this is the low level of digital investments, as presented in Subsection 3.3. However, in terms of profitability, enterprises do have the necessary financial incentives to invest in digital technologies. Return on digital developments is realised faster. Disruptive innovations occur frequently (often implemented by enterprises coming from outside the respective sector), which is best illustrated by the appearance of fintech companies in the financial sector. These companies fundamentally change the operation of the sector, immediately altering business models that were previously believed to be stable. Neo-banks and other financial service providers in the digital space can access millions of customers in a short time, thereby rapidly acquiring a consumer base for their products (for more details on the topic, see the Fintech and Digitalisation Report). It is crucial that regulators keep abreast of these innovations, while at the same time giving the green light to efficiency-improving innovation.

Chart 3-12: Profit ratio compared to enterprises' investments in software and database



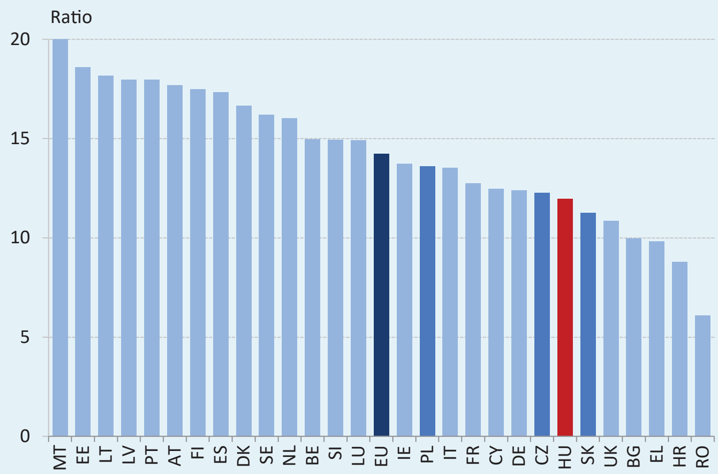
Note: V3 without Poland, average of EU-28 without Poland, Ireland, Cyprus, Portugal and Greece.
Source: MNB calculations based on Eurostat and AMECO.

3.5 Digital efficiency of the state

The government's digitalisation developments create a more efficient framework for the economy. Electronic public administration (e-governance) saves money and time for households and enterprises, while government expenditures also decline; accordingly, these types of investments are vital. The government's digital developments also foster digital developments at enterprises, setting a good example and boosting entrepreneurship. Electronic administration is faster, since the connection of public administration data systems reduces waiting time and there will be fewer personal identification steps. In Hungary, such types of developments include the new e-personal ID card, as a result of which it is not necessary to physically carry a health insurance card, and later it will also be possible to store tickets and season tickets used on public transport on it or verify personal identification from home for official administration.

The maturity of Hungary's e-governance lags behind the EU average (Chart 3-13). Hungary's deficit is particularly large compared to the TOP5 countries, as the Hungarian ratio compared to them is 65 percent. The 5 most developed countries in terms of state digitalisation are: Malta, Estonia, Lithuania, Latvia and Portugal. The indicator takes into consideration the interconnectedness of government registers and the number of administration steps in major civil events (e.g. childbirth or marriage). Compared to the EU average, Hungary's indicator stands at 84 percent. Thus, despite the recent major developments in Hungarian public administration, there is still room for the digitalisation of public administration. Hungary's maturity is ranked 22nd in the EU, preceding Slovakia and Romania.

Chart 3-13: Maturity of digital public administration (2019)



Note: The index is derived from the completeness of public administration systems and the frequency of pre-filled information during public administration (sub-indices of the DESI digital public administration index).
Source: MNB calculations based on Eurostat data.

References

European Parliamentary Research Service (2015): *Industry 4.0: Digitalisation for productivity and growth.* Available at: https://www.europarl.europa.eu/RegData/etudes/BRIE/2015/568337/EPRS_BRI(2015)568337_EN.pdf

Forbes (2013): *A Very Short History Of Big Data.* Available at: https://www.forbes.com/sites/gilpress/2013/05/09/a-very-short-history-of-big-data/#62e7bc0d65a1

Gal, P. – Nicoletti, G. – Sorbe, S. – Timiliotis, C. (2019): *Digitalisation and Productivity: In Search of the Holy Grail – Firm-Level Empirical Evidence from EU Countries,* OECD Economics Department Working Papers, No. 1533, OECD Publishing, Paris. Available at: https://dx.doi.org/10.1787/5080f4b6-en

ITO: ICT Price Basket (IPB). Available at: https://www.itu.int/net4/ITU-D/ipb/#ipbtimeseries-tab

Magyar Nemzeti Bank (2019): *Growth Report,* Magyar Nemzeti Bank, Available at: https://www.mnb.hu/en/publications/reports/growth-report/growth-report-november-2019

Magyar Nemzeti Bank (2020): *FinTech and Digitalisation Report*, Magyar Nemzeti Bank, Chapter 6, Available at: https://www.mnb.hu/letoltes/fintech-es-digitalizacios-jelente-s-final-eng.pdf

Matolcsy, Gy. – Nagy, M. – Palotai, D. – Virág, B. (2020): *Infláció a digitális korban – Az infláció mérése és torzításai a 21 században* (Inflation in the Digital Age: Inflation Measurement and Bias in the 21st Century) Hitelintézeti Szemle (Financial and Economic Review), Vol. 19 Issue 1, March 2020, pp. 5–36.

McKinsey (2018): *Átalakuló munkahelyek: Az automatizálás hatása Magyarországon* (Transforming our jobs: automation in Hungary)

OECD (2019): *Digitalisation and productivity: A story of complementarities.* Available at: http://www.oecd.org/economy/outlook/digitalisation-and-productivity-complementarities/

The Economist (2017): *The world's most valuable resource is no longer oil, but data*. Available at: https://www.economist.com/leaders/2017/05/06/the-worlds-most-valuable-resource-is-no-longer-oil-but-data

4 Ecological productivity

The historically unprecedented growth in the world's economy and population have resulted in increased utilisation of the available natural resources. As a result, the environmental burden has increased in past decades and has now become a tangible barrier to long-term sustainable growth. Natural resources are not merely input factors of production, but also serve as a framework for it. The volume of available resources is finite, and thus – with a view to ensuring sustainable growth – the depletion of resources and environmental damages must be prevented, i.e. efforts should be made to use resources efficiently also in ecological terms.

Ecological productivity means the efficiency of absorbing the environmental resources (or harmful substances, waste) necessary for producing the value added created by an entire economy (macro) or by an enterprise (micro). Acquiring production and consumption habits consistent with the principles of a circular economy also contributes to reducing waste generation in the economy, the emission of greenhouse gases, energy consumption and material use. With economic policy taking on an active role, it may greatly foster the shift in attitude necessary to curb the presently unsustainable processes and may become the driver for a turnaround.

