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HUMAN CAPITAL, EDUCATION AND ECONOMIC GROWTH: ANALYSIS OF INVESTMENT AND POLICY IMPERATIVES IN SELECTED CEE COUNTRIES

Abstract. This paper provides an analysis of the complex interrelationships between human capital, education, and sustainable economic growth, with a critical focus on the context of Central and Eastern European (CEE) nations. The core argument posits that strategic investment in the quality of human capital, particularly within professional education and training and research and development (R&D&I), is an indispensable prerequisite for achieving endogenous economic growth and long-term prosperity. The study moves beyond measuring simple school enrollment metrics to assessing the quality of learning outcomes, utilizing measures like the World Bank's Human Capital Index (HCI) to highlight existing disparities across CEE. A significant structural deficiency common to most CEE economies is the persistent skills shortage, often arising from vocational education and training systems that lack sufficient practical relevance. The article concludes by proposing targeted fiscal and educational policy mechanisms–including R&D tax incentives focused on labor costs – essential to accelerate economic convergence, boost Total Factor Productivity (TFP), and ensure long-term corporate and national resilience.

Keywords: human capital, professional education, economic growth, R&D investment, pedagogical sciences, vocational training, cognitive skills.

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ЛЮДСЬКИЙ КАПІТАЛ, ОСВІТА ТА ЕКОНОМІЧНЕ ЗРОСТАННЯ: АНАЛІЗ ІНВЕСТИЦІЙНИХ ТА ПОЛІТИЧНИХ ІМПЕРАТИВІВ У ВИБРАНИХ КРАЇНАХ ЦЕНТРАЛЬНОЇ ТА СХІДНОЇ ЄВРОПИ

Анотація. Ця стаття містить аналіз складних взаємозв'язків між людським капіталом, освітою та сталим економічним зростанням з критичним акцентом на контекст країн Центральної та Східної Європи (ЦСЄ). Основний аргумент полягає в тому, що такі стратегічні інвестиції, як людський капітал, особливо в рамках професійної освіти та навчання, а також дослідження і розробки (НДДКР), є невід'ємною передумовою для досягнення ендогенного економічного зростання та довгострокового процвітання. Дослідження виходить за рамки вимірювання простих показників зарахування до шкіл та спрямоване на оцінку якості результатів навчання, використовуючи такі показники, як Індекс людського капіталу (ІЛК) Світового банку, щоб виявити дійсні відмінності в країнах ЦСЄ. Значним структурним недоліком, спільним для більшості економік ЦСЄ, є постійний дефіцит кваліфікованих кадрів, який часто виникає через те, що системи професійної освіти та навчання не мають достатньої практичної значущості. Стаття завершується пропозицією цільових механізмів фіскальної та освітньої політики, включаючи податкові стимули для досліджень і розробок, зосереджені на витратах на робочу силу, які є необхідними для прискорення економічної конвергенції, підвищення загальної факторної продуктивності (СПП) та забезпечення довгострокової корпоративної та національної стійкості.

Ключові слова: людський капітал, професійна освіта, економічне зростання, інвестиції в дослідження та розробки, педагогічні науки, професійна підготовка, когнітивні навички.

Problem statement. Human capital, defined as the basic factor of production used in the production of outputs offered by individuals in the labor market, is at the heart of all processes in the economy. The historical experiences of many nations that successfully transitioned from economies focused on manual labor–often serving as «assembly workshops» for more advanced economies–to innovation- and service-based models confirm that this shift is predicated on increased educational attainment and investments in applied research and development.

Despite the broad theoretical consensus in macroeconomics that stresses the necessity of HC for generating unconstrained growth, many transforming CEE economies struggle with the effective implementation of this theory into functional policies. The key disconnect lies between the recognition of HC's importance and the strategic allocation of effective investments. High-quality HC in science, education, and management directly translates into increased innovation, productivity, and labor market participation, which are essential components of sustainable economic growth.

The global economy, accelerated by technological progress and digitalization, demands continuous adaptation and skill upgrading. CEE countries often lag in productivity convergence, primarily due to a structural mismatch between educational output and market demand. This is particularly pronounced in Vocational Education and Training (VET) systems.

Research analysis. Human capital can be broadly defined as the stock of knowledge, skills, and other personal characteristics inherent in people that help them to be productive [OECD, 2024]. This aligns with definitions from pioneers such as Gary S. Becker [1964], who defined HC as «investment in people in the form of knowledge, skills and abilities», and Theodore W. Schultz [1961], who viewed it as the sum of human capabilities acquired by investing in education and training.

Macroeconomic models incorporate human capital into growth specifications, moving beyond the limits of the neoclassical Solow model by ensuring that investments in knowledge and skills are not subject to diminishing returns [Wilson & Briscoe, 2004]. Paul M. Romer's work [1990], foundational to endogenous growth theory, established that HC accumulation is a key to generating positive externalities and sustaining growth. This framework emphasizes that the initial level (stock) of human capital, such as literacy, is crucial for predicting subsequent investment rates and overall growth [Romer, 1990]. Robert Lucas's model formalizes HC accumulation through education, demonstrating that a higher level of HC in one worker can raise the productivity of others [Wei-Bin Zhang, 2024]. The shift in focus from capital accumulation alone to knowledge and technology transfer is also underscored by research on ideas and technology transfer in economic growth [Chadwick, 1996].

