Chapter 3
Innovation, human capital and competitiveness in Central and Eastern Europe with regard to the challenges of a digital economy

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1. Introduction

The objective of this paper is to examine how the competitiveness of the four Central Eastern European EU members states (the four Visegrad countries – the V4, namely Poland, Czechia, Slovakia and Hungary) developed over the post-crisis 2008-2015 period and how these changes were related to innovation and human capital development. In particular, changes in the competitive position of these countries will be discussed in the context of the development of a digital economy. The focus is on two pillars of competitiveness, innovation and human capital, and how they facilitate the development of a digital economy.

Competitiveness has been at the heart of economic debates among academics and policymakers since the 1980's. The concept of competitiveness is discussed in the literature at three levels at least, including:

1. The competitiveness of countries (macro level);
2. The competitiveness of regions, sectors or industries (meso level);
3. The competitiveness of companies (micro level).

This paper focuses on the macro-level competitiveness of the four Visegrad countries (V4), building on the definition of the competitiveness of nations introduced by Michael Porter in 1990 (Porter 1990). However, even after narrowing down this broad category to macroeconomic aspects there are still a lot of facets that have to be taken into account, such as prices, productivity changes, technological specialization, structure of the economy, etc. (Aiginger *et al.* 2013). The traditional approach to the assessment of a country's competitiveness focuses on cost-based productivity measurements, such as unit labour costs or labour productivity, while the real exchange rate measures the development of cost-price competitiveness (Rozmahel *et al.* 2014).

According to the broad approach taking all these elements into account, national competitiveness can be defined as a country's ability to achieve sustainable growth of the living standard of its citizens, mainly through productivity increases (Porter 2008: 176). This definition will be used in this paper as a general framework for assessing various economic and social issues that define an economy's competitive position. However, there are some other elements that reflect competitiveness and in particular its international dimension. In recent years, the definition of competitiveness has been re-interpreted by adding social and environmental factors determining the quality of life. This goes beyond GDP growth, capturing such development goals as social inclusion

and environmental protection (Blanke *et al.* 2011; Aiginger *et al.* 2013; Corrigan *et al.* 2014; Weresa 2015). As there can be no doubt that inclusive and sustainable growth is extremely important nowadays, the notion of sustainable competitiveness seems to be relevant as a response to the major challenges the world faces today. This so-called 'sustainable competitiveness' encompasses institutions, policies and other factors that help increase a country's productivity and ensure social and environmental sustainability over the longer term (Blanke *et al.* 2011: 63; Corrigan *et al.* 2014: 55).

Furthermore, in today's knowledge-based economy further challenges could be included in the analysis of country competitiveness. Digitalization for instance is penetrating all areas of the world economy from manufacturing, construction, trade or transportation to education, health, social interactions and culture. The rapid development of information and communication technologies (ICT) is creating growing convergence between ICT and the economy. New features of the economy nowadays include Industry 4.0 and 'the Internet of Things' (OECD 2015: 240). This new phenomenon is thus also included in our analysis of V4 competitiveness.

This paper aims to answer the following research questions:

— What are the sources of V4 competitiveness in the post-FDI period?
— To what extent did innovation and human capital become the basis for competitive capacity building in the 2008-2015 period?
— Does digitalization affect the competitiveness of V4 economies?
— What policies are needed to support innovation and economic convergence in the V4 countries?

The paper is structured as follows. This first introductory section is followed by a short literature review showing how innovation, human capital and competitiveness are interrelated. Next, digital competitiveness and how it is measured are discussed. This theoretical background is used as a framework for empirically analysing how the competitiveness of V4 countries developed over the 2008-2015 period. The last section concludes by presenting policy recommendations derived from theoretical and empirical analyses.

2. Innovation, human capital and competitiveness: an interface

Theoretical and empirical studies confirm that innovation and human capital are key determinants of the competitiveness of enterprises, regions and countries (see for instance: Porter 1990; 2008; Edquist and McKelvey 2000; Solleiro and Castanon 2005; Weresa 2014). The concept of national innovative capacity developed by J. Furman *et al.* (2002) allows us to examine the role of innovation and human capital in shaping a country's competitiveness. National innovation capacity is defined as a country's ability to produce and commercialize a flow of innovative technologies and ideas over the long term (Furman *et al.* 2002). The framework we present here is an attempt to integrate macro- and microeconomic perspectives regarding the sources of innovation. It draws on the following strands of prior research:

— models of ideas-driven growth (Romer 1989; 1990),
— the cluster approach (Porter 1990),
— the innovation systems concept (Nelson and Rosenberg, 1993).

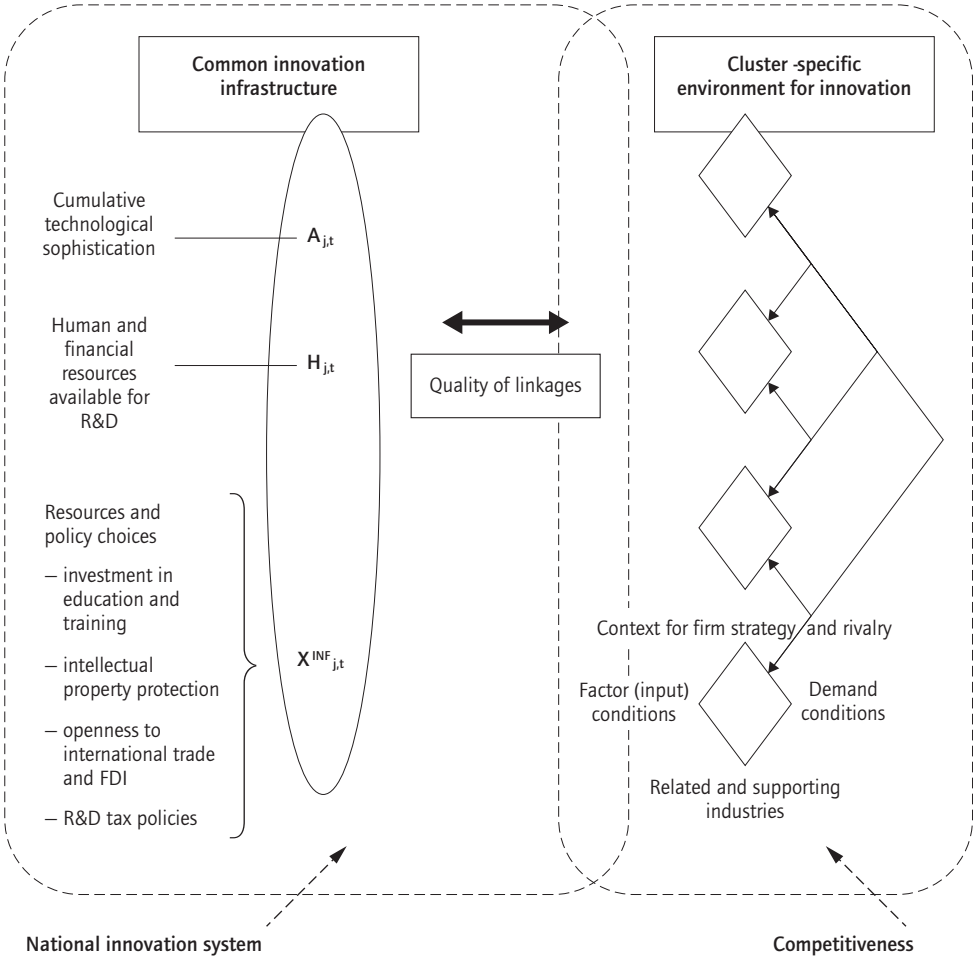
These three perspectives provide common insights into the creation of knowledge and the commercialization of new ideas. Their integration indicates that the determinants of national innovative capacity can be divided into three broad areas: (1) a common innovation infrastructure, (2) a cluster-specific environment for innovation, and (3) the quality of linkages (Furman *et al.* 2002: 905-906).

This approach has been applied empirically by different scholars, using various indicators to measure these three determinants of innovation capacity. Nevertheless, all scholars agree that this concept includes not only the creation of new ideas and their flow into the economy, but also human capital development. The strength of a nation's common innovation infrastructure can be measured empirically using such indicators as aggregate research and development (R&D) expenditure, investment in higher education (in particular, the share of GDP spent on secondary and tertiary education) as well as human resources (for instance: aggregate personnel employed in R&D, share of the population with tertiary education, or employment in the high-tech sector). These elements are supplemented by policy choices regarding the tax system, trade openness and intellectual property protection. Openness to foreign direct investment (FDI) can also be added as a factor shaping innovation in a country as it is commonly admitted in the literature that FDI inflows affect innovation performance (see for instance: Lipsey 2002; Dunning and Narula 2004; Narula and Pineli 2016).

The second area, a 'cluster-specific innovation environment', is reflected in the financing of R&D by the private sector. The third determinant of innovation capacity concerns the quality of linkages between the common innovation infrastructure and clusters. These linkages depend to some extent on the organization of a country's university system as well as the funding mechanism for new ventures. They determine the ability of a country to commercialize new ideas and can be measured as the percentage of R&D performed by universities (Furman *et al.* 2002: 914; Furman and Hayes 2004: 1338; Mouhallab and Jianguo 2016: 54).