Hungary is ranked favourably in ecological productivity in a regional comparison. Recently, there has been a positive change in ecological terms, but there is still room for improvement. The value added per one unit of carbon dioxide emissions has improved significantly recently and is close to the EU average. In this respect, Hungary stands at 89 percent of the EU average, while compared to the average of the TOP5 EU countries this value is merely 48 percent. The order of the five most efficient countries is as follows: Sweden, Malta, Ireland, Denmark and France. There is an improving trend in the green productivity ratios in a wide range of sectors. Over the past two decades, ecological productivity calculated as value added per unit of carbon dioxide emissions has almost doubled in manufacturing. The ecological productivity of the service sector rose by almost 40 percent. Under major volatility, there has been a moderate improvement in the ecological productivity of agriculture, as reflected in improved crop yields. On the other hand, there is a deteriorating trend in construction, where ecological productivity decreased by 40 percent over the past two decades.

On the other hand, the Hungarian economy fall short compared to the developed Western European countries in material productivity, while in a regional comparison Hungary's indicator can be considered average. In this respect, Hungary stands at 53 percent of the EU average, while compared to the average of the TOP5 EU countries this value is merely 33 percent. The order of the five most efficient countries is as follows: the Netherlands, the United Kingdom, Luxembourg, Italy and Belgium. Based on an international comparison, a higher share of industry in economy is accompanied by a higher material requirement, and thus material efficiency is a more important consideration in these countries.

In 2018, slightly more than 37 percent of municipal waste was recycled in Hungary, which somewhat exceeds the average of the region, but falls short of the EU average. Due to the penetration of renewable energy sources, dependence on fossil fuel fell by 15 percent over the past one and a half decades. Although in recent years the volume of electricity from renewable resources (produced from biomass, water, solar and wind energy) has increased significantly in Hungary, still only roughly 12 percent of the total power generation comes from such sources. Among the EU countries, Sweden, Finland and Latvia are the leaders in the exploitation of renewable resources, with the share of renewable energy reaching at least 40 percent in each of those countries.

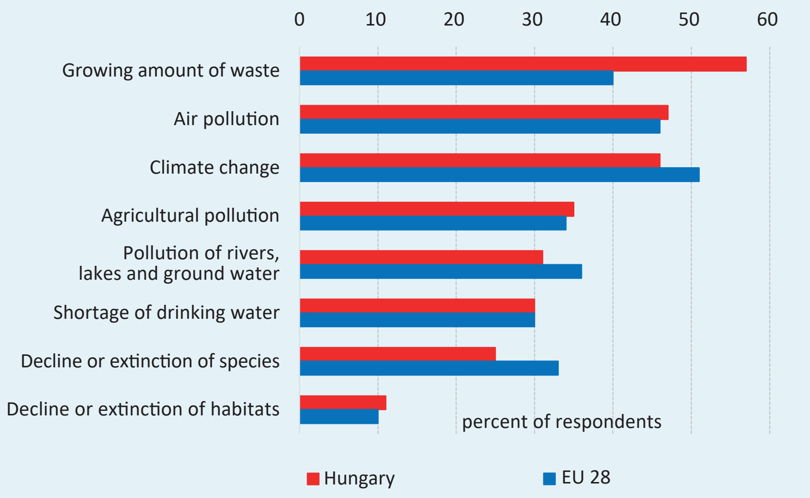
In parallel with the emergence of the decarbonisation process, Hungary may gradually change over to the low carbon dioxide emissions economic model. The economy's improving energy absorption efficiency and increasing material and waste productivity both contribute to the favourable trend.

4.1 Introduction

In past decades, the environmental burden resulting from economic activity has assumed increasing proportions, and thus over the longer term the assessment of sustainable growth should not ignore ecological aspects. In past decades and centuries, the supply of goods and services improved to an unprecedented degree. As a result of the exceptional growth, vast swathes of society emerged from extreme poverty. In the past century, there was six-fold growth in global real GDP per capita. In parallel with the improvement in healthcare, infant mortality decreased and life expectancy at birth increased. As a result of the foregoing, the global population has been steadily growing. While in 1900 global population was 1.6 billion, by the end of the 2010s it exceeded 7.6 billion.

The historically unprecedented growth in the world's economy and population resulted in increased utilisation of the available natural resources. Ignoring the ecological aspect of economic development entails, among other things, negative externalities such as emission of greenhouse gases at an increased rate, the volume of waste assuming increasing proportions, global warming, extreme weather conditions, loss of forest areas and biodiversity (MNB, 2019). Air pollution and extreme weather conditions all affect the quantity and quality of the factors of production. Negative externalities not only cause material damages, but also deteriorate living conditions. Based on Eurobarometer, most of the respondents specified the growing amount of waste, air pollution and climate change as environmental concerns both in Hungary and in the European Union (Chart 4-1).

Chart 4-1: Environmental concerns



Source: EC (2017) "Attitudes of European citizens towards the environment", Special Eurobarometer 468.

Efficient absorption of the remaining and available resources in ecological terms is essential for long-term sustainable growth. The more efficiently ecological aspects are implemented, the sooner we can embark on a long-term growth path which is sustainable over many decades and centuries. The volume of available resources is finite, and for this very reason excessive absorption of those may hit the next generations hard. Sustainable absorption of resources is essential for sustainable growth.

In the past period, the global economy has followed an increasingly resource-intensive development model, but a new concept is needed. Essential points of the new concept include efforts to prevent the depletion of resources and reduce damage to the environment, while at the same time maintaining conditions for growth. By implementing the principles of a circular economy in practice, the value of resources can be preserved for a longer time, while the volume of waste generated is minimal. In order to come closer to circular economy, everyday production and consumption habits must be altered. Following the successful implementation of ecologically more efficient production, the economy will be much less resource-intensive, as the enterprises will become more productive. Acquiring consumption habits consistent with a circular economy also contributes to reducing waste generating in the economy, the emission of greenhouse gases, energy consumption and material use.

