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## HUMAN CAPITAL EFFICIENCY IN THE VISEGRAD COUNTRIES AND ACHIEVING THE SUSTAINABLE DEVELOPMENT GOALS

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**ABSTRACT:** After the change of the economic system in the 1990s, the countries of the Visegrad group (V4: Czechia, Hungary, Poland and Slovakia) began to catch up economically with developed countries. After joining the EU, this process accelerated. The article concerns the relationship between the level of employee education and the efficiency of human capital in the V4 countries and the impact of this efficiency on sustainable growth. The aim of the article is to answer the question of whether the increase in the efficiency of human capital can be explained by the increase in employee education. To estimate the efficiency of human capital, the real GDP to employment ratio was used. The obtained results indicate that the efficiency of human capital in the V4 countries is approaching. The EU average, which, among others, contributes to the achievement of Sustainable Development Goals.

**KEYWORDS:** economic growth, employees' education level, human capital efficiency, the Visegrad Group, Sustainable Development Goals

## Introduction

The aim of the article is to assess to what extent the convergence processes of the Visegrad Group (V4: Czechia, Hungary, Poland and Slovakia) countries in relation to the average EU level can be explained by the increase in the efficiency of human capital and the increase in the education level of employees and how they contribute to achieving the sustainable development goals.

The efficiency of human capital determines the competitiveness of human resources available to individual economies (Dakhli & De Clercq, 2004; Huggins et al., 2017). The article assesses changes in the level of human capital in terms of education and changes in its efficiency (understood as average employee productivity) in the Visegrad Group (V4) countries after their accession to the EU. The indicator of human capital efficiency used in the article is Real GDP to Employment.

The inspiration for this article derives from the V4 countries' notable achievements, including rapid economic growth and labour market balancing following their EU accession. A key driver in these processes was the increasing educational attainment of the workforce and enhanced efficiency in utilising human capital. Previous studies on human capital efficiency and its economic impacts have primarily focused on individual countries or comparisons within the OECD group, which is highly heterogeneous in terms of economic development levels, complicating direct comparisons. A research gap was identified in the lack of longitudinal studies examining the relationship between workforce education levels, human capital efficiency, and macroeconomic indicator changes in countries with similar starting points. Choosing the V4 group facilitates a more reliable examination of these relationships due to reduced confounding factors such as differences in development levels, economic structure, institutional conditions, and membership in diverse economic blocs.

The article contributes to the existing literature in several ways. First, we complement theoretical work on the importance of the employees' education level on the efficiency of human capital and on the macroeconomic indicators achieved by the economies of individual countries. Second, we complement empirical work using macroeconomic data to examine the relationship between the structure of employment by educational level (distinguishing between higher and secondary education) and the rate of economic growth. These studies are significant due to the ongoing discussion in the literature regarding whether an average education level of employees is sufficient to enhance human capital efficiency or whether efforts should be directed towards increasing the share of individuals with higher education in employment. Finally, our article contributes to the extensive and intensified policy and academic literature on the profitability of investing public funds in higher education and its economic effects.

The article consists of a theoretical introduction based on a literature review, a presentation of the methods and data sources, an empirical section, a discussion and conclusions.

## An overview of the literature

The pursuit of sustainable development through the elimination of poverty and social marginalisation, creation of equal opportunities, integration, health protection, improvement of the quality of life and reduction of demographic problems is the overarching goal of the European Union (Kryk, 2017). The 2030 Agenda for Sustainable Development Goals (SDGs), adopted by the UN General Assembly in September 2015, defines 17 SDGs (Nilsson et al., 2016). The implementation of the eighth of the above goals, formulated as "Decent Work and Economic Growth", divided into 12 targets (United Nations, 2023), depends on the degree of use of labour resources and their potential (Kozera-Kowalska, 2024; Zieliński, 2024).

Human capital, considered as a resource related to an individual's knowledge and skills, is a key element in economic development (Angrist et al., 2021). In terms of the economy as a whole, it is important to ensure an adequate system of formal education, which is treated as an investment in human capital. Education increases people's productivity by preparing them for the challenges of advanced economies (Becker, 1993; Goldin, 2016; Habib et al., 2019), facilitating innovation and absorption of new technologies, and improving the productivity of physical capital (Mulliqi, 2018; Castell'o-Climent, 2019; Diebolt & Hippe, 2019; Rossi, 2019; Sasso & Ritzen, 2019).