The framework of national innovation capacity shows how innovation and human capital are interrelated. However, it does not precisely explain the relationship between a country's innovation capacity and the competitive advantages described by Michael Porter's so-called diamond model (Porter 1990). Nevertheless, this concept shows that there is a link between the ability to innovate and competitiveness, as Porter concluded 'A nation's competitiveness depends on the capacity of its industry to innovate and upgrade' (Porter 2008: 171). Furthermore, innovation infrastructure and linkages can be regarded as elements of innovation systems, while clusters are related to a country's competitiveness. Therefore, it can be concluded that the framework of national innovation capacity integrates innovation, human capital and national competitiveness. Figure 1 shows the national innovation capacity framework and how it is related to competitiveness.

Figure 1 **National innovation capacity and competitiveness**



Note: $A_{j,t}$ - the total stock of knowledge held by an economy; $H_{j,t}$ - the total level of capital and labour resources in the ideas sector of the economy; $X^{INF}_{j,t}$ - Resources and policy choices related to innovation.
Source: adapted from Furman *et al.* 2002, p. 906-908

3. Competitiveness in a digital world

We are currently observing the rapid transformation of economies and society induced by the growing use of information and communication technologies (ICT), a process referred to as digitalization (OECD 2016a: 66). Involving the use of ICT to create new value opportunities, in its broadest understanding digitalization refers to a way in which technology connects people, machines and information.

In this context a question arises: how should a country's competitiveness be understood in the digital world?

Recent studies show that there is a need to supplement the notion of competitiveness with new elements reflecting the development of the digital economy. Digitalization brings new business models and changes the ways in which organizations communicate with the market, produce and innovate. The Internet economy is defined 'as the value generated by undertaking economic activities either supporting the Internet or purely based on the Internet' (OECD 2013: 18). Thus, this definition covers:

— value added generated in activities that support the development of Internet (e.g. production of broadband equipment);
— value added generated in activities based on the Internet (e.g. e-commerce, web services).

This approach shows that the Internet impacts competitiveness and thus should be reflected in productivity developments. However, evidence on the magnitude of such productivity effects is mixed. In the 1990s, empirical research pointed to a so-called productivity paradox, i.e. not confirming any significant contribution of ICT to productivity growth (Brynjolfsson 1993; Brynjolfsson and Yang 1996). Further research showed some positive productivity effects, though results varied across sectors and also depended on the methodology employed (see for instance: Dedrick *et al.* 2003; Kretschmer 2012; Belloc and Guerrieri 2015). Recent studies point to an overall positive influence, showing that digitalization contributes directly to economic growth through the ICT supply side (OECD 2016a: 6). However, certain components are needed to achieve these positive effects. The effective use of ICT and data requires not only investment in ICT, but also additional investments in complementary knowledge-based capital, such as skills development, organizational changes and new business models. Thus, digitalization is connected with the introduction of so-called 'digital innovation', understood narrowly 'as the implementation of a new or significantly improved ICT product, i.e. ICT product innovation' or broadly, as ICT-enabled innovation, i.e. any product, process, marketing or organizational innovation which occurs as a result of the use of ICT (OECD 2016a: 14).

Furthermore, the increasing use of digital technologies is creating demand for new skills to develop new applications, use ICT for professional purposes and perform new tasks necessary for using ICT at work (such as information processing, communication, e-marketing) (OECD, 2016b: 6). Thus, competitiveness in a digital world is associated with digital innovation and the necessary digital skills on the input side, together with productivity developments resulting from the introduction of ICT. This implies that the measurement of competitiveness should be adjusted accordingly, as has been widely pointed out in the literature (see for instance: Coyle 2015; 2016; OECD 2015; Pearson and Theofilou 2016; Lacy *et al.* 2016; Ahmad and Schreyer 2016; European Commission 2015b). Attempts have been made to find new competitiveness indicators of relevance in the digital economy. This is no straightforward task, with problems associated not only with methodology, but also at the data level. It is extremely difficult to provide a single measurement capturing the whole digital economy. The role of Internet has changed from being a service to becoming a fundamental business infrastructure impacting most economic activities and short- and long-term economic processes.

The Digital Economy and Society Index (DESI) has been introduced to monitor the development of the digital economy and society, and thus measure digital competitiveness. It is a composite index featuring five dimensions: connectivity, human capital, use of Internet, integration of digital technology and digital public services (European Commission 2015b: 4). These five dimensions are used in the competitiveness assessment of the V4 countries conducted in the next sections of this paper.

4. Competitive performance of V4 economies over the 2008-2015 period

The aim of this section is to analyze the competitive positions of the Visegrad countries, assessing how they developed over the 2008-2015 period. This assessment uses the definition of sustainable competitiveness discussed in the introductory section of this paper, supplemented by the digital dimension of competitiveness described above. Three basic competitiveness dimensions are thus taken into account:

1. From an output perspective, a country's prosperity measured by a set of indicators reflecting economic and social progress, such as GDP growth, real GDP per capita level;

2. From a combined input and output perspective, social and environmental aspects of development reflected in the Human Development Index (HDI) and the Social Progress Index (SPI);

3. The digital economy and society development measured by the Digital Economy and Society Index (DESI) and its five dimensions, which might be treated as competitiveness drivers.

These three perspectives allow us to examine the current competitive positions of the V4 countries in a more complex way, covering aspects of both the input and output side of this complex phenomenon.

4.1 Developments in the economic prosperity of the V4 countries over the 2008-2015 period

The first step of this analysis is to show the economic potential of the V4 countries based on the size of their national income. Gross domestic product (GDP) is the basic measure of the size of an economy. It is often used in macroeconomic analyses as a comprehensive measure of economic activity. To compare countries, GDP values in local currencies are converted to an international currency, such as USD or EUR using current exchange rates or the purchasing power standard (PPS[1]). It should be noted that a GDP converted at the market exchange rate may be affected by exchange rate fluctuations, while PPS

1. According to the Eurostat definition, Purchasing Power Standards (PPS) is a weighted average of relative price ratios in respect to a homogeneous basket of goods and services, both comparable and representative for each country.

conversion factors may overestimate the value of GDP in relatively less developed countries compared to more developed economies. Therefore, any conversion has its shortcomings and needs to be taken into account while interpreting results.

In 2015, the GDP of the V4 countries measured at current prices amounted to 5.4% of total EU28 GDP, with this share remaining stable over the 2008-2015 period. Poland was the largest country among the V4 group in terms of GDP, and its share of total V4 GDP grew from 52.3% in 2008 to 54.7% in 2015. Czechia occupied second place in 2015, with a share of 21.3%, a slight decrease (-1.7 percentage points) compared to 2008. Hungary also had a decreasing share of total V4 GDP, dropping from 15.4% in 2008 to 14.0% in 2015. Slovakia experienced mild gains; with its share in total V4 GDP increasing slightly from 9.4% in 2008 to 10.0% in 2015 (Table 1).

While the size of the economy measured by total GDP converted into EUR using the current exchange rate allows us to estimate the position of the V4 group and its individual countries in the EU, GDP per capita measured by the purchasing power standard (PPS) can provide a more precise picture of competitiveness as it is a proxy for the standard of living (prosperity). It also allows us to examine changes in the relative development level, i.e. convergence or divergence with more developed European countries or the EU average. In the 2008-2015 period, all V4 countries improved their position vis-à-vis the EU28 average with regard to the GDP per capita when measured by PPS. However, the gap vis-à-vis the EU average remained the highest for Hungary and Poland, with 2015 GDP per capita constituting 68% of the EU28 average in Hungary and 69% in Poland, despite the fact that both countries increased their GDP per capita in 2008-2015 measured as a percentage of the EU average by 6 p.p. and 14 p.p. respectively. Over the same period, Czechia managed to decrease the distance to the EU average by 3 p.p., reaching the 87% of average GDP per capita in the EU, while Slovakia caught up by 6 p.p. (77% of the EU average in 2015) (Tables 2 and 3).

Economic literature proves that a more competitive economy is likely to grow faster over time (Porter, 2008; WEF, 2015). Therefore, it is worth analysing the competitive position of V4 countries, looking at their GDP growth rate and how it is related to GDP per capita. A faster growth rate allows a country to catch up faster in terms of GDP per capita. Figure 2 relates the average GDP growth rates for the 2008-2015 period to GDP per capita in 2015 in the V4 countries. We see that all V4 countries grew at a relatively higher rate than the EU28 average in the post-crisis period, moving forward in terms of competitiveness measured by GDP per capita in PPS, but still behind EU28 average GDP per capita in PPS terms in 2015 (Table 2). There were however differences between the V4 countries with regard to both average real GDP growth rate and GDP per capita in the post-crisis period (Figure 2).

A comparison of the real GDP growth rates of the V4 countries and the EU average in 2008-2015 and how these growth rates are related to GDP per capita shows the V4 relative development position within the European Union (measured by GDP per capita) in 2015 and how fast it developed over the 2008-2015 period.