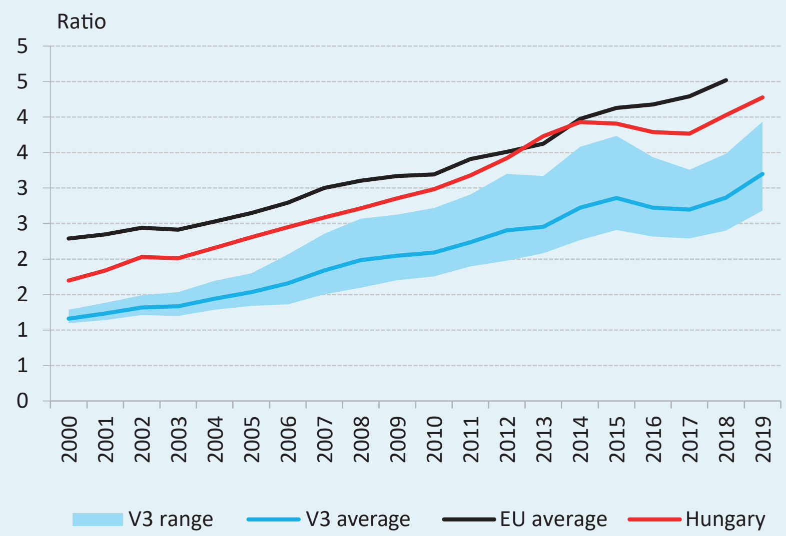
As economic policy takes on an active role, it may greatly foster the shift in attitude necessary to curb the presently unsustainable process and it may become the driver of a turnaround. Through taxes and subsidies, it may be able to foster development and investment processes that point to green growth. Upon realising a green growth scenario, the economy follows a desirable path that achieves growth in the respective period in an ecologically sustainable manner, while at the same time preserving natural resources underlying the welfare of future generations. An economy that operates in a manner that is sustainable in the longer run has a number of advantages. It reduces the harmful effects caused by negative externalities, increases productivity, improves resource management, increases welfare, and – last but not least – also has positive physiological effects. In order to achieve green growth, we need green investments that are capable of maintaining the conditions of growth while at the same time efficiently absorbing natural resource. The focus of discourses on sustainability is on increasing ecological productivity (Virág, 2019).

4.2 Measurement of ecological productivity

Ecological productivity means the efficiency of absorbing the environmental resources (or harmful substances, waste) necessary for producing the value added created by an entire economy (macro) or by an enterprise (micro). Ecological productivity measures the volume of natural resources required for producing goods or services and the environmental burden generated by production. There are several possibilities of quantifying ecological productivity depending on the approach.

Hungary is ranked first in ecological productivity in a regional comparison. Since 2000, the value added per unit of carbon dioxide emissions has more than doubled in Hungary, i.e. ecological productivity improved significantly (Chart 4-2). By enhancing the ecological productivity of production under constant emission level, the Hungarian economy is capable of producing twice as much goods. This figure is outstanding in a regional comparison, well exceeding the V3 average and coming close to the EU average in the past one and a half decade. In this respect, Hungary stands at 89 percent of the EU average, while compared to the average of the TOP5 EU countries this value is merely 48 percent. Sweden, Malta and Ireland excel among the EU countries.

Chart 4-2: Value added per unit of carbon dioxide emissions



Source: MNB-calculation based on Eurostat and IEA.

Box 4-1: Analytical description of the environmental impact of human activity by the IPAT formulal

The IPAT formula is one possible method of describing the environmental effect of human activity. The correlation in its original form was published by Ehrlich and Holdgren (1971). The equation was published in the form below:

Impact (I) = Population (P) X Affluence (A) X Technology (T) (1)

According to their assumption *T* is the inverse ecological productivity index, calculated as the quotient of environmental impact *(I)* and total economic activity *(P*A).* Based on the inverse correlation, it is not obvious that the increasing of ecological productivity reduces the environmental burden of economic activity. Due to this, it is advisable to revise and transform the formula.

Let us indicate ecological productivity with *X*. Considering that *T* is the inverse ecological productivity index, then *X=1/T.* Substituting this correlation in equation (1), we obtain the following equation:

$$I = PA * (1/X) \qquad (2)$$

The transformation of the formula results in the growth of *X* rather than in the decrease of *T* when we examine the impact of increasing ecological productivity.

Taking into consideration that the economic processes are interrelated, it is worth allocating technologies to two separate categories. The technical literature differentiates physical and social technology. The essence of the first is to enhance the method of its production, while of the latter one is to improve the division of labour and coordination. When the practice of the labour division tasks is not aligned with a technological innovation, it may happen that the improvement of physical technology deteriorates social technology, which on the whole worsens macroeconomic efficiency rather than improving it.

At the time of their introduction, new technologies do not necessarily form integral part of the economy as a whole, and due to this their integration in economic processes may entail additional investments. Increasing the efficiency of the technology applied in production alone is a necessary, but not sufficient condition of increasing the ecological productivity of the economy. The improvement of human capital and harmonisation of the labour division duties are also essential. A practical example of this is when a country employing technology of low efficiency imports highly efficient technology from a developed country. It must acquire the knowledge necessary for the operation and servicing of the imported technology, and create the workshops essential for those. The creation of workshops represent additional (social) technological innovation. This is why Bajmócy – Málovics (2011) propose the integration of the breakdown of technological change in the dynamic version of the IPAT formula.

Hereinafter, *ΔX* denotes the change in technology, Δtp the change in physical technology and Δts the change in social technology. After transformation, the formula is as follows:

$$\Delta X = \Delta tp + \Delta ts \qquad (3)$$

In the framework under review, Δtp inevitably may only take a positive value, but Δts may also be negative. Due to this, innovation is only able to increase ecological productivity at the macro level, if the increase in physical efficiency has no negative impact on social technology.

In summary, the macro level ecological productivity of an economy is influenced by the production method and division of labour employed by the enterprises of the respective economy. At the micro level, an enterprise may become capable of raising the ecological productivity of its production through innovation, and during its production higher value added is created per unit of pollution. At the macro level, improvement in the ecological productivity in a country or region is achieved through innovations that enhance the ecological productivity (physical and social) of enterprises.

According to Bajmócy – Málovics (2011), an enterprise can enhance its ecological productivity in terms of the following seven components:

- reducing the material intensity of goods and services,
- reducing the energy intensity of goods and services,
- reducing the emission of toxic compounds,
- increasing material recycling,
- maximising the sustainable consumption of renewable resources,
- extending the lifetime of goods, and
- increasing the service intensity of goods and services (Bajmócy – Málovics, 2011).

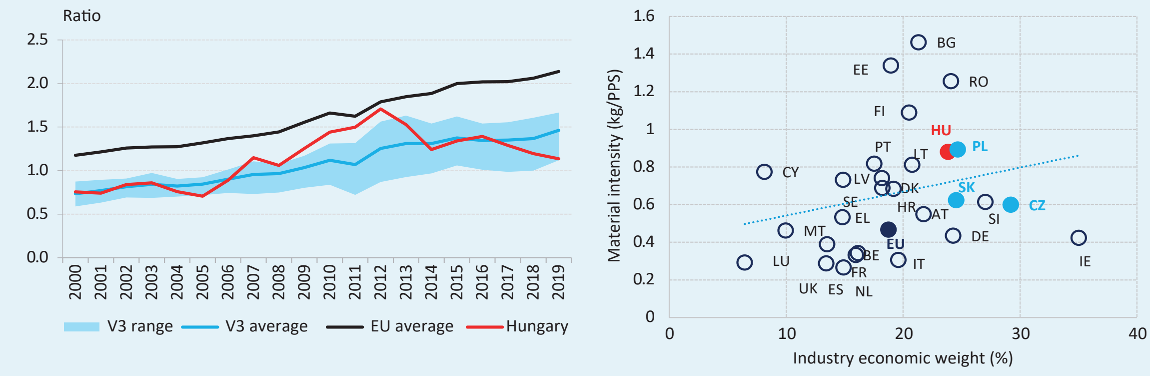
In the next part of the Productivity Report, we examine the ecological productivity of the Hungarian economy based on the aforementioned criteria relying on empirical data, in a regional and European Union comparison.