Initially, the valuation of education's contribution to human capital was based on the number of years spent in school. Nowadays, the need to take into account the quality of education is emphasised (Mulligan, 2000; Lundberg, 2015; Angrist et al., 2021) and the alignment of education courses with the needs of the economy.

Effective investment in human capital, manifested by increasing resources for education, is crucial for economic development, especially in the long term (Kraay, 2018; Lenkei, 2020; Andrijauskienė et al., 2021). If the increase in earnings of higher-educated citizens is large enough, it will allow the costs of educational programs to be repaid through increased tax revenues (Deming, 2022). Individuals with higher education, in addition to earning higher wages on average, can take up employment in professions requiring knowledge, exhibit higher professional activity and are less likely to be unemployed (Goldin, 2016). In addition, there is the potential for external effects when one person's higher level of human capital increases the earnings of others working with them and society as a whole (Bal-Domańska, 2022; Blundell, 2022; Zimmer, 2023; Clark et al., 2024).

In addition to school factors, human capital is also influenced by: self-directed further education, on-the-job training, public training in the labour market policy, and work experience in different types of organisations, social environment, peers, intergenerational transmission of human capital in the family (parental income and education), innate abilities (genes), medical care, sports and migration processes (Hanushek & Woessmann 2008; Antonelli et al. 2010; Flabbi & Gatti, 2018).

Differences in the level of human capital determine income disparities between countries (Jones, 2014; Lucas, 2015; Rossi, 2019). The current level of human capital in each country is historically determined. Of great importance are the broad institutional conditions that determine its economic development i.e.: a well-defined system of property rights, openness of the economy, and security of the nation (Hanushek et al., 2021).

According to Woessmann (2002), in a sample of OECD countries, virtually all income dispersion can be explained by differences in human capital adjusted for the quality of education, a finding confirmed by more recent studies (Sianesi & Van Reenen, 2000; Hoeller et al., 2012; OECD, 2021). The impact of increased education on GDP growth tends to vary, depending on a country's level of development. Higher education has a greater impact on economic growth in OECD countries (OECD, 2023).

There are ongoing disputes in the literature regarding the method of valuing human capital and its efficiency. In cost terms, the human capital of an individual worker is treated as the outlay for acquiring: knowledge, experience and skills acquired in school, on-the-job training and other forms of further training (Østergaard & Marinova, 2018; Naval et al., 2020). This estimate can be expanded to include the costs incurred by the state and family (for education, health care), the companies that employed the worker (expenses for on-the-job training and development), the expenses of the worker himself, and the value of the employee's non-market activities, personality traits and individual skills (Lee & Lee 2016).

In addition to the cost approach to human capital (level of education), an income approach can be used to measure it. The income approach focuses on worker productivity, which, according to economic theory, equals the equilibrium wage rate (Buessellmann, 2009), which should optimally reflect the entire stock of an individual's human capital (i.e., experience, training, education, health, etc.) (Škare & Lacmanović, 2015).

From the perspective of the article topic, it is important to be able to assess the efficiency of human capital on a macroeconomic scale over the long term. Since both the level of GDP and the level and structure of employment change over time, a good measure of efficiency seems to be the GDP/employment ratio (Klinger & Weber, 2019; Vladušić et al., 2020).

Accepting the V4 countries as the subject of comparison is justified insofar as they share geographical, historical and cultural proximity, similar levels of development, institutional similarities and a similar structure of the economy and employment, in addition, at the same time (in 2004), the V4 countries joined the EU (Dmytrów & Bieszk-Stolorz, 2019). The process of convergence of the V4 economies with the EU is noticeable (Kokocinska & Puziak, 2018), which results in, among others, a decreasing unemployment rate (Antoñi et al., 2019), increasing professional activity and rising employment rates, which were initially lower than in Western Europe, especially in Hungary and Poland (Sulich, 2016; Kónya, 2018).

## Research methods

The literature study allowed the following research hypotheses:

H1: Visegrad countries are reducing the gap with the EU-27 average due to an increase in human capital efficiency.

H2: Wage growth is conditioned by the growth in human capital efficiency.

H3: The efficiency of human capital increases due to the increase in the level of employees' education.

H4: The increase in the efficiency of human capital facilitates the implementation of SDGs.