Table 1 **GDP of the V4 countries in current prices in 2008-2015 (million euro and percentage)**

	2008	2009	2010	2011	2012	2013	2014	2015
European Union (28 countries)	13 054 560.5	12 297 013.4	12 817 343.1	13 192 520.4	13 448 619.5	13 558 617.4	14 001 004.1	14 710 625.9
Czechia	160 961.5	148 357.4	156 369.7	164 040.5	161 434.3	157 741.6	156 660.0	166 964.1
Hungary	107 637.3	93 808.8	98 322.6	100 820.1	99 085.6	101 483.3	104 953.3	109 674.2
Poland	366 182.3	317 082.9	361 803.6	380 239.0	389 368.9	394 721.1	410 989.7	429 794.2
Slovakia	66 002.8	64 023.1	67 577.3	70 627.2	72 703.5	74 169.9	75 946.4	78 685.6
Total V4 GDP	700 783.9	623 272.2	684 073.2	715 726.8	722 592.3	728 115.9	748 549.4	785 118.1
V4 as % of EU28	5.4%	5.1%	5.3%	5.4%	5.4%	5.4%	5.3%	5.3%
Share of countries in total V4 GDP (in percentage)								
	2008	2009	2010	2011	2012	2013	2014	2015
Czechia	23.0%	23.8%	22.9%	22.9%	22.3%	21.7%	20.9%	21.3%
Hungary	15.4%	15.1%	14.4%	14.1%	13.7%	13.9%	14.0%	14.0%
Poland	52.3%	50.9%	52.9%	53.1%	53.9%	54.2%	54.9%	54.7%
Slovakia	9.4%	10.3%	9.9%	9.9%	10.1%	10.2%	10.1%	10.0%

Source: own elaboration based on Eurostat data, http://ec.europa.eu/eurostat/data/database, accessed 20 January 2017

Table 2 **GDP per capita in the V4 countries in 2008-2015 (in euro, current prices, PPS per capita)**

	2008	2009	2010	2011	2012	2013	2014	2015
European Union (28 countries)	26 100	24 500	25 400	26 100	26 600	26 700	27 500	28 800
European Union (15 countries)	29 000	27 100	28 100	28 700	29 100	29 200	29 900	31 300
Czechia	21 100	20 200	20 600	21 600	21 800	22 300	23 500	25 000
Hungary	16 300	15 700	16 500	17 100	17 200	17 700	18 600	19 500
Poland	14 200	14 500	15 700	16 800	17 600	17 900	18 600	19 700
Slovakia	18 500	17 300	18 600	19 000	19 700	20 200	21 100	22 000

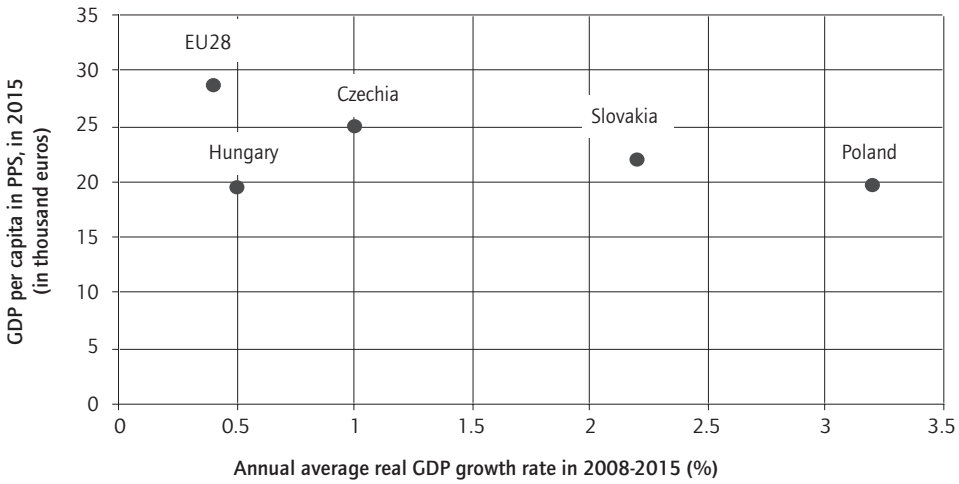
Source: own elaboration based on Eurostat data, http://ec.europa.eu/eurostat/data/database, accessed 15 September 2016

Table 3 **GDP per capita in the V4 countries as a percentage of the EU average (%)**

GEO/TIME	2008	2009	2010	2011	2012	2013	2014	2015
European Union (28 countries)	100	100	100	100	100	100	100	100
Czechia	84	85	83	83	83	84	86	87
Hungary	62	64	64	66	65	67	68	68
Poland	55	60	62	65	67	67	68	69
Slovakia	71	71	74	75	76	77	77	77

Source: Eurostat data, http://ec.europa.eu/eurostat/data/database, accessed 12 February 2017

Figure 2 **Competitiveness of the V4 countries measured by GDP per capita (in euro in PPS terms) in 2015 and real annual average GDP growth rate in 2008-2015 (in %)**

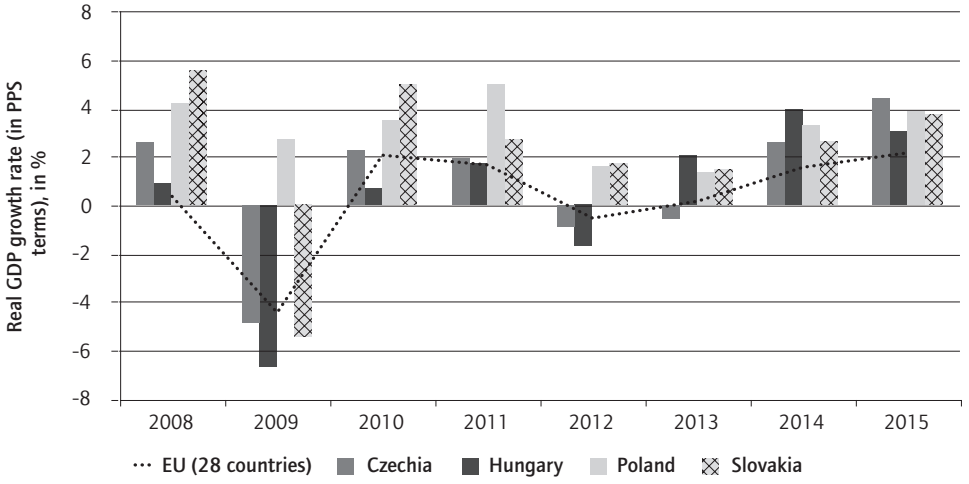


Source: own elaboration based on Eurostat data and Weresa (2016), p. 245

Though Poland led the way in terms of annual average real GDP growth in 2008-2015, it nevertheless lagged behind Czechia and Slovakia in 2015 in terms of GDP per capita (in PPS). However, since 2012 it has been outpacing Hungary in this respect. Slovakia also had a relatively high annual average real GDP growth rate in 2008-2015, lower than Poland but higher than Czechia and Hungary, and held second place in the V4 group (after Czechia) when ranking living standards in GDP per capita in PPS terms. It should also be noted that both Poland and Slovakia slightly lost their growth momentum in 2012-2013 before recovering in 2015. However, Poland has not regained the peak level noted in 2011 (Figure 3).

Over the whole 2008-2015 period, Czechia led the V4 group in terms of competitiveness measured by GDP per capita in PPS, though its real GDP growth rate was the second lowest (after Hungary) until 2015, when it achieved the highest growth rate (4.5%) in the V4 group. Hungary was the laggard in terms of annual real GDP growth rate over the period and since 2012 also in terms of GDP per capita.

Figure 3 **Real annual GDP growth rate in the V4 countries, 2008-2015 (in %)**



Source: own elaboration based on Eurostat data, http://ec.europa.eu/eurostat/data/database, accessed 7, February, 2017

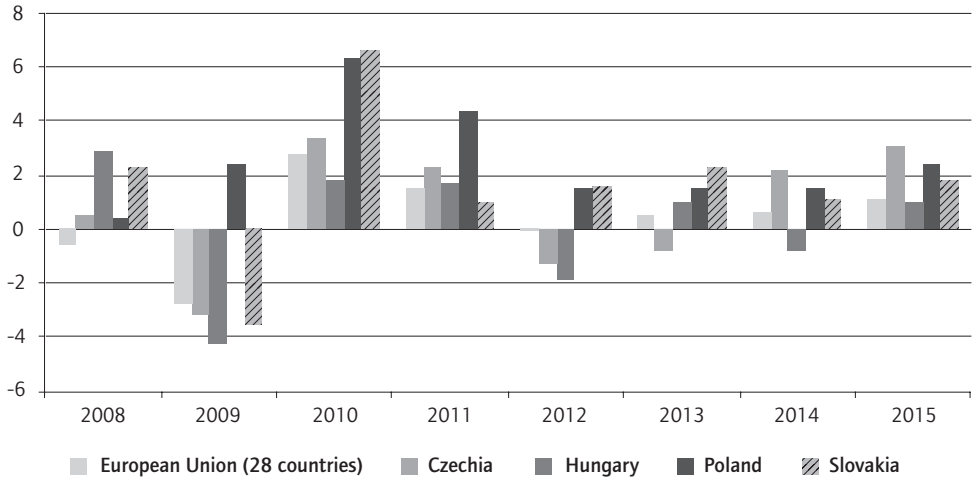
It can be concluded that, over the 2008-2015 period, Czechia was the most competitive V4 country measured by real GDP per capita, while Poland showed the greatest improvement (see Figures 2 and 3; Tables 2 and 3).