4.2.1. Material productivity

Sustainable material management is particularly important for Hungary, as the country is poor in raw materials, and is thus dependent on energy and raw material imports. Open economies, such as the Hungarian economy, are characterised by higher demand for imported raw materials, as a major part of finished product exports is based on raw material imports. Nevertheless, the Hungarian economy is less resource intensive than the economy of the other European OECD member states. The more moderate resource requirement reduces not only environmental sustainability, but also external balance and economic dependence.

Hungary's material productivity is better than the OECD average. Material productivity is defined as the value added per unit of domestic material consumption. A country's material productivity improves when it is able to produce one unit of value added with lower material consumption, and at macro level, when the economy grows faster than its material consumption. Relatively speaking, the economy detaches from its raw material demand when it is able to produce higher value added by absorbing a specific volume of material. Based on the OECD data, Hungary's material consumption per capita is around 30 kg/person, which is lower than the OECD average of 35 kg/person (OECD, 2018). Hungary's material productivity trend fits into the regional pattern, and in certain years it was even better (Chart 4-3). In this respect, Hungary stands at 53 percent of the EU average, while compared to the average of the TOP5 EU countries this value is merely 33 percent. Based on international comparison, a higher share of industry in the economy is accompanied by a higher material requirement, and thus material efficiency is a more important consideration in these countries.

Chart 4-3: Value added per unit of domestic material consumption (left), relation between material intensity and the weight of industry (right)



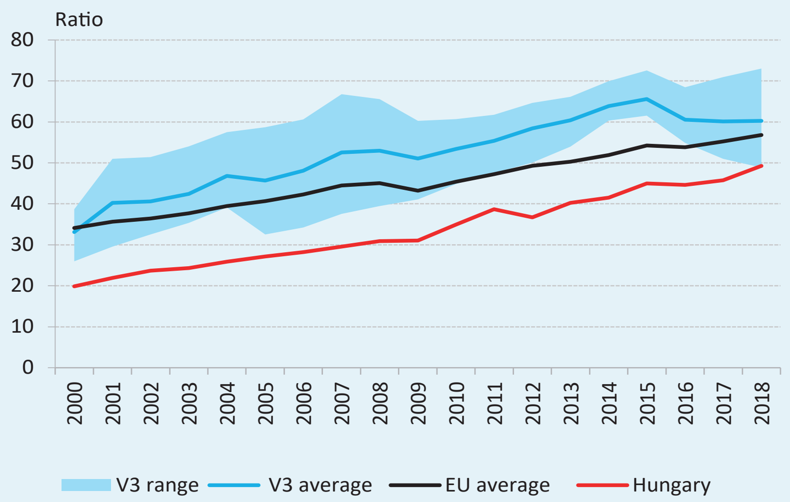
Note: The chart illustrating the relation between the material intensity and the weight of industry was prepared based on data from 2019.
Source: MNB-calculation based on Eurostat.

Ecological productivity can be raised by increasing material productivity. Prolonging the life cycle of products and recycling materials has a beneficial effect on the environment. The degree of environmental burden may be reduced, not only by improving material productivity, but also by including the positive impact of waste management and considering the full life cycle of products. Material circulation is the core of the principle in the circular economy.

4.2.2. Waste productivity

Growing population and higher income levels entail the production of larger volumes of waste. However, this trend may be decelerated and turned around via green investments, more intensive waste collection and recycling. Compared to 2008, the volume of recycled waste almost doubled in Hungary, while the rate of municipal waste generation started to decouple from the growth rate of the economy (OECD, 2019). In 2018, municipal waste generation per capita was 381 kg/ person in Hungary, which is well below the EU average of 492 kg/person. Over the past one and a half decades, the degree of municipal waste generation fell by 18 percent in Hungary, while the volume of hazardous waste generation declined by 74 percent during the same period (OECD, 2018). International waste productivity trends are improving, in which the trends observed in Hungary fit well (Chart 4-4). Although the Hungarian waste productivity value more than doubled in the past two decades, it still falls short of the regional and EU average.

Chart 4-4: Value added per unit of municipal waste generation



Source: MNB calculation based on Eurostat.

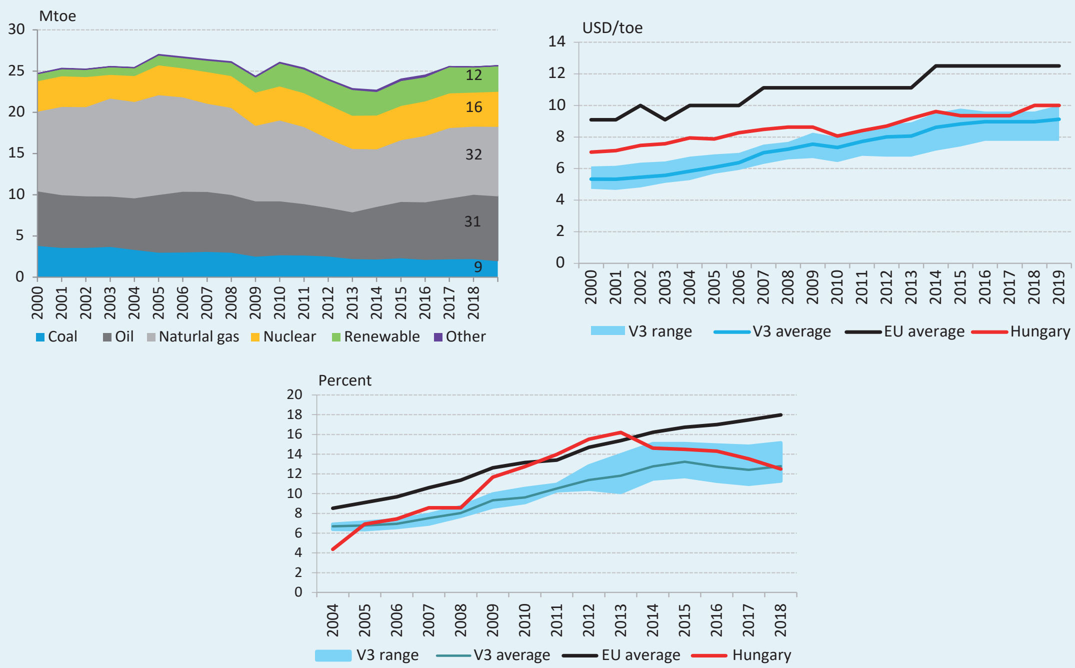
With the selective collection and recycling of recyclable materials, the economy's demand for raw materials can be reduced, along with the demand for primary energy sources. Waste management and recycling is one of the key elements of sustainability. Based on empirical data in 2018, slightly more than 37 percent of municipal waste was recycled in Hungary, which somewhat exceeds the average of the region, but falls short of the EU average. Most countries register a positive trend, with an increasing ratio of recycled waste. Waste containers suitable for selective waste collection appear at an increasing number of places in Hungary, and households also exhibit increasing willingness to collect waste selectively.