Verification of the first three hypotheses was based on Eurostat data (Eurostat 2024), i.e.:

- employment by sex, age and educational attainment level – sex: Total; age: 15-64; educational attainment level: Upper secondary and post-secondary non-tertiary education (levels 3-4), Tertiary education (levels 5-8); all in thousand persons;
- Gross Domestic Product (GDP) and main components: output (including Gross Value Added), expenditure and income (including Compensation of employees, Gross Operating Surplus and Mixed Income, Taxes on Production and Imports Less Subsidies) – current prices, chain linked volumes (2010); all in million euro.

For the verification of the first hypothesis, the initial assumption was made that the depiction of the efficiency of human capital (understood as the ratio of outputs to inputs), is the efficiency (productivity) of labour, which can be expressed using an indicator based on the size of employment (1):

$$\text{Real GDP to Employment} = \frac{\text{GDP in Market Prices (Constant Prices from 2010)}}{\text{Employment}} \quad (1)$$

In order to verify the second hypothesis, human capital efficiency indicators, i.e. Real GDP to Employment (1) and Real Compensation per Employee (2) in the Visegrad Group countries against the EU-27, were analysed. Real Compensation per Employee (2) was established based on indicators (3) and (4) concerning, respectively real wages and the GDP deflator:

$$\text{Real Compensation per Employee} = \frac{\text{Real Compensation of Employees}}{\text{Employment}} \quad (2)$$

$$\begin{aligned} \text{Real Compensation of Employees} = \\ = \frac{\text{Compensation of Employees (Current Prices)}}{\text{GDP deflator}} \end{aligned} \quad (3)$$

$$\text{GDP deflator} = \frac{\text{GDP in Market Prices (Current Prices)}}{\text{GDP in Market Prices (Constant Prices from 2010)}} \quad (4)$$

For the purpose of verifying the third hypothesis, data on education levels were used in accordance with Eurostat methodology, for the 15-64 age group. The groups of “upper secondary and post-secondary non-tertiary education” (3-4 education level) were used as secondary education, and “tertiary education” (5-8 education level) was used as tertiary education. Shares among employees with tertiary education and persons with at least secondary education (sum of persons with secondary and tertiary education) were contrasted with Real GDP to Employment (1).

Relationships between the considered quantities (indicators) were examined using Pearson's linear correlation coefficient ( $p < 0.05$  was used as the level of significance), at the same time providing the coefficient of determination  $R^2$ , as a measure of the fit of the regression function to the empirical data.

Hypothesis 4 was verified using a descriptive method by relating the effects of increasing human capital efficiency to the SDGs.

## Results of the research

For the economies under consideration, comparing the changes in the efficiency of human capital expressed by the Real GDP to Employment ratio (1), it can be seen that in the period 2004-2024, all the economies of the Visegrad Group countries were characterised by significantly higher growth rates in both categories than the EU economy in general (EU-27). The most positive changes occurred in the economies of Poland and Slovakia, The lowest growth rate can be found in the economy of Hungary (Figure 1 and Table 1).

Over the period 2004-2024, real GDP more than doubled in Poland (106.9%), increased by 86.4% in Slovakia, by 53.0% in Czechia and 44.9% in Hungary, respectively, with an average increase for the EU-27 of 29.4%. These changes are reflected in the Real GDP to Employment ratio (indicator1). The ranking based on the scale of Real GDP to Employment (1) growth shows the same order (Poland ahead of Slovakia, Czechia and Hungary) as in the case of Real GDP growth. It should be noted that Poland had the lowest value of Real GDP to Employment (1) at the beginning of the analysed period, and despite its growth of 64.2%, it was ahead of only Hungary in the ranking. Given the similar growth in the number of employees over the 2004-2024 period in Hungary (21.1%), Poland (25.9%) and Slovakia (22.0%) (Eurostat data: Population and social conditions, Labour market, Employment and unemployment), by far the faster growth in the Real GDP to Employment ratio (1) in the latter two countries has been generated by faster gains in average employee productivity (human capital efficiency).