Causality and Quality in Economic Growth: Empirically, the strong relationship between HC and economic growth means investment tends to increase productivity [Nickolas, 2023], which in turn can help to revive the economy [Kenton, 2023]. However, long-term GDP growth is overwhelmingly determined by the quality

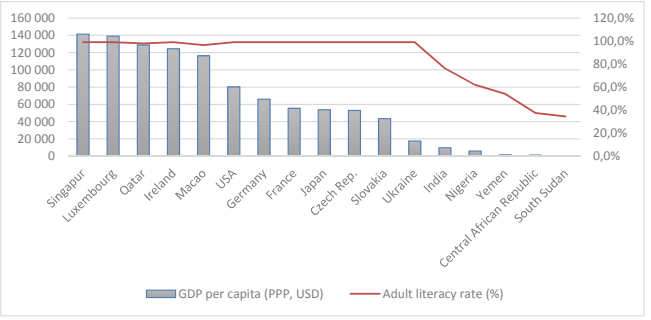
of cognitive skills–the knowledge capital of a nation–which explains approximately 75% of the cross-country variation in growth [Hanushek & Woessmann, 2021]. This finding necessitates a policy focus on measurable learning outcomes rather than simple enrolment rates.

Furthermore, HC also directly influences Total Factor Productivity (TFP). Higher education levels enhance employees› professional skills, increase their ability to learn and adapt to new technologies, and strengthen their awareness of innovation, thereby boosting firm TFP [Barro & Lee, 2010; Alvi & Ahmed, 2014]. The effective use of human resources is consequently the foundation for successful development of the economy, both on the enterprise and regional/national level [Fiľa & Juráňová, 2015]. This reinforces the idea that countries with higher literacy rates generally have significantly better education systems and higher levels of investment in human resource development and R&D, which ultimately impacts high GDP per capita [World Bank, 2019].

Purpose of the article is to synthesize the theoretical and empirical foundations linking human capital quality (knowledge capital) to economic growth and Total Factor Productivity, and subsequently to develop a comprehensive, evidence-based strategic policy framework for strengthening HC as a driver of endogenous growth within the specific economic and structural context of the selected Central and Eastern European countries, focusing particularly on investment in professional education and R&D.

Presentation of the main material. The first of the assessed factors is a comparison of GDP per capita in PPS and the literacy rate of the country's adult population. As can be seen in Figure 1, countries with virtually full literacy rates have significantly higher GDP per capita values compared to countries with lower literacy rates. While it cannot be argued that literacy alone influences a country's GDP per capita, it is worth pointing out that countries with high literacy rates generally have better education systems and higher levels of investment in education, human resource development, research, development, and innovation, which ultimately have an impact on high levels of GDP per capita and hence better macroeconomic development of the country. OECD countries, in particular, for example, the Scandinavian countries, are a case in point.

Figure 1 Literacy levels and GDP per capita of selected countries



Source: World Bank, UNESCO, own processing

The next monitored indicator is the Human Capital Index (HCI). The analysis of Czechia, the Slovak Republic, and Ukraine uses the World Bank's Human Capital Index (HCI) to measure the amount of human capital a child born today can expect to attain by age 18, given the risks of poor health and poor education. The HCI is grounded on three pillars: survival, quantity and quality of education (LAYS), and health (Adult survival rates) [World Bank, 2023].

The HCI [World Bank, 2023] values demonstrate that a child born in Czechia can expect to be 75% as productive as they could be with complete education and full health, which is higher than the average for High-Income countries (71%). In contrast, the potential productivity for a child born in Ukraine is only 63%.

Table 1

Comparative Human Capital Index (HCI) and Educational Quality in CEE (2020 Data)

Country	Human Capital Index (HCI)	Expected Adult Productivity (% of potential)	Learning-Adjusted Years of School (LAYS)	Adult Survival Rate (to age 60)
Czechia	0.75	75%	11.1 years	92%
Slovakia	0.665	66.5%	N/A	N/A
Ukraine	0.63	63%	9.9 years	81%

Source: World Bank, 2023, 2024

Czechia: While Czechia exhibits strong human capital and R&D investment, it shares a common CEE weakness: a notorious skills shortage and a vocational training system that often lacks practical relevance [KfW, 2021].

Table 2

Comparative Investment in Education and R&D (% of GDP)

Country	Gross Domestic Expenditure on R&D (% of GDP)	Total Public Expenditure on Education (% of GDP)	Key Investment Challenge
Czechia	2.00%	4.2%	Maintaining R&D intensity and improving VET practical relevance.
Slovak Republic	< 1.0% (Regional disparity)	4.2%	Education spending below OECD average; extreme concentration of R&D investment.
Ukraine	0.37% (2023)	Significant budget cuts (2022)	Critically low R&D; risk to HC stock due to conflict and health crisis.