4.2.3. Energy absorption efficiency

Energy absorption efficiency is one of the cardinal criteria of ecological productivity, since it shows the volume of value added that can be created by absorbing one unit of energy. The more output that can be produced per unit of energy consumption, the more efficient and sustainable the production process is. The energy absorption efficiency of the Hungarian economy may be deemed good in an international comparison and it is improving year by year (Chart 4-5, right). Similarly to the energy absorption efficiency of the Hungarian economy, the international trend is also positive.

Owing to the penetration of renewable energy sources, Hungary's dependence on fossil fuels has declined. Similarly to most countries, the Hungarian economy also relies on fossil fuel to a large degree, which accounted for almost 70 percent of the total primary energy supply (Chart 4-5, left). Due to the penetration of renewable energy, dependence on fossil fuel has declined by 15 percent since 2000. The share of renewable energy sources relative to the total primary energy supply exceeded 12 percent by 2018, and in this respect only the Czech Republic is ahead of Hungary among the V4 countries. Although in recent years the volume of electricity from renewable resources (produced from biomass, water, solar and wind energy) has increased significantly in Hungary, still only roughly 12 percent of total power generation comes from such sources. These factors also contributed to the improvement in Hungary's ecological productivity. Among the EU countries, Sweden, Finland and Latvia are the leaders in the exploitation of renewable resources, with the share of renewable energy reaching at least 40 percent in each of those countries.

Chart 4-5: Sources of energy (left), energy absorption efficiency (right) and share of renewable energy sources (bottom)



Note: The numbers in the left pane show the distribution of the energy source. Mtoe is million tonne oil equivalent, while toe is tonne oil equivalent.
Source: MNB-calculation based on Eurostat and IEA.

With economic policy taking an active role, it may foster the use of renewable energy sources instead of non-renewable energy sources to an increasing degree. Under a differentiated subsidy and tax regime it can be achieved that market and non-market participants turn to the use of renewable energy sources. This can help reduce carbon dioxide emissions, further increasing the economy's ecological productivity. In recent years, several government support programmes have been announced in Hungary, for which it is still possible to apply. In addition to the subsidies for the energy efficiency of buildings using renewable energy, it is possible to apply for the installation of solar panel systems.

The decrease in dependence on fossil fuels has a number of benefits. On the one hand, it reduces Hungary's dependence on fuel imports, and on the other hand the substitution of power plants using fossil fuel with renewable energy sources is a significant change both in terms of environmental protection and sustainability. As the energy sector accounts for a significant portion of emissions, the use of renewable energy instead of fossil fuels may substantially reduce emissions of greenhouse gases.

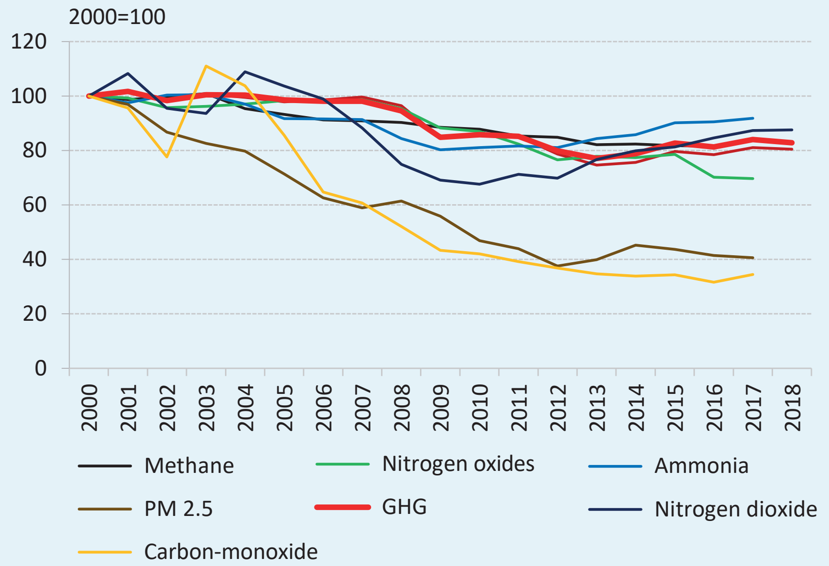
In parallel with the emergence of the decarbonisation process, Hungary may gradually change over to the low carbon dioxide emissions economic model. The economy's improving energy absorption efficiency and increasing material and waste productivity both contribute to the favourable trend.

4.2.4. Emissions of greenhouse gases

With a view to ensuring sustainability, the volume of greenhouse gases emitted during production must be reduced. It is now a well-known fact that excessive atmospheric concentration of greenhouse gases and dust increase the global average temperature. With due care and an approach that focuses on environmental considerations, this process can be slowed down.

In Hungary, greenhouse gas emissions have been decreasing since 2000, which greatly contributes to the improvement in Hungary's ecological productivity. While emissions of air pollutants decreased by 18 percent between 2000 and 2018, the economy grew by 53 percent. The decrease in emissions of air pollutants was attributable to the structural transformation of chemical industry, the modernisation of buildings and lower utilisation of fossil fuels (Chart 4-6). Carbon monoxide, particulate matter (PM 2.5) and various nitrogen oxides were reduced to the largest degree.

Chart 4-6: Emissions of air pollutants



Note: GHG indicates greenhouse gases.
Source: MNB-calculation based on Eurostat.