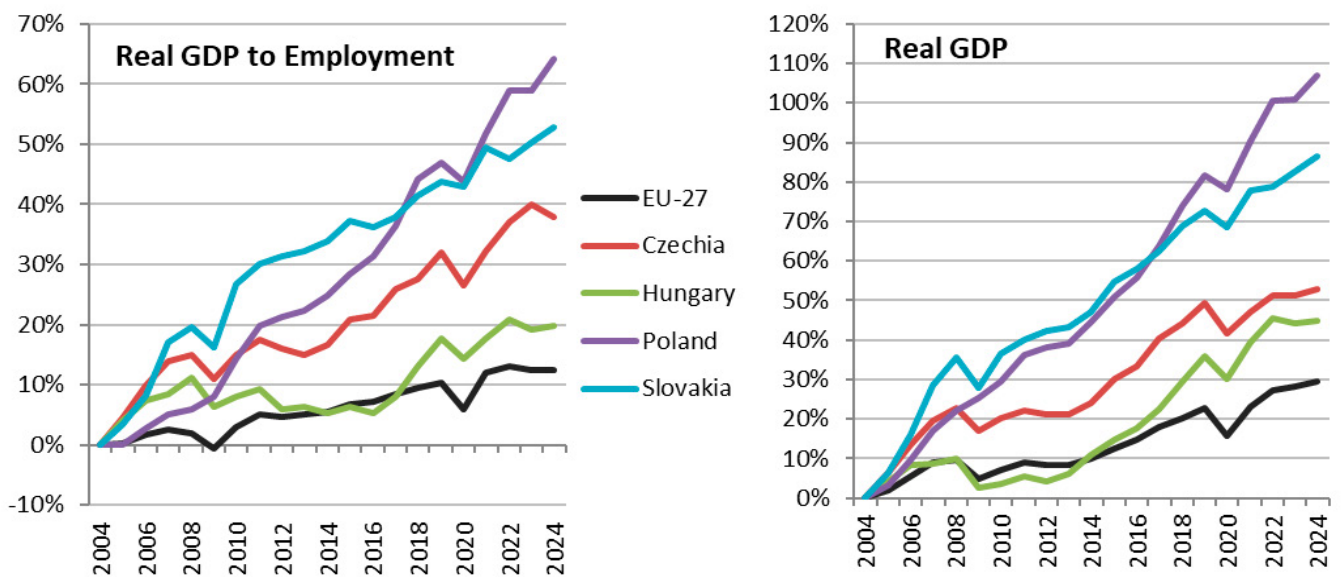


Figure 1. Growth rates of Real GDP to Employment and Real GDP in the EU-27 and Visegrad countries from 2004 to 2024. Cumulatively (year 2004 = 0%). GDP data at constant market prices from 2010

Source: authors' work based on Eurostat data: Population and social conditions, Labour market, Employment and unemployment, GDP and main components (output, expenditure and income).

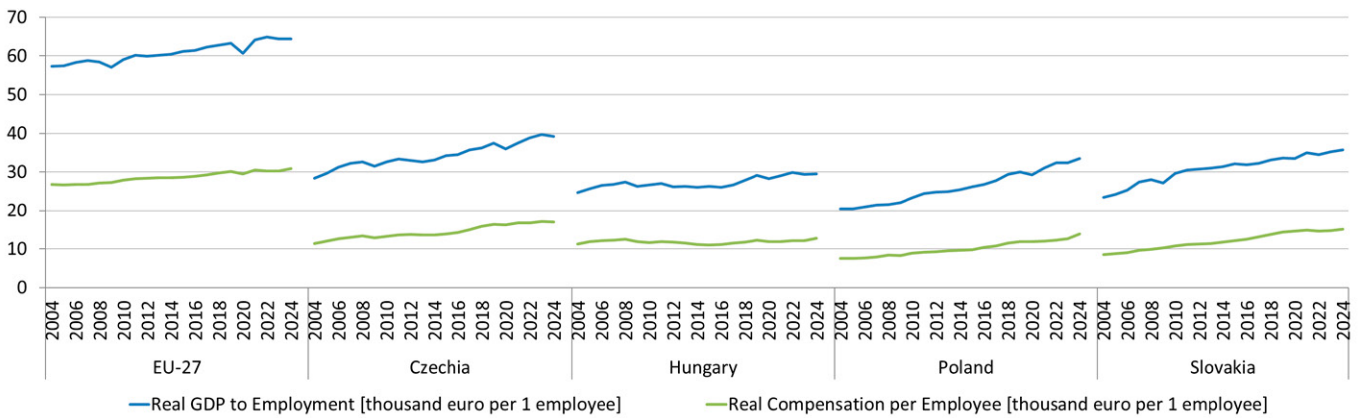
**Table 1.** Real GDP and Real GDP to Employment in V4 and EU-27 (period 2004-2024)