Productivity is another important dimension of competitiveness (Porter 2008). Its level determines the level of prosperity that can be achieved by an economy. Sustained economic growth and competitiveness improvements come from increases in productivity. Therefore, it is worth examining how productivity developed in the V4 countries over the 2008-2015 period.

Figure 4 compares real productivity growth in the V4 countries with the EU average over the 2008-2015 period. The data shows the percentage change of real labour productivity over the previous period calculated in national currencies. Poland was the only V4 country with real labour productivity growth throughout the 2008-2015 period. Slovakia also experienced increases but a decrease in 2009, while in Czechia and Hungary productivity fluctuated during the whole 2008-2015 period (Figure 4).

A different picture emerges when productivity levels in the V4 countries are compared to the EU average. In 2008-2015 Slovakia was the leading V4 country in terms of labour productivity, with its level in nominal terms growing from 74.9% to 83.3% of the EU average. In Czechia, labour productivity increased from 77.6% in 2008 to 79.9% of the EU28 level in 2015. Poland managed to catch up 12.2 p.p. in 2008-2015, achieving 74.3% of the EU28 average in 2015. Hungary's labour force was the least productive in the V4 region: despite fluctuations, labour productivity per person remained the same in 2015 as it was in 2008, constituting 70.3% of the EU average (Table 4).

Figure 4 **Changes in the real labour productivity per person in the V4 countries, 2008-2015 (percentage change on previous period)**



Source: own elaboration based on Eurostat data, http://ec.europa.eu/eurostat/data/database, accessed 7, February, 2017

Table 4 **Nominal labour productivity per person (percentage of EU28 total based on million PPS in current prices), 2008-2015**

GEO/TIME	2008	2009	2010	2011	2012	2013	2014	2015
European Union (28 countries)	100	100	100	100	100	100	100	100
Czechia	77.6	79.1	77.0	77.4	76.2	76.7	79.3	79.9
Hungary	70.3	72.2	72.7	73.8	72.5	72.9	71.0	70.3
Poland	62.1	65.4	70.2	72.7	74.1	74.0	73.9	74.3
Slovakia	79.4	79.3	83.6	81.6	82.5	83.8	84.1	83.3

Source: Eurostat data, http://ec.europa.eu/eurostat/data/database, accessed 12 February 2017

4.2 Social and environmental dimensions of V4 competitiveness

As indicated in the introductory part of this paper, the overall assessment of competitiveness should take into account not only economic aspects but also social and environmental factors. To measure the quality of life in the V4 countries, broader yardsticks of competitiveness should be used. These include for instance the school enrolment ratio, tertiary educational attainment, life expectancy, child mortality rate, access to piped water, quality of electricity supply, access to information and communications.

One composite measure of social development and living standard is the Human Development Index (HDI). It is the geometric mean of normalized indices reflecting gross national income per capita (in PPS), life expectancy at birth, and mean years of schooling combined with expected years of schooling. The index ranges from 0 to 1, with a higher value reflecting a higher development level (UNDP 2015: 3).

The HDI of the V4 countries has grown consistently, confirming their socioeconomic progress. All V4 countries belong to the very high human development category. However, the positions of the individual V4 countries in terms of the HDI have been changing from one year to another depending on changes in the indices constituting the HDI. The leading position in the V4 group was consistently occupied by Czechia, which has maintained its 28th position in the HDI ranking since 2009. Poland was next, ranked 36th in 2015, followed by Slovakia and Hungary. Compared with the HDI ranking list of 2009, Poland dropped three places in the 2015 ranking, though managing to outpace Slovakia (-7 places) and Hungary (-4 places). Furthermore, in the decade 2000-2010 and in the five-year period 2010-2015, all V4 countries experienced higher annual HDI growth than the OECD average. However, the HDI grew faster in 2010-2015 than in 2000-2010 only in Poland, while in the other three countries it was higher in the first decade of the 21st century than in the post-crisis 2010-2015 period (Table 5). These trends indicate that in Czechia, Slovakia and Hungary the pace of socio-economic development slightly slowed down in the post-crisis period, to some extent due to relatively slow growth (or even a plateauing) in the indicator reflecting expected years of schooling. Nevertheless, it should be stressed that the competitive position of all V4 countries assessed by the Human Development Index was much better than when expressed in gross national income per capita terms alone (Table 5).

Table 5 **Human Development Index (HDI) trends for the V4 countries, 2010-2015**

Country	Human Development Index (HDI)		HDI rank 2015	HDI rank change	Average annual HDI growth (%)		Gross national income per capita rank minus HDI rank
	2010	2010	2015	2009-2014	2000-2010	2010-2015	2014
Czechia	0.861	0.861	28	0	0.47	0.39	+11
Slovakia	0.829	0.829	40	-7	0.83	0.39	+1
Poland	0.829	0.829	36	-3	0.56	0.62	+11
Hungary	0.821	0.821	43	-4	0.67	0.36	+6
OECD	0.872	0.872	-	-	0.44	0.33	-
World	0.697	0.697	-	-	0.82	0.61	-

Source: UNDP (2016), p. 198 and p. 202-205

Social development can also be measured by the Social Progress Index (SPI), an index bringing a new perspective going beyond GDP and covering social and environmental aspects. It combines three dimensions: basic human needs, foundations of wellbeing, and opportunity for personal development (Porter *et al.* 2016: 32). As economic performance is not included as an SPI component, this indicator allows us to measure social progress directly, without taking economic aspects into account (Porter *et al.* 2016: 35). Nevertheless, economic development and social progress are interrelated, though the relationship is not linear. There has been a positive and strong relationship between the SPI and GDP per capita. The correlation coefficient for the 133 countries for which SPI is calculated was 0.78 in 2014 (Porter *et al.* 2015: 18) and 0.89 in 2015 (Porter *et al.* 2016: 72). This also holds true for the EU member states from the CEE region, including the V4 countries (Weresa 2016: 248).

SPI was first calculated in 2015, meaning that there is no long-time series allowing a longer-term country comparison. The available data indicates that, with regard to the social and environmental dimensions of competitiveness covered by the Social Progress Index, Czechia led the V4 countries, while Hungary had the weakest results in 2015-2016 (Table 6).

Table 6 **Social Progress Index for the V4 countries, 2015-2016**

	Social Progress Index 2015	Social Progress Index 2016
Czechia	80.59	82.80
Poland	77.98	79.76
Slovakia	78.45	78.96
Hungary	74.80	76.88

Source: Porter *et al.*, 2015 p. 17 and 2016 p. 51

4.3 Digital competitiveness of the V4 countries in the 2008-2015 period

Digital competitiveness is important for Europe, as ICT is playing a growing role in boosting innovation, employment and growth. The ICT sector generates new technologies which are then applied in other sectors. The development of high-speed Internet impacts the way we do business and shapes consumer behaviour, creating the need for new skills (European Commission 2015b; OECD 2016a).

Over the first decade of the 21st century, information and communication technologies (ICT) confirmed their role as one of the major drivers of Europe's economic and social modernization (European Commission 2009: 8). In 2005, the European Commission presented its i2010 strategy aimed at boosting Europe's lead in ICT and increasing the benefits of the information society for European growth and jobs. One of its objectives was to increase digitalization in the EU. In 2010, the European Digital Agenda was introduced as a part of the Europe 2020 strategy and ICT was acknowledged as one of the key drivers for smart and sustainable growth (European Commission 2017).

Digital competitiveness can be measured by many different indicators. The European Commission selected more than 100 measures to monitor and compare progress across European countries in the area of digitalization. They are divided into groups corresponding to European information society dimensions, such as development of the telecom sector, broadband infrastructure, Internet usage, mobile networks, ICT skills (European Commission 2015b). Based on 30 selected indicators, the Digital Economy and Society Index (DESI) has been calculated for all EU member states and for the EU as a whole. Calculated for the first time in 2014, it has since been used to monitor progress in digital competitiveness in the EU. It is a weighted average of five components or dimensions: (1) connectivity (weight: 25%), (2) human capital (weight: 25%), (3) use of Internet (weight: 15%), (4) integration of digital technology (weight: 20%) and (5) digital public services (weight: 15%) (European Commission, 2015a, p. 4). It allows the comparative analysis of digital competitiveness. The first DESI dimension is connectivity. It is composed of 7 indicators showing the availability of infrastructure

necessary for a digital economy and society. Human capital, and in particular the skills needed to produce and consume digital goods and services, represents the second DESI dimension. Four indicators cover these types of skills. Use of Internet, the third DESI dimension, is measured by 7 indicators, while integration of digital technology, the fourth dimension, is represented by 8 indicators. The development of digital public services is reflected in 4 indicators (for a detailed description of these indicators see: European Commission 2016a: 5-10, Mateus 2016).