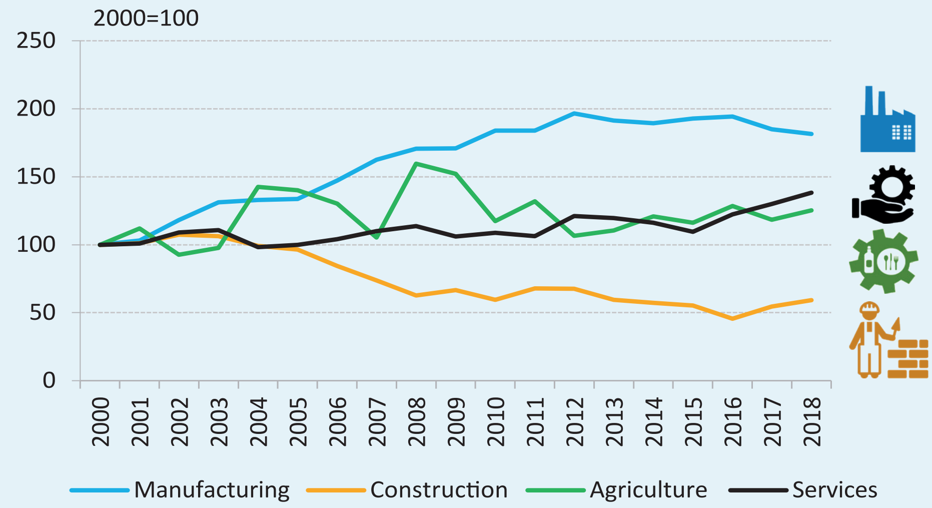
The greenhouse effect is a natural process, without which the average temperature on Earth would be lower by 30 degrees Celsius. The name of greenhouse gases originates from the fact that they absorb heat reflected from the Earth's surface, and thus it does not escape from the atmosphere, thereby causing a greenhouse effect and raising the average temperature. Water vapour is responsible for the greenhouse effect to the largest degree. However, water vapour is the result of a natural process as well, with minimum human impact, and it stays in the atmosphere for a very short time, only for a few days. By contrast, the impact of human activity on the atmospheric concentration of gases listed in Chart 4-6 is significant, and these gases stay in the atmosphere for a long time (10-200 years). A surge in the atmospheric concentration of these gases can be observed since industrialisation. The phenomenon is mostly attributable to the use of fossil fuels as well as of fertilisers and chemicals used for agricultural production.

4.2.5. Sectoral breakdown

Energy absorption is also influenced by the structure of the economy. The energy intensity and GHG emissions of individual economic sectors also vary. We regarded those sectors to be of higher ecological productivity that produce one unit of value added under low absorption of harmful substances.

There is an improving trend in the green productivity ratios in a wide range of sectors. Over the past two decades, ecological productivity calculated as value added per unit of carbon dioxide emissions has almost doubled in manufacturing (Chart 4-7). The ecological productivity of the service sector rose by almost 40 percent. Services typically require smaller material expenditures, due to which their emissions are lower compared to industrial activities. A large part of the service sector's emissions is attributable to transport and storage. Under major volatility, there has been a moderate improvement in the ecological productivity of agriculture, as reflected in improved crop yields. On the other hand, there is a deteriorating trend in construction, where ecological productivity decreased by 40 percent over the past two decades.

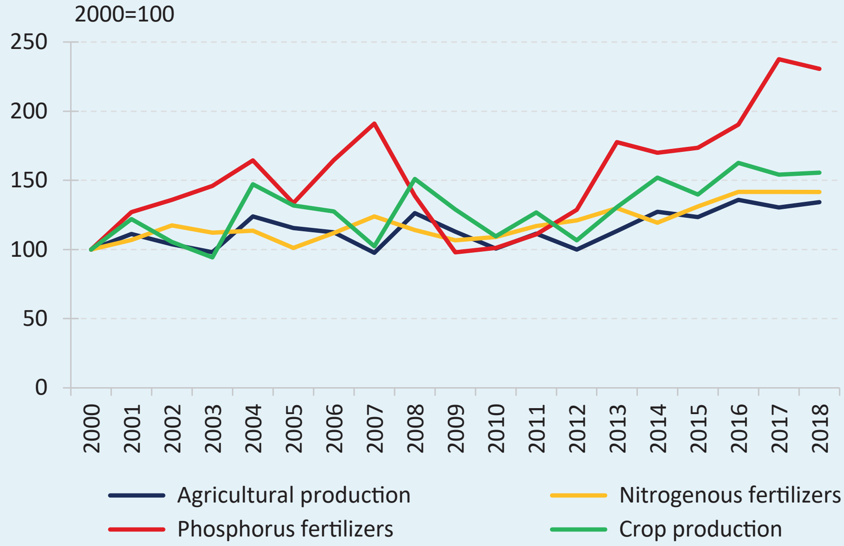
Chart 4-7: Change in value added by sector in relation to direct CO_2 emission



Source: MNB-calculation based on Eurostat and HCSO.

Emissions of greenhouse gases come mostly from the activity of the energy sector, transport and agriculture. The energy sector contributes to the largest degree (22 percent) to greenhouse gas emissions. Half of the energy sector's high ratio comes from the use of old, inefficient power plants. Transport is the other sector with the highest emission, accounting for 20 percent of emissions. Emissions from transport have moved on an upward trend in the past 20 years. Accordingly, changeover to cleaner transport is of particularly high importance. The share of agriculture in emissions is relatively high (12 percent) and it is rising, and also exceeds the average of the OECD member states. The volume of agriculture's greenhouse gas emissions stems from the use of chemicals and fertilisers. In examining the time series data, it can be observed that the use of phosphorous fertilisers more than doubled since 2000, while the use of nitrogenous fertilisers moves closely together with agricultural production (Chart 4-8).

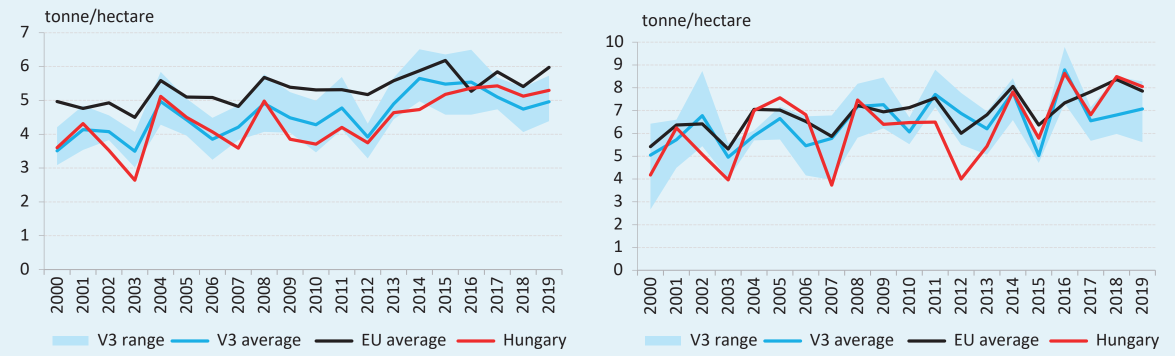
Chart 4-8: Agricultural production and use of fertilisers



Source: HCSO, STADAT.