	Real GDP					Real GDP to Employment					
	EU-27	Czechia	Hungary	Poland	Slovakia	EU-27	Czechia	Hungary	Poland	Slovakia	
2004	10318179	132863	96164	278935	50288	2004	57.3	28.4	24.7	20.4	23.4
2005	10518237	141333	100299	288031	53549	2005	57.5	29.7	25.7	20.4	24.2
2006	10889824	150694	104245	305895	58329	2006	58.3	31.2	26.5	21.0	25.3
2007	11229421	158965	104591	326575	64639	2007	58.8	32.3	26.8	21.4	27.4
2008	11299559	163117	105631	340891	68106	2008	58.5	32.6	27.4	21.6	28.0
2009	10817523	155291	98511	349806	64357	2009	57.0	31.5	26.3	22.0	27.2
2010	11048419	159506	99563	360891	68727	2010	59.1	32.7	26.7	23.3	29.7
2011	11260056	162333	101471	379857	70488	2011	60.2	33.3	27.0	24.4	30.4
2012	11171220	161082	100112	385600	71594	2012	60.0	32.9	26.2	24.7	30.7
2013	11166363	161015	102146	388238	72097	2013	60.2	32.6	26.2	24.9	31.0
2014	11347084	164630	106574	403459	74050	2014	60.5	33.1	26.0	25.4	31.3
2015	11612875	172794	110474	421340	77883	2015	61.2	34.3	26.2	26.2	32.1
2016	11837936	177253	113168	434111	79400	2016	61.5	34.5	26.0	26.8	31.9
2017	12168429	186423	117836	456478	81683	2017	62.2	35.7	26.7	27.8	32.3
2018	12417723	191700	124442	484989	85001	2018	62.8	36.2	27.9	29.4	33.1
2019	12651116	198535	130760	507204	86935	2019	63.3	37.4	29.1	30.0	33.6
2020	11948463	188003	125086	496880	84688	2020	60.7	35.9	28.2	29.3	33.5
2021	12701551	195578	134121	531299	89515	2021	64.2	37.5	29.0	31.0	35.0
2022	13144962	201146	139849	559222	89906	2022	64.9	38.9	29.9	32.4	34.5
2023	13215209	201035	138671	560618	91855	2023	64.4	39.7	29.4	32.4	35.2
2024	13351148	203288	139381	577007	93749	2024	64.4	39.2	29.6	33.5	35.8
Growth rate 2024 vs 2004	29.4%	53.0%	44.9%	106.9%	86.4%	Growth rate 2024 vs 2004	12.3%	38.0%	19.7%	64.2%	52.8%

Source: authors' work based on Eurostat data (as in Figure 1).

Given the considerations presented above, hypothesis H1 should be considered as confirmed. The V4 countries are reducing the gap with the EU average, due to the increase in the efficiency of human capital, while doing so at different rates.

According to H2, it was assumed that an increase in the efficiency of human capital is associated with an increase in compensation, i.e. employees receive higher wages due to an increase in the efficiency (productivity) of their work. Figure 2 shows the trends in the following indicators: Real GDP to Employment (1) and Real Compensation per Employee (2). The first two of these for the EU-27 remained stable during the period under review, increased for Hungary, and decreased for the other three V4 countries. Hungary stands out when it comes to the Real Compensation per Employee index (4), which remains stable, while it is rising in the other V4 countries and in the EU-27 as a whole.



**Figure 2.** Labour productivity and the value of human capital per employee in the EU-27 and Visegrad countries from 2004 to 2024

Source: authors' work based on Eurostat data (as in Figure 1).

Across the EU-27 and all V4 economies under consideration, there is a statistically significant, strong, positive and confirmed by a high R2 reading correlation between Real Compensation per Employee (2) and the Real GDP to Employment ratio (1) (Table 2). In the case of Hungary, this relationship is slightly weaker.