The EU countries have been grouped into clusters according to their DESI index scores and growth. All V4 countries belong to 'the falling behind' cluster of countries (together with Bulgaria, Cyprus, Greece and France), as their DESI scores are not only below the EU average, but also have grown slower than the EU average (Mateus 2016). When comparing the DESI for the V4 countries with the EU average score and the cluster score, we see that only Czechia is close to the European average, even though its ranking dropped from 15th in 2015 to 17th in 2016. The other three countries progressed slowly, without significant changes in their position among the EU countries. Nevertheless, all V4 countries except Poland had a higher DESI that the average of the 'falling-behind' cluster (Table 7).

Table 7 **Digital Economy and Society Index (DESI) for the V4 countries, 2015-2016**

	DESI 2015	DESI 2016	Rank in the EU in 2015	Rank in the EU in 2016
Czechia	0.50	0.50	15	17
Hungary	0.45	0.45	21	20
Slovakia	0.45	0.45	22	22
Poland	0.42	0.42	20	21
EU	0.50	0.50	-	-
Cluster score	0.44	0.44	-	-

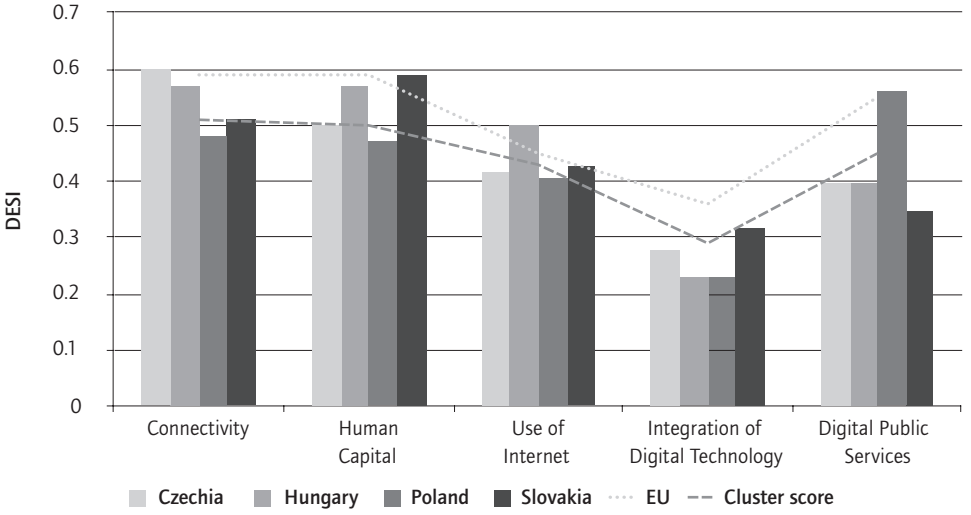
Source: own elaboration based on European Commission (2015c; 2016c,d,e,f)

Performance varied across the V4 countries for different DESI dimensions (Figures 5 and 6). In the connectivity dimension, only Czechia performed slightly above the European average. Hungary remained just below it, despite improvement in 2015 caused mainly by progress in rolling out fast broadband technologies (European Commission 2016d: 2). Connectivity is one of the DESI 2016 dimensions where Slovakia and Poland underperformed, attributable to the still relatively low fixed broadband coverage of households. Poland's ranking is, however, partly offset by the rapidly growing use of mobile broadband.

The second DESI dimension, the human capital necessary for digitalization, is relatively well developed in Slovakia and Hungary, where scores are close to the EU average. Digital skills and the availability of ICT specialists are among Slovakia's strengths relative to the EU average (European Commission 2016f: 3), as is the case with Hungary (European Commission 2016d: 3). In Czechia and Poland, this DESI dimension needs improving as their performance is much below the EU average, mainly due to the lower-than-average level of digital skills in both countries. Another weakness in this field is the declining share of ICT specialists in total employment observed in both

counties in 2016 compared to the preceding year (European Commission 2016e: 3 and 2016c: 3).

Figure 5 **Digital competitiveness of the V4 countries, 2015-2016 (measured by the DESI)**



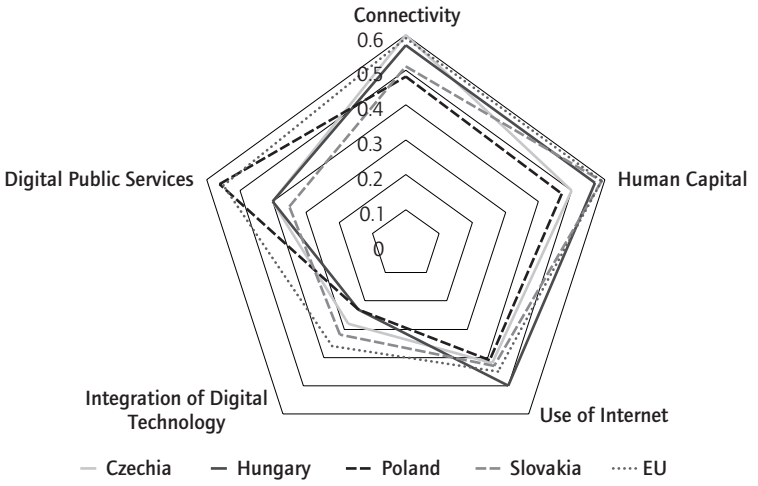
Source: own elaboration based on European Commission (2016c,d,e,f)

With regard to individuals' propensity to use Internet, Hungary scores highest, exceeding the EU average, followed by Slovakia. Both countries experienced some improvement in this respect in 2016 compared to the preceding year. In Czechia and Poland, no progress was made in this DESI dimension, although some of the component indicators were quite well developed, above the EU average: in Poland, the consumption of audio-visual content using broadband connections; in Czechia the usage of Internet banking and online shopping.

In a developed digital economy, businesses are able to use digital technologies to improve their efficiency and productivity, as well as to sell their products and services. None of the V4 countries performed well in this fourth DESI dimension, with all below the EU average (Figure 6).

In the fifth dimension, 'digital public services', Poland took the lead among the V4 countries with a score exceeding the EU average. In the other V4 countries, the distance to the average was quite big. Although the V4 countries have made progress in digitalising the public administration, progress remans insufficient and the uptake of digital public services remains low.

Figure 6 **Digital Society and Economy Index (DESI) in the V4 countries by dimension, 2016**



Source: own elaboration based on European Commission (2016c,d,e,f)

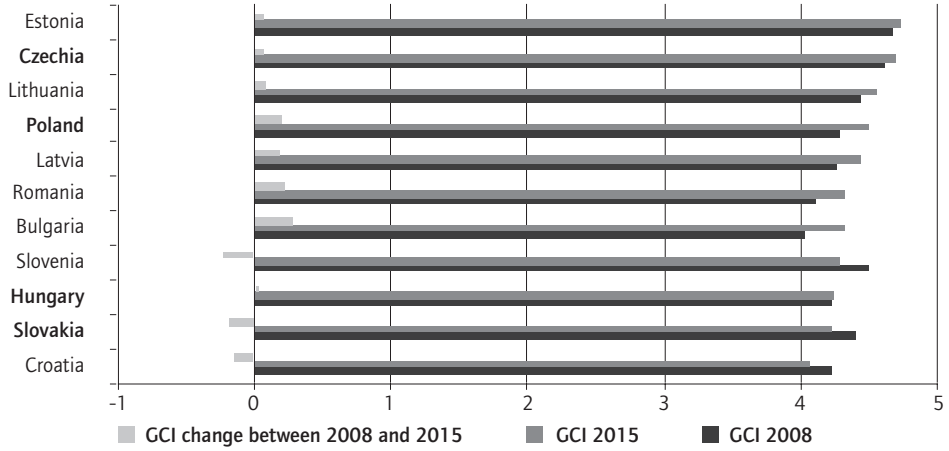
4.4 Competitiveness leaders and laggards within the V4 group

The results of the analyses conducted above can be summarized using the Global Competitiveness Index (GCI) calculated by the World Economic Forum in its World Competitiveness Reports. It is based on 12 competitiveness pillars: institutions, infrastructure, macroeconomic environment, health and primary education, higher education and training, goods market efficiency, labour market efficiency, financial market development, technological readiness, market size, business sophistication, and innovation. These pillars are used to calculate three sub-indexes representing basic requirements, efficiency enhancers, and innovation and sophistication factors. The three sub-indexes make up the overall Global Competitiveness Index (for the detailed description of methodology see: WEF 2016, Appendix A). Figure 7 shows changes in the composite Global Competitiveness Index over the 2008-2015 period, with the positions of the V4 countries compared to other CEE EU member states. Data presented in Figure 7 allows the conclusion that the overall competitive positions of three V4 countries improved from 2008 to 2014, despite the fact that all four countries suffered from the global crisis. Slovakia was the exception, with its overall competitive position deteriorating from 2008 to 2015. In 2015, Estonia was the most competitive economy in the whole CEE region, followed by Czechia, Lithuania and Poland. Hungary, Slovakia and Croatia were the lowest-ranked countries (Figure 7).