In recent years, the crop yields of Hungarian agriculture reached the EU average (Chart 4-9). Over the past two decades, the crop yields in agriculture improved, which is mostly attributable to rising capital intensity, the use of fertilisers and the penetration and modernisation of irrigation systems. At the same time, there is still major room for development in irrigation. While between 2000 and 2010 maize crop yields in Hungary fell short of the EU average by 10 percent, this value rose to -0.1 percent in the past 5 years. The shortfall of Hungarian wheat crop yields compared to the EU average yield during the same period rose from -18.8 percent to -4.4 percent. In recent years, the crop yield of wheat and maize exceeded the average of the region.

Chart 4-9: Wheat (left) and maize (right) crop yield per hectare



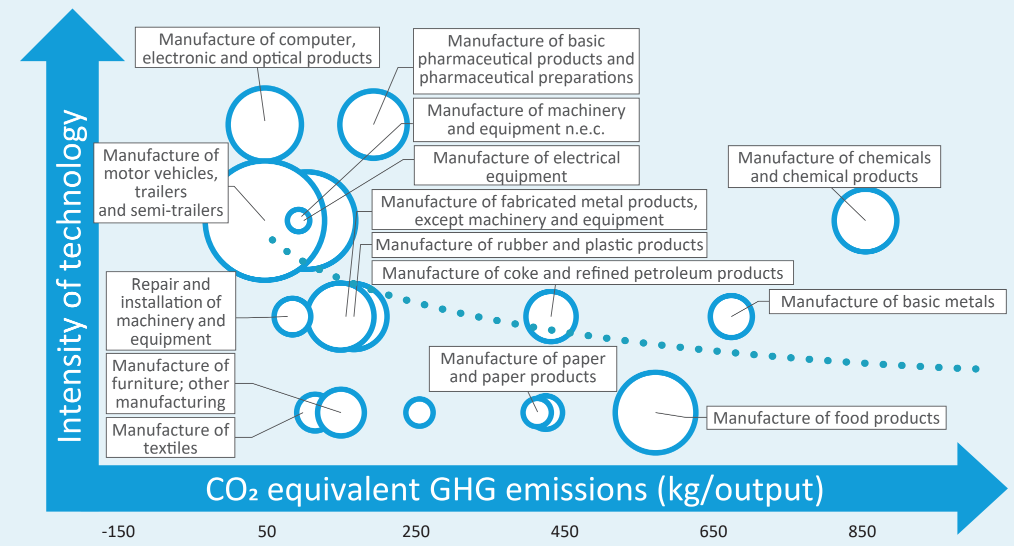
Source: MNB-calculation based on Eurostat.

Economic sectors are not independent of each other. Relying on the Input-Output Table (IOT) and considering spillover effects, it is possible to calculate the total ecological productivity of the individual sectors. In view of the fact that the absorption of harmful substances may be interpreted as material expenditure, we should identify a benchmark that also contains the sectors' intermediate consumption. In this respect, gross output is the appropriate indicator, as it contains – in addition to the value added – taxes on production and subsidies on production, imports and the absorption of domestic input consumption. The operation of economic sectors are not independent of each other. Due to this it would be misleading to assess sectors on their own and isolated, since through their activity the individual enterprises and sectors cover not only one segment, but are related to several other enterprises and sectors. Thus, it may happen that an otherwise ecologically efficient enterprise purchases base material that was produced in a relatively polluting way (e.g. agricultural products, chemical industry base materials, base materials produced with high energy consumption), and thus the end product is also not produced in an ecologically efficient way. The national statistical offices publish their Input-Output tables to answer these and similar questions. The tables describe the relations between the industries and sectors in a consistent framework, and thus the ecological productivity of the individual sectors can be calculated, while taking into consideration the spillover effects. However, the latest tables are available for 2015; they are suitable for calculations, but they do not reflect the changes in economic structure after that (GHG emissions data by sector are from 2018). Relying on the Leontief inverse, which can be obtained by the mathematical transformation of the Input-Output tables, the total emissions content can be calculated.[46]

Enterprises using more advanced technology have lower emissions (Chart 4-10). However, the obtained lower degree of emission is partly attributable to methodological effects. Namely, the Input-Output tables only contain domestic relations at the sector level, and thus the emissions attributable to imported products cannot be measured using this method. Due to this, the environmental burden of import-intensive industries are presented only partially without the foreign part of the production chain. It may be attributable to the high import demand that – although the emissions intensity of the manufacture of transport equipment is high globally – the Hungarian value is low (Chart 4-11).

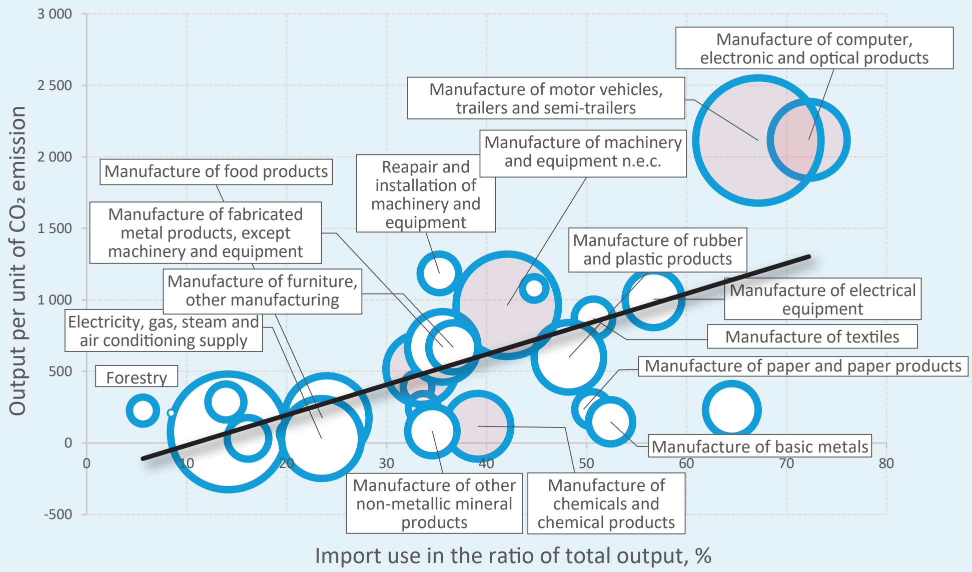
46 See further information about IOT and Leontief inverse calculation in Koppány (2017)

Chart 4-10: GHG emissions of sectors based on their technology intensity



Note: The size of the bubbles indicate the weight of the sectors.
Source: MNB-calculation based on Eurostat and HCSO.

Chart 4-11: Emissions of sectors based on import absorption



Note: The size of the bubbles indicate the weight of the sectors.
Source: MNB calculation based on Eurostat and HCSO.