**Table 2.** Pearson correlation (r) and determination coefficients (R2) between Real GDP to Employment ratio (1) and Real Compensation per Employee (2) in the Visegrad countries

EU-27		Real Compensation per Employee (2)				
		EU-27	Czechia	Hungary	Poland	Slovakia
Real GDP to Employment (1)	r	0.9596*	0.9822*	0.6623*	0.9921*	0.9672*
	R <sup>2</sup>	0.9209	0.9647	0.4386	0.9842	0.9356

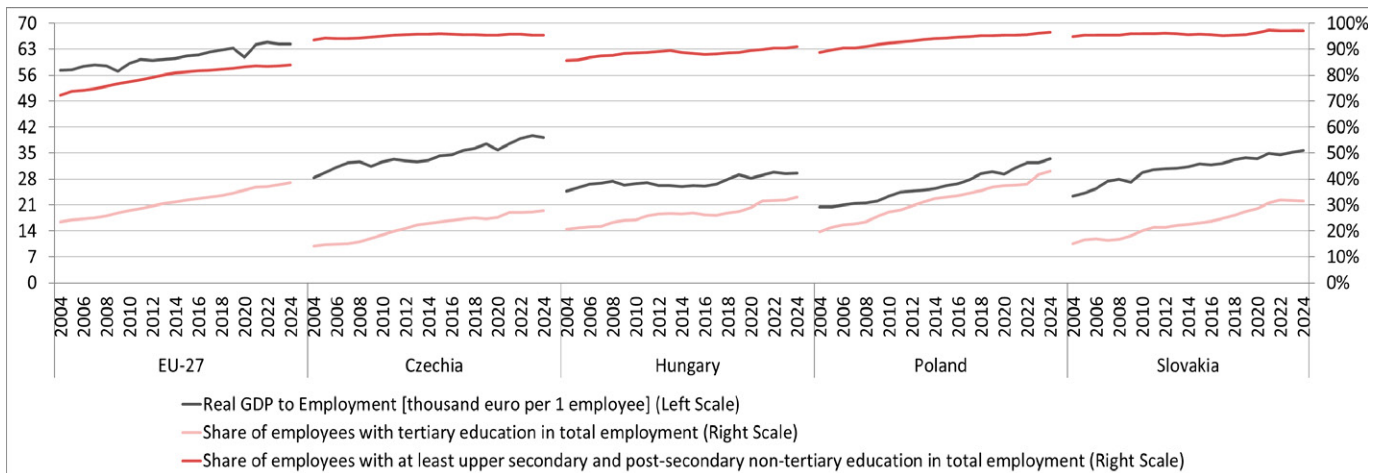
\* correlation is significant at the 0.05 level

Source: authors' work based on Eurostat data (as in Figure 1).

By examining the relationship between Real GDP to Employment (1) and Real Compensation per Employee (2), it can be concluded that in all economies under consideration, there is a statistically significant positive correlation, confirmed generally by high values of R2 (Hungary is an exception). Accordingly, hypothesis H2 can be considered confirmed for all V4 economies.

Referring to the third hypothesis, which assumes that faster growth in the efficiency of human capital occurs in economies where the level of education among the employed grows faster, data on the Real GDP to Employment indicators (1) and changes in the share among the employed of workers with at least secondary education (the sum of those with secondary and high school education) and those with tertiary education were compiled (Figure 3).

During the period under review, all these figures grew, both in the EU-27 and in the V4 countries (the exception is the Czechia, where the share of the sum of workers with secondary and tertiary education in employment remained generally stable). It should be noted that Poland is the only country in the V4 group where the share of people with higher education among the employed exceeded the EU27 average. This may be one of the factors determining the pace of development of the Polish economy.



**Figure 3.** Real GDP to Employment and changes in the share of employees with secondary and tertiary education in the EU-27 and Visegrad countries between 2004 and 2024

Source: authors' work based on Eurostat data (as in Figure1).

In the context of hypothesis H3 verification, the correlation between human capital efficiency, measured as the Real GDP to Employment (1) ratio, and the share of workers with tertiary education, for all analysed economies and the EU-27 was generally strongly positive, statistically significant and further confirmed by high R2 values (Table 3).

**Table 3.** Pearson correlation (r) and determination coefficients (R2) between Real GDP to Employment ratio (1) and selected indicators of employment structure in terms of education in the Visegrad countries

EU-27		Real GDP to Employment (1)				
		EU-27	Czechia	Hungary	Poland	Slovakia
Share of employees with tertiary education in total employment	r	0.9417*	0.9142*	0.8091*	0.9789*	0.9458*
	R <sup>2</sup>	0.8868	0.8358	0.6547	0.9582	0.8946
Share of employees with at least upper secondary and post-secondary non-tertiary education in total employment	r	0.9096*	0.6391*	0.7587*	0.9483*	0.7056*
	R <sup>2</sup>	0.8274	0.4085	0.5756	0.8992	0.4978

\* correlation is significant at the 0.05 level

Source: authors' work based on Eurostat data (as in Figure 3).