There is no doubt that Czechia is the V4 leader in the majority of competitiveness indicators analyzed above, i.e. living standard measured by real GDP per capita, productivity level, social and environmental dimensions measured by human development and social progress indices. This country is also the most advanced among the V4 with regard to digital competitiveness measured by the Digital Economy and Society Index. However, the competitiveness index does not correlate well with DESI

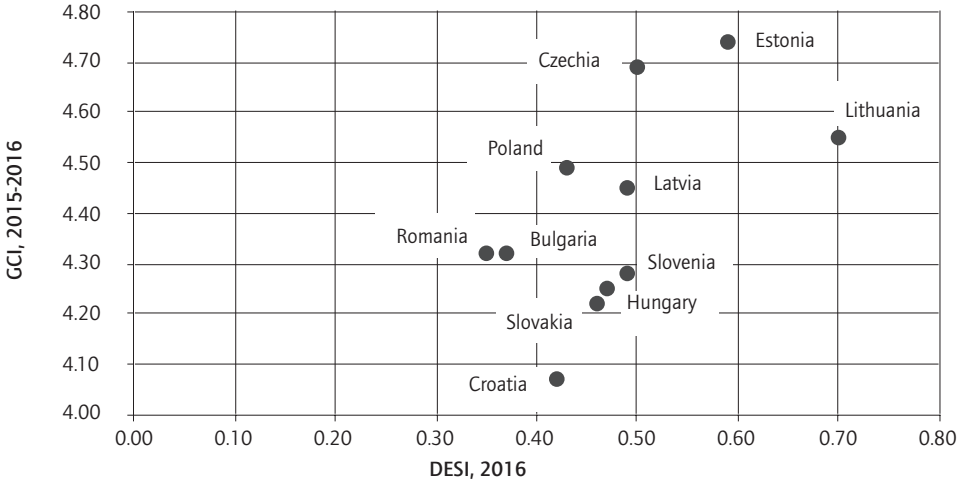
(Figure 8), possibly indicating that digital development alone is not enough to advance a country's competitive performance. Therefore, other competitiveness drivers, such as human capital and innovation, will be analyzed in depth in the next sections of this paper.

Figure 7 **Changes in competitiveness, 2008-2015: V4 compared to other CEE countries**



Source: own elaboration based on data from the World Economic Forum: WEF, 2008 and 2015

Figure 8 **Digital competitiveness (measured by DESI) and competitive performance (measured by GCI) of the CEE countries, 2016**



Source: own elaboration based on data from the World Economic Forum (WEF, 2015) and European Commission (2016)

5. National innovation capacity: Czechia, Hungary, Poland and Slovakia compared over the 2008-2015 period

As shown in the literature review presented in the second section of this paper, economies are searching for new sources of competitiveness allowing sustainable development. The theory confirms the growing importance of non-traditional competitiveness factors. In the past, the focus was on factors related to geographical location, including population, climate and the availability of natural resources. In the digital economy, innovation, human resources, education and training, technological sophistication and institutional factors become increasingly important as competitiveness drivers. All these factors taken together constitute a country's national innovation capacity (see: Figure 1). Countries capable of building up and using knowledge can improve their competitive position faster than other economies. Therefore, an assessment of V4 competitiveness should take innovation performance and human capital development into account.

5.1 Innovation performance of the V4 countries and developments over the 2008-2015 period

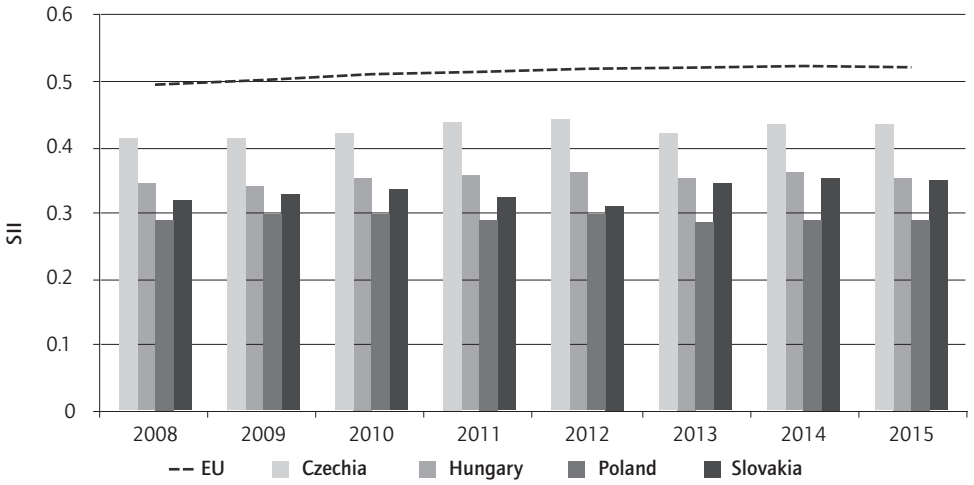
As innovativeness is a very complex phenomenon, it is worth looking at the innovation process from a broader perspective, taking the whole innovation system into account. It encompasses the human capital and knowledge resources accumulated in the system, as well as institutions related to the development of science, technology, education and entrepreneurship (Weresa 2014: 79).

To evaluate an economy's innovativeness in a summary form, the methodology used by the European Commission for assessing the level of innovativeness of individual European Union member states is adopted. The focal element of this methodology is the Summary Innovation Index (SII), a composite index capturing the complex nature of innovative processes by measuring various elements of innovativeness, starting with innovation enablers (measured by R&D expenditure, doctorate graduates, educational attainment, scientific publications, etc.), through company activities (reflected in business R&D, collaboration in innovation activity, patent applications, etc.), up to the output of innovative activities (e.g. sales of new-to-market and new-to-firm innovations, knowledge-intensive services exports, high-tech product exports in proportion to total exports).[2]

Based on the average innovation performance measured by the Summary Innovation Index, the EU member states have been divided into four different performance groups: innovation leaders, strong innovators, moderate innovators and modest innovators (European Commission 2016g: 6). All V4 countries fall into the group of 'moderate innovators'. Throughout the 2008-2015 period, the innovation performance of the V4 countries measured by the SII lagged behind the EU average (Figure 9).

2. For a detailed methodology and complete list of the 25 indicators constituting the Summary Innovation Index see: the Methodology Report of the European Innovation Scoreboard 2016, http://ec.europa.eu/growth/industry/innovation/facts-figures/scoreboards/index_en.htm.

Figure 9 **Innovation in the V4 countries: Changes in the Summary Innovation Index (SII) in 2008-2015**



Source: own elaboration based on European Commission (2016g) - EIS database, http://ec.europa.eu/growth/industry/innovation/facts-figures/scoreboards/index_en.htm, accessed 16 August 2016

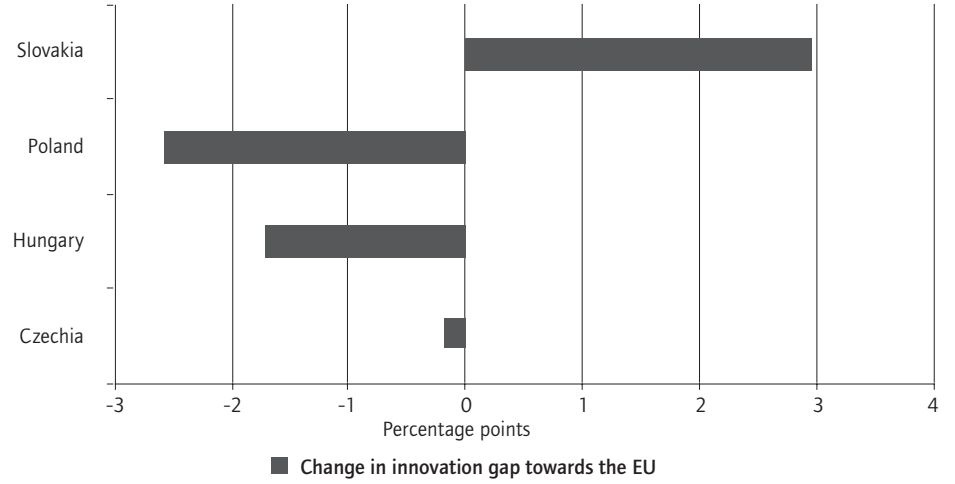
The performance of Czechia relative to the EU average was 83.1% in 2015, down from 83.3% in 2008. Hungary's performance in 2015 represented 68% of the EU average, down from 69.7% in 2008. A similar trend was observed in Poland, declining from 58.5% in 2008 to 55.9% in 2015. Slovakia improved over the 2008-2015 period, with its SII 64.2% of the EU average in 2008 and 67.1% in 2015. Therefore, it can be concluded that in three V4 countries the gap vis-à-vis the EU average grew, most of all in Poland (by 2.6 p.p.), followed by Hungary (1.7 p.p.) and Czechia (0.2 p.p.). Slovakia was the only V4 country able to reduce the innovation gap over the 2008-2015 period (by 3 p.p.). Though it remained behind the best V4 performer, Czechia, it caught up with Hungary. Poland was the laggard, not only with regard to innovation performance measured by the SII, but also to its negative development over the 2008-2015 period.