References

Bajmócy, Z. – Málovics, Gy. (2011): *Az ökológiai hatékonyságot növelő innovációk hatása a fenntarthatóságra* (The effects of eco-innovations on sustainability), Közgazdasági Szemle (Economic Review), Vol. LVIII, October 2011 (pp 890–904).

Ehrlich, P.R. – Holdren, J.P. (1971): *Impact of Population Growth,* Science, New Series, Vol. 171, No. 3977. (Mar. 26, 1971), pp. 1212–1217.

Koppány, K. (2017): *Makrogazdasági és regionális hatáselemzés multiplikátor modellekkel* (Macroeconomic and Regional Impact Analysis with Multiplier Models), Széchenyi István University. ISBN 978-963-06-4385-6

Magyar Nemzeti Bank (2019): *Growth Report,* 2019, Magyar Nemzeti Bank, Budapest, ISSN: 2416-3643, Download link: https://www.mnb.hu/letoltes/novekedesijelentes-2019-digitalis-en.pdf

OECD (2018): *Environmental Performance Reviews: Hungary 2018,* OECD Publishing, Paris

OECD (2019): *Waste Management and the Circular Economy in Selected OECD Countries: Evidence from Environmental Performance Reviews,* OECD Environmental Performance Reviews, OECD Publishing, Paris, ISBN 978-92-64-30939-5

Virág, B. (ed.) (2019): *A jövő fenntartható közgazdaságtana* (Long-term Sustainable Econo-mix), Magyar Nemzeti Bank, Budapest, ISBN: 978-615-5318-28-3, Available at: https://www.mnb.hu/en/publications/mnb-book-series/long-term-sustainable-econo-mix

1. ANNEX

The productivity ratios belonging to the individual pillars present the ratio of two variables. Formally this means that we divide a valuable ouput (gain, numerator) by a scarce resource (using item as denominator). In the table below, we summarised the productivity indicators used in the report, the derivation of those and the reference year of the latest available data.

Table 1: Various productivity ratios and their quantification

VARIABLE NAME	NUMERATOR	DENOMINATOR	DATA YEAR
I. LABOUR PRODUCTIVITY			
GDP per employment (PPS)	GDP (PPS)	Employment (total, national accounts concept)	2019
GDP per hour worked (PPS)	GDP (PPS)	Full Time Equivalent	2019
SME labour productivity in comparison to the EU labour productivity	Labour productivity of SMEs (PPS)	EU-28 labour productivity (PPS)	2018
II. EFFICIENCY OF INNOVATION			
Patents in the ratio of R&D expenditures	Patent applications	National R&D expenditures (PPS)	2018
Gap to EU average for the average number of citations per document by issuance year	Citations per document HUN	Citations per document EU	2019
Output of knowledge-producing sectors for intermediate consumption within the total intermediate consumption of the national economy	Knowledge-producing sectors' aggregated output for domestic intermediate consumption	Total economy intermediate consumption	2015
R&D expenditures of domestically owned companies in the ratio of total business R&D expenditures	R&D expenditures of domestically owned companies	Total Business R&D expenditures	2017
III. DIGITALIZATION EFFICIENCY			
Utilisation rate of digital infrastructure by households	Use of internet services (DESI index)	Connectivity (DESI index)	2019
Households' digital skills and quality of infrastructure	Digital skills, human capital (DESI index)	Connectivity (DESI index)	2019
Utilisation rate of digital infrastructure by enterprises	Integration of digital services (DESI index)	Connectivity (DESI index)	2019
Efficiency of digital specialists	Proportion of companies using ERP and CRM softwares	Proportion of companies employing ICT specialists	2019
Maturity of digital public administration	Completeness and connectedness of the digital public sector (DESI-index)		2019
IV. ECOLOGICAL PRODUCTIVITY			
Value added per GHG emission	Value Added (PPS)	CO_2 Equivalent GHG Emission	2018
Energy absorption efficiency	Value Added (PPS)	Total Energy Supply	2019
Share of renewable energy	Renewable Energy Supply	Total Energy Supply	2018
Value added per Domestic material consumption	Value Added (PPS)	Domestic Material Consumption	2019
Value added per Municipal waste generation	Value Added (PPS)	Municipal Waste Generation	2018

Source: MNB compilation

List of Charts and Tables

Ányos Jedlik

Hungarian naturalist, inventor, a Benedictine monk, university professor and academic

(Szímő, 11 January 1800 – Győr, 13 December 1895)

Ányos Jedlik, a Benedictine monk and naturalist, dedicated his life to the study of electromagnetism and light. Although Jedlik's name has remained in the public mind primarily because of the dynamo and soda water, the scientist pursued a much more diverse research programme, and by describing the principle of dynamo and self-excitation, he even preceded his world-famous contemporaries.

The inventor was born under the name of István Jedlik in Szímő, Komárom county. His parents were simple farmers, yet Jedlik's father put great emphasis on his son's education, so after the third grade of high school, he sent the child to the Benedictines in Pozsony (Bratislava). Jedlik soon applied to Pannonhalma, and in 1847, he also entered the Order of Saint Benedict. That is when he took on the first name Ányos.

He later continued his studies in Győr and then at the University of Pest, where he earned a doctorate at the age of 22. Already at the beginning of his career, Jedlik had a wide range of interests, as he embarked on research in physics, chemistry and optics as well. In 1821, even as a university student, he published an article about what he called "lightning-magnetic self-rotor", which he indeed built around 1827–1828.

The device was an early electric motor, which, due to electromagnetism, made a continuous rotational motion. Furthermore, the lightning-magnetic self-rotor laid the foundation for Jedlik's later discoveries, as the dynamo created by 1861, the tubular voltage generator built by the early 1870s, or even the invention of the arc lamp presented in Pannonhalma in 1856 were due to the scientist's efforts to develop more and more powerful devices.

After his ordination in 1825, Ányos Jedlik taught in Győr. The scientist accepted a position in Pozsony in 1831, and then in 1839 at the department of the University of Pest, and a year later, he was appointed to a chair as a head of department. In 1846, Jedlik became the Dean of the Faculty of Humanities. In 1848–1849, he joined the National Guard, and therefore he soon lost his teaching position. However, even after having been set aside, the great scientist worked for the benefit of his nation and science.

He printed at his own expense his university textbook's first volume entitled Súlyos testek természettana [Physics of Heavy Bodies]. In 1858, Jedlik was immediately made a full member of the Hungarian Academy of Sciences, and five years later, he was appointed as Rector of the University of Pest. The inventor finished his earthly course on 13 December 1895.

The physicist Lóránd Eötvös said of Ányos Jedlik: "His patriotism was just as simple as he himself was, not something viewed as a merit entitling him to a special reward, but only the fulfilment of his duty, yet multiplied in the hearts of millions it is the strongest guarantee of the life and prosperity of a nation."

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