The correlation between Real GDP and Employment (1) and the share of workers with at least secondary education (the sum of those with secondary and tertiary education) was also found to be strong and statistically significant in all V4 economies, but with slightly lower correlation and R2 results (Table 3).

Therefore, hypothesis H3 can be considered confirmed. An increase in the level of education of employees is statistically significantly associated with an increase in the efficiency of human capital, both in the case of employees with higher education and employees with secondary education.

Referring to hypothesis 4, the successive increase in the efficiency of human capital, accompanied by an increase in the level of employment, contributes to the implementation of the eighth SDG “Decent Work and Economic Growth” (United Nations, 2025). It confirms the direct achievement of the targets: sustain per capita economic growth, achieve higher levels of economic productivity, achieve full and productive employment and decent work, indirectly contributing to the implementation of the targets: protect labour rights and promote safe and secure working environments for all workers and decent job creation. The effective use of human capital also supports the implementation of the remaining sustainable development goals.

## Discussion

The findings presented in the article confirm that effective investment in human capital- understood as the long-term enhancement of the educational attainment of the workforce-is of pivotal importance for economic development (Kraay, 2018; Lenkei, 2020; Andrijauskiene, 2021).

Statistical data indicate that the reduction in the gap between the level of economic development of the V4 countries (Czechia, Poland, Hungary, Slovakia) and the EU-27 average can be explained by the increase in the efficiency of human capital. The real GDP to Employment ratio (1) is growing the fastest in the case of Poland, which at the beginning of the analysed period was in the last place in the ranking, which is consistent with the neoclassical growth theory (Kokocińska & Puziak, 2018; Vatsa & Pino, 2023). One of the factors determining the success of the Polish economy may be the fastest growth in the share of employed people with higher education.

The share of financial compensation of employees (wage levels) to the increase in the efficiency of human capital is growing, and is weakest in the case of Hungary. The weakest relationship between GDP and compensation in Hungary may affect the limited motivation to undertake studies by employees (Lee et al., 2015). Such conclusions in the case of Hungary are supported by the lowest growth in the number of employees with higher education among the V4 countries during the analysed period and the highest growth in employment of people with secondary education.

The relationship observed in the late 20th century and in subsequent studies (Woessmann, 2002; OECD, 2023) that tertiary education has an impact on economic growth in countries which are able to create a sufficient number of high-quality jobs capable of discounting the higher education of workers is confirmed in the case of the V4 countries. It should be emphasised here that the work efficiency of people with secondary education also increases. A greater contribution to economic growth in the V4 group by individuals with higher education may be attributable to collaboration with more highly developed “old” EU countries and the structure of inward foreign investment (which requires a better-qualified workforce). Sector-specific and industry-wide studies on human capital efficiency in Poland have demonstrated an association between the levels of remuneration and employee benefits, with human capital effectiveness, and the efficient utilisation of tangible fixed assets. Industries and sectors with the highest efficiency thus employ workers who demonstrate the greatest productivity (Nawrocki, Zieliński, 2024).

The generalisation of the results of this study is limited by the nature of the V4 economies, which are catching up with the most developed and benefiting from participation in the EU common market since 2004. The measures recommended in the article may have less effect in the case of underdeveloped countries, in economies with different institutional conditions, a distinct structure, or divergent development pathways. The article uses only macroeconomic data, without delving into a number of issues affecting the effectiveness of human capital (e.g., the quality and structure of education, migrations, or changes in the sectoral structure of economies).

The impact of the above-mentioned microeconomic factors on human capital efficiency will be the subject of further research. This research will cover the quality of education (based on the comparison of international student competence studies such as PISA, PIAAC, and PIRLS across countries) and the structure of education (including the share of technical graduates), from the perspective of their influence on potential technological innovation. Due to the significant role of labour migration in building economic resilience, future research will also take into account the flows of workers between regions and economic sectors.