Nevertheless, all V4 countries have some relative strengths bringing them closer to the EU average when individual SII indicators are taken into account. In Czechia, the top five innovation indicators see the country outperforming the EU average: international scientific co-publications, R&D expenditure in the public sector, exports of medium- and high-tech products, collaboration of innovative SMEs, and upper secondary education. The weakest areas of Czech innovation are: venture capital investment, PCT patent applications and the number of non-EU doctorate students. The area in which the country is increasingly underperforming is innovation funding and support, in particular venture capital investment (European Commission 2016g: 49).

Hungary performs below the EU average in nearly all 25 SII indicators, with only two areas in which performance is much above European average: revenues from abroad for licences and patents, and exports of medium- and high-tech products.

The Hungarian innovation system is especially weak in the following areas: non-EU doctorate students, community designs and PCT patent applications (European Commission 2016g: 63).

Figure 10 **Change in the innovation gap of the V4 countries vis-à-vis the EU average in 2008-2015 (EU average SII=100)**



Note: The innovation gap is measured by the Summary Innovation Index in relation to the EU28 average in 2008 and 2015 respectively; the change in the innovation gap represents the difference between this ratio in 2015 and 2008.
Source: own elaboration based on European Commission (2016g) - EIS database, http://ec.europa.eu/growth/industry/innovation/facts-figures/scoreboards/index_en.htm, accessed 16 August 2016

Poland's innovation performance is stronger than the EU average in four areas: non-R&D innovation expenditure, community designs and human resource development measured by the population with completed tertiary education as well as by upper secondary education. The indicators furthest below the EU average are: non-EU doctorate students, private-public scientific co-publications, PCT patents applications, and revenues from abroad for licences and patents. The strongest deterioration in Poland's innovation performance was noted in collaboration of innovative SMEs (European Commission 2016g: 67).

Slovakia's largest relative strengths in terms of indicators above the European average include: sales share of new innovations, new doctorate graduates, exports of medium- and high-tech products, non-R&D innovation expenditure, and upper secondary education. A huge performance decline is observed in revenues from abroad for licences and patents and non-R&D innovation expenditure. The former also belong to the weaknesses of Slovakia's national innovation system. Other indicators well below the EU average are: non-EU doctorate students, venture capital investments, and PCT patent applications (European Commission 2016g: 71).

Table 8 summarizes main strengths and weaknesses of national innovation capacity of V4 countries in 2015.

Table 8 **Major strengths and weaknesses of national innovation capacity of the V4 countries in 2015**

	Strengths	Weaknesses
Czechia	– international scientific co-publications – R&D expenditure in the public sector – exports of medium- and high-tech products – collaboration of innovative SMEs – non-R&D innovation expenditure – upper secondary education	– venture capital investment – PCT patent applications – number of non-EU doctorate students
Hungary	– revenues from abroad for licences and patents – exports of medium- and high-tech products – non-R&D innovation expenditure – upper secondary education	– non-EU doctorate students – community designs – PCT patent applications
Poland	– non-R&D innovation expenditure – community designs – population with completed tertiary education – upper secondary education	– non-EU doctorate students – private-public scientific co-publications – PCT patent applications – revenues from abroad for licences and patents
Slovakia	– sales share of new innovations – new doctorate graduates – exports of medium- and high-tech products – non-R&D innovation expenditures – upper secondary education	– revenues from abroad for licences and patents – non-EU doctorate students – venture capital investments – PCT patent applications

Source: own elaboration based on European Commission, 2016g

One common feature of innovation capacity in which the V4 group has a relatively good performance is upper secondary education. This result points to potential improvements in the countries' innovation performance in the future. Furthermore, it can be observed that all V4 countries base their innovation performance first of all on non-R&D expenditure, an indicator above the EU average, while both public and private R&D expenditure in relation to GDP is much below the EU average. The only exception to this trend is Czechia, where the public R&D to GDP ratio exceeds the EU average. This is one of the elements contributing to the country's leading innovation position in the V4 group.

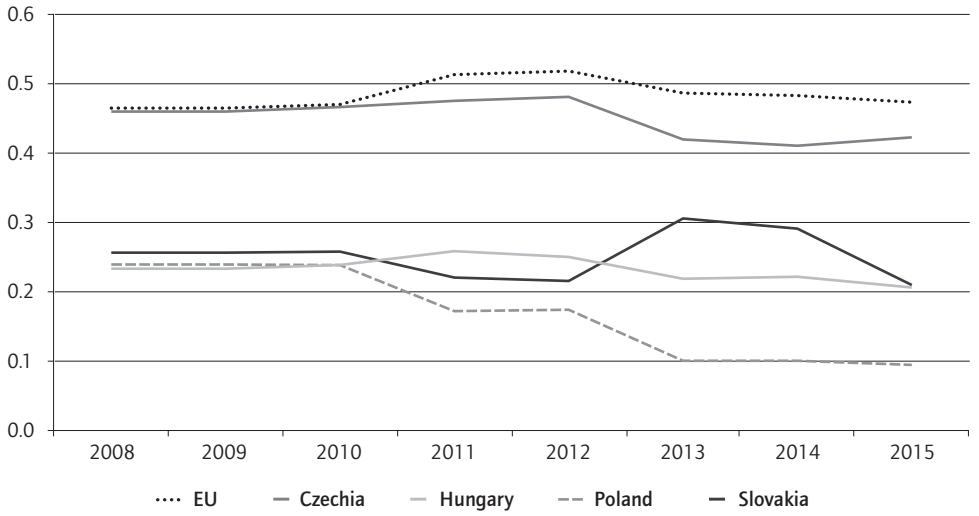
It should also be noted that Czechia, Hungary and Slovakia are relatively strong in manufacturing, with the shares of medium- and high-tech products in total exports of these countries higher than the EU average.

There are two very weak indicators common to the whole V4 group. These are PCT patent applications and the share of non-EU doctoral students. Furthermore, in Czechia and Slovakia there is also a need to improve the venture capital market, as in these countries venture capital investments are much below the EU average.

Looking at the weaknesses from a broader perspective, an insufficient development of linkages and entrepreneurship should be pointed out, as reflected in the SII 'Linkages & entrepreneurship' sub-index. Over the 2008-2015 period this sub-index was

significantly lower in the V4 (except in Czechia in 2008-2009) than the EU average, and, what is more, declined in all V4 countries (Figure 11).

Figure 11 **Linkages & entrepreneurship sub-index in V4, 2008-2015 (a composite indicator that constitutes SII)**



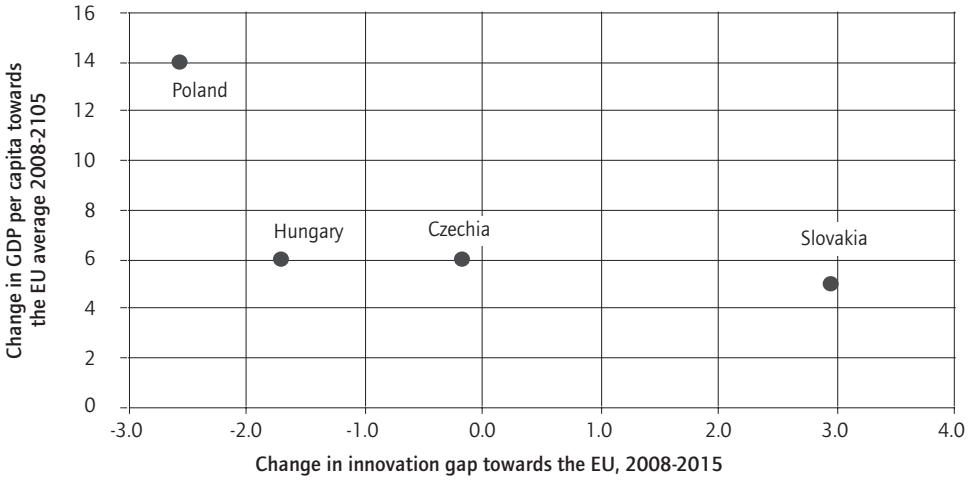
Source: own elaboration based on European Commision (2016g) - EIS database, http://ec.europa.eu/growth/industry/innovation/facts-figures/scoreboards/index_en.htm, accessed 16 August 2016

The weaknesses of V4 innovation capacity are all in areas where policy intervention is needed. This aspect will be discussed in the concluding section of this paper.

Summing up, the analysis of the developments over the 2008-2015 period with regard to the national innovation capacities of the V4 countries shows that Slovakia is the only one where convergence with the EU28 average in terms of prosperity (measured in real GDP per capita) has been accompanied by a catching-up with the EU average in terms of innovativeness. Yet convergence in prosperity in Slovakia was the slowest among the V4 countries. While prosperity in the other V4 countries also converged, their innovation performance diverged. Poland is an extreme case among the V4 group, showing the fastest prosperity convergence, yet the largest innovation divergence in the 2008-2015 period (Figure 12).

These differences in convergence/divergence trends in prosperity and innovation performance allow us to draw a tentative conclusion that innovation was not the driver of V4 competitiveness in the post-crisis period. While the innovation performance of the V4 countries (except Slovakia) declined compared to the EU average, their competitiveness improved. Therefore, it seems that the availability of resources and their relatively lower prices still constitute the main competitiveness pillars in the V4 countries.