Source: OECD 2024, World Bank, 2025, KfW, 2021

Slovak Republic: Slovakia lags with an HCI of 0.665, and its public expenditure on education (4.2% of GDP) is below the OECD average of 4.7%. The most significant barrier to endogenous growth is the extreme regional inequality in R&D investment. This is related to the fact that Bratislava spends 1.6% of GDP on R&D, while other regions spend below 0.7%. As [Fiľa & Juráňová, 2015] states, such concentration limits broader innovation potential and the effective use of human resources.

Ukraine: Ukraine faces the most severe challenges, with the lowest HCI (0.63) 10 and critically low R&D spending (0.37% of GDP).14 The government budget share allocated to education dropped significantly from 14.25% to 8.49% in 2022 due to the military conflict (Shevchenko University data). Research by Kurbet, O., Nebrat, V., Gorin, N., & Bodnarchuk, T. [2025] highlights the critical need for an accelerated international educational and R&D integration strategy as vital for structural survival and future economic revival. Institutional support for academic mobility and R&D cooperation are central mechanisms for labour market recovery, often supported by international partners.

Investment in Human Capital: Mechanisms and Fiscal Efficiency. Investing in human capital requires a synchronized approach involving public and private funding. Effective public and private investments should stimulate each other, forming a positive feedback loop through economic growth [Alvi & Ahmed, 2014].

Fiscal Stimuli and Knowledge Capital Accumulation. Fiscal policy is the most potent lever a state possesses to influence corporate investment behavior. Tax incentives are widely used to stimulate R&D spending.

A crucial design element for effective R&D fiscal incentives is prioritizing the eligibility of wage costs for research personnel and training expenses, as this directly encourages investment in domestic human capital and generates positive spillovers [Appelt et al., 2016]. For example, some jurisdictions grant tax credits based on a 3% increase in annual R&D expenses compared to the previous two years.

However, the use of tax incentives is controversial due to concerns about:

1. Interfering with market-based decisions, leading to inefficient resource allocation.

2. Failing the «but for» test, meaning businesses would have made the investment decisions without the incentive.

3. Crowding out more effective uses of resources.

Furthermore, the fiscal effectiveness of R&D tax incentives is compromised if they lead merely to the shifting of intellectual property or taxable income offshore without a substantive change in domestic human capital accumulation [OECD, 2013].

The Notorious Skills Shortage in CEE. CEE countries consistently face a notorious skills shortage, which is a direct consequence of VET systems that often lack practical relevance, standardization, and a demand-driven approach [KfW, 2021]. This structural flaw directly limits the TFP growth of firms. If the workforce is inadequately prepared, it cannot efficiently adopt cutting-edge technologies, which constrains the economy's ability to transition to high-quality specialization [Radcliffe, 2023]. Rectifying this skill deficit through effective professional education is mandatory for faster convergence to the average EU productivity level [KfW, 2021].

Corporate Investment and Lifelong Learning. Amidst accelerating technological change (Industry 4.0 and 5.0), the importance of lifelong learning has intensified [OECD, 2024]. Companies are increasingly investing in proprietary models, such as corporate universities, to rapidly align employee skills with new technological demands. Kenton [2023] states, that investment in human capital development

is underscored as an essential element for successful corporate performance, productivity, and efficiency.

Strategic Policy Recommendations for human capital and R&D Investment. Based on the analysis, the following strategic policy interventions are necessary for CEE economies to capitalize on their HC potential:

VET Reform Focused on Quality and Outcomes.

Decentralization of Knowledge Capital.

Targeted Fiscal Incentives for Labor-Linked R&D.

Prioritization of Recovery and Integration (Focus on Ukraine).

Conclusions and prospects for further investigations. The high-quality human capital, underpinned by strategic investment in pedagogical sciences and professional education, represents the single most crucial factor for achieving long-term economic growth and corporate prosperity. When HC improves its quality in areas such as science, education, and management, it leads to increased innovation, social well-being, equality, increased productivity, and higher participation rates.

The fundamental conclusion of this analysis is that HC development must be viewed as a strategic fiscal imperative. Countries that significantly invest in comprehensive human resource development, including R&D activities, achieve a more significant innovation potential, reflected in better GDP per capita, higher employee wages, and improved quality of life. To maximize the return on these investments, policymakers must:

1. Prioritize Cognitive Quality: Reform education systems to focus relentlessly on improving standardized cognitive skills, leveraging modern pedagogical concepts to cultivate critical thinking and adaptability.

2. Synchronize Investment and Institution: Recognize that investments in education and professional training are only robustly effective when accompanied by strong legal and economic institutions and stable organizational practices.

3. Bridge the R&D Investment Gap: Increase public and private R&D spending, particularly in the CEE region, and specifically in the university sector, to ensure a sustained flow of high-skilled graduates and radical innovation.

Ultimately, an economy's success lies in its workforce's ability to operate industries where it holds a competitive advantage. Only through consistent, strategic investment in the quality of human capital can nations CEE like Slovakia, Czechia, and Ukraine ensure long-term economic resilience and replace traditional jobs with new, high-value opportunities driven by innovation.

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