## Conclusions

The increase in the efficiency of human capital accompanying the increase in employment supports the achievement of SDGs not only on the labour market (eighth SDG “Decent Work and Economic Growth”). It also supports:

- high-quality education (which fosters the growth of human capital and its demand),
- gender equality (as the increased demand for labour facilitates employment opportunities for potentially discriminated groups, including women),

- improving the quality of life (by increasing the availability of goods and services as well as the income of employees),
- reducing poverty and social marginalisation (by reducing the number of social welfare beneficiaries),
- creating equal opportunities (by easier access to employment),
- integration (by easier access to employment and reducing the number of individuals requiring support),
- facilitates obtaining funds for financing health care (thanks to higher tax and contribution revenues).

An important conclusion of the presented research is the slightly higher impact on the growth of human capital efficiency of the share in employment of people with higher education than those with secondary education. Hence, the basic recommendation of the article, i.e. the state should support a high level of enrolment in higher education (Bal-Domańska, 2022; Schultheiss et al., 2023). Investments in higher education benefit students by facilitating easier entry into the labour market, improving career prospects, and yielding anticipated higher incomes. The state recoups the costs of educational programs through increased tax revenues (Deming, 2022), owing to greater labour market participation and higher incomes among individuals with tertiary education. An elevation in the educational attainment of the workforce facilitates the development and implementation of innovations, the absorption of new technologies (including foreign investments), and also improves the utilisation of physical capital (Goldin, 2016; Mulliqi et al., 2018; Castelló-Climent, 2019; Diebolt & Hippe, 2019; Rossi, 2019).

The above recommendation aligns with the EU's policy supporting initiatives that foster the growth of human capital, including the enhancement of the education system, promotion of broad-based innovation, and the balancing of the labour market. Three key EU programs are (EC, 2025):

- **Erasmus+ Program**, which supports inclusive, high-quality education and training, mobility, and skills development to enhance human capital, employability, and innovation capacity across the EU;
- **Horizon Europe**, the EU's flagship research and innovation framework, which fosters investments in R&D, supports institutional quality improvements, promotes technological innovation, and strengthens cross-sector collaboration among member states, including V4 countries;
- **European Social Fund Plus**, this program is focused on improving employment opportunities, social inclusion, and labour market balance through targeted funding on skills development, reducing inequalities (including gender equality), and supporting worker mobility between sectors and regions.

These initiatives collectively support the enhancement of education quality, innovation capacity, and labour market balance-core themes emerging from the empirical analysis and essential for further improving human capital efficiency in the V4 countries.

## The contribution of the authors

Conceptualisation, M.Z., T.N.; literature review, M.Z., T.N. and M.A.; methodology, M.Z., T.N.; formal analysis, M.Z., T.N.; writing, M.Z., T.N. and M.A.; conclusions and discussion, M.Z., T.N. and M.A.

The authors have read and agreed to the published version of the manuscript.

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## EFEKTYWNOŚĆ KAPITAŁU LUDZKIEGO W KRAJACH GRUPY WYSZEHRADZKIEJ A REALIZACJA CELÓW ZRÓWNOWAŻONEGO ROZWOJU

**STRESZCZENIE:** Po zmianie systemu gospodarczego w latach 90. XX wieku kraje Grupy Wyszehradzkiej (V4: Czechy, Węgry, Polska i Słowacja) zaczęły nadrobić opóźnienie gospodarcze w stosunku do krajów rozwiniętych. Po przystąpieniu do UE proces ten przyspieszył. Artykuł dotyczy związku między poziomem wykształcenia pracowników a efektywnością kapitału ludzkiego w krajach V4 oraz wpływu tej efektywności na zrównoważony rozwój. Celem artykułu jest odpowiedź na pytanie, czy wzrost efektywności kapitału ludzkiego można wiązać ze wzrostem wykształcenia pracowników? Do oszacowania efektywności kapitału ludzkiego wykorzystano wskaźnik realnego PKB do zatrudnienia. Uzyskane wyniki wskazują, że efektywność kapitału ludzkiego w krajach V4 zbliża się do średniej UE, co między innymi pozwala na osiągnięcie Celów Zrównoważonego Rozwoju.

**SŁOWA KLUCZOWE:** wzrost gospodarczy, poziom wykształcenia pracowników, efektywność kapitału ludzkiego, Grupa Wyszehradzka, Cele Zrównoważonego Rozwoju