Figure 12 **Changes in the Summary Innovation Index (SII) and changes in real GDP per capita (in PPS) in relation to the EU average levels, 2008-2015 (percentage points)**



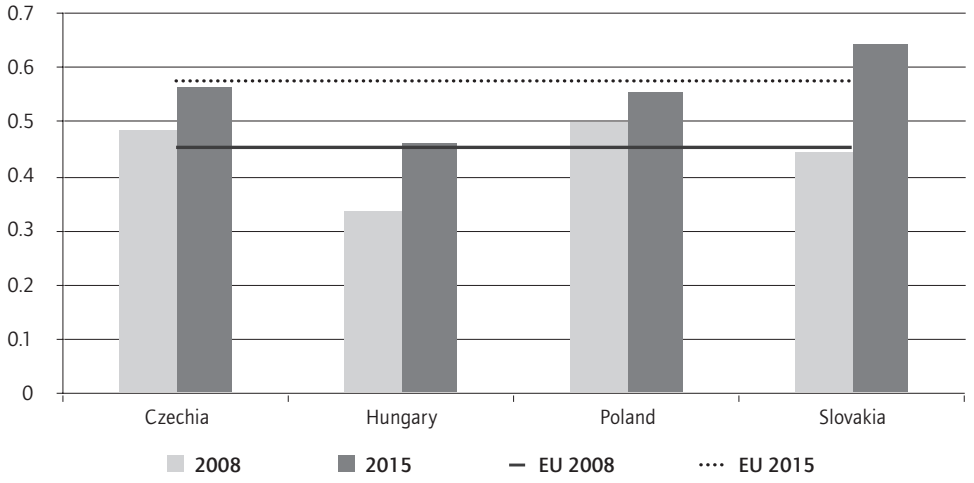
Source: own elaboration based on Eurostat and the database of European Commission (2016g)

5.2 Human capital for a digital economy in the V4 countries

Human resources are one of the most important elements of national innovation capacity (Figure 1). This is also one of sub-indices constituting the Summary Innovation Index. In terms of human resources, the V4 countries have relatively strong positions when compared to the EU average. Poland and Czechia were originally the V4 leaders in this respect, but were overtaken by Slovakia in 2015, followed by Czechia, Poland, and Hungary (Figure 13).

The human resource sub-index is composed of 3 indicators: (1) new doctorate graduates per 1000 population aged 25-34; (2) percentage of the population aged 30-34 having completed tertiary education, and (3) percentage of 20 – 24-year-olds having attained at least upper secondary level education. A more detailed look at these indicators and a comparison of V4 achievements in 2008 and 2015 reveals that Slovakia has made most progress with regard to the first 2 indicators, as well as leading the V4 group when it comes to new doctorate graduates and the percentage of young people aged 20-24 having attained at least upper secondary level education. The values of these 2 indicators were much higher for Slovakia than the EU average. Poland was the V4 leader in the percentage of the population aged 30-34 having completed tertiary education, and its performance here was 10 p.p. higher than the EU average (Table 9). It should however be pointed out that in recent years there has been growing emigration from Poland. Estimates published by the Polish Statistical Office at the end of 2015 put the number of Poles residing temporarily abroad at approximately 2.4 million, a number that has increased by nearly 200,000 since 2008 (GUS 2016). While to a certain extent mitigating the problem of unemployment, this emigration may cause some shortages in human resources.

Figure 13 **Changes in Human Resources Index in 2008-2015: V4 countries and EU average compared**



Source: own elaboration based on the database of European Commission (2016g)

Table 9 **Human capital development in the V4 countries, 2008-2015**

Indicators constituting Human Resources Sub-Index	EU		Czechia		Hungary		Poland		Slovakia	
	2008	2015	2008	2015	2008	2015	2008	2015	2008	2015
New doctorate graduates per 1000 population aged 25-34	1.6	**1.8**	1.3	**1.7**	0.8	**0.9**	1.0	**0.6**	1.5	**2.5**
Percentage population aged 30-34 having completed tertiary education	31.2	**38.5**	23.7	**29.5**	22.8	**34.9**	29.7	**43.2**	15.8	**27.9**
Percentage youth aged 20-24 having attained at least upper secondary level education	78.7	**82.6**	91.6	**90.7**	83.5	**84.3**	91.3	**90.9**	92.3	**91.2**

Source: own elaboration based on European Commission, 2016g

Furthermore, the availability of human resources and some progress in human capital creation might not be sufficient to take advantage of a digital economy. Increasing use of digital technologies creates demand for new specialist (ICT) skills in the fields of programming, developing applications and managing networks; enabling the use of ICT in businesses; information processing and problem solving with the use of ICT, communication, etc. Digital literacy as well as social and emotional skills are also crucial to enable the effective use of digital technologies (OECD 2016b: 6). In the context of human capital development, these skills have been concisely characterized and assessed for EU member states in the EU's Digital Progress Report. The Human Capital dimension of the DESI covers two elements:

— basic skills and usage, comprising indicators showing whether people have basic digital skills and to what extent they use the Internet;

— advanced skills and development, consisting of indicators describing ICT specialist employment and the number of graduates in science, technology and mathematics (European Commission 2016b).

Table 10 **Digital human capital indicators**

	% of citizens aged 16-74 having at least basic digital skills		Internet Users as % individuals (aged 16-74)		ICT specialists as % individuals (aged 16-74)		STEM graduates per 1000 individuals (aged 20-29)	
	DESI 2015*	DESI 2016*	DESI 2015*	DESI 2016*	DESI 2015*	DESI 2016*	DESI 2015*	DESI 2016*
EU average	59%	55%	75%	76%	2.8%	3.7%	17	18
Czechia	n.a.	57%	76%	77%	4.4%	4.1%	17	17
Hungary	n.a.	50%	74%	72%	4.7%	4.9%	9.5	10
Poland	n.a.	40%	63%	65%	3.1%	3.0%	18	19
Slovakia	n.a.	55%	76%	74%	3.9%	4.1%	18	18

Note: *data for DESI 2015 are mostly of 2014; data for DESI 2016 are mostly for 2015
Source: European Commission (2015c; 2016a; 2016b; 2016c; 2016d; 2016e; 2016f;)

As shown in Table 10, digital human capital is underdeveloped in the V4, with the majority of indicators of digital capital development below the EU average in Poland and Hungary and around this EU average in Slovakia and Czechia. Furthermore, all V4 countries show limited progress in the development of digital skills, with some indicators even declining in 2015 compared to the preceding year (for example: the percentage of internet users in Hungary and Slovakia, the percentage of ICT specialists in Czechia and Poland – see: Table 10). As a result, all V4 countries still belong to the so called 'falling behind cluster' with regard to Digital Economy and Society Index, with their overall scores below the EU average and growing slower than that of the EU as a whole.[3]

6. Policy recommendations for the V4 countries in the post-FDI period

The aim of this chapter was to assess the competitiveness of the V4 countries in the post-crisis period, identifying the role of innovation and human capital in shaping competitive advantages for these countries in the era of digitalization.

The analysis conducted above allows the conclusion that the role of innovation in shaping competitiveness in V4 countries remains limited. All V4 countries still use relatively low input costs as their main base for competitiveness. However, this is no longer sufficient to keep up with other emerging economies and to catch up with developed countries. The main barriers for the V4 countries in switching to a new competitiveness model based on skills and innovation are:

— a too low R&D level (including business R&D); with innovation mainly supported by non-R&D investments;

3. Detailed analysis of digital competitiveness was conducted in the section 4.3 of this paper.

— inefficient links between science and business;
— barriers to knowledge diffusion and learning processes;
— insufficient development of digital skills.

Therefore, a long-term economic policy challenge for the V4 countries is to create a framework for achieving competitiveness through innovation and digitalization. To make V4 economies more competitive, long-term policy aims should focus on accelerating the catching-up process with regard to innovation and human capital development. This should be accompanied by steps to reduce the digital divide vis-à-vis more advanced Western European EU member states. However, these goals can only be achieved when a broader institutional environment is addressed by appropriate policy measures. Further institutional changes are needed, including reforms in the education and science sectors, further deregulation of markets and support for entrepreneurship and establishing start-ups.

Furthermore, these steps should be coupled with policies aimed at fostering the development of assets embodying creativity potential, such as knowledge, technology, human capital. At the same time, innovation should be enhanced as a primary driver of V4 competitiveness. The expansion of innovative companies requires reforms in the R&D sector, the introduction of new policies aimed at boosting business R&D as well as the injection of additional funds, in particular, higher investment in knowledge diffusion. The latter can be eased by incentives for venture capital market development. The improvement of innovative capacity should be supported by cluster development, including the strengthening of local supplier networks around foreign investments.

Last but not least, multi-level governance of research and innovation needs to be reshaped. The main focus here should be on the territorial dimension, including the better use of EU funds and the implementation of smart specialization strategies.

To achieve these policy goals, significant improvements in the business environment in the V4 countries are indispensable, as are the reduction of bureaucracy and the introduction of more efficient public-sector management. Innovation as a base for competitiveness should be promoted not only in business, but also in the public sector in order to increase the quality of public services.

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