Science & Technology Development Journal – Economics - Law and Management 2025, ():1-14

Open Access Full Text Article

Global evidence on human capital and economic growth: The role of investment and demographics

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ABSTRACT

This study investigates the interplay between human capital, investment, and demographic factors in shaping economic growth across 167 countries from 2010 to 2022. Using data sourced from the World Bank's Global Financial Development dataset and employing robust regression models, the research highlights the significant contribution of human capital to enhancing productivity and growth. The analysis identifies investment and urbanization as key moderating factors that amplify the positive effects of human capital on economic growth. Specifically, the interaction between human capital and investment in physical assets, as well as human capital and urbanization, yields greater economic benefits than these elements independently. These findings underscore the synergy between skilled labor and infrastructure development in fostering sustainable growth. The results further reveal the nuanced role of health and education expenditures, which, despite their essentiality for long-term development, demonstrate short-term cost implications. The study also emphasizes the importance of trade openness, foreign direct investment, and institutional quality in supporting economic performance, while acknowledging the variability of these effects across different economic contexts. Urbanization emerges as a critical factor, enhancing access to services and optimizing the use of human capital. This research contributes to the existing literature by integrating investment and demographic dimensions into the analysis of human capital's impact on growth. It offers actionable insights for policymakers, investors, and managers, advocating for integrated strategies that prioritize education, healthcare, infrastructure, and urban development. The findings suggest that balanced and synergistic investments in human and physical capital are crucial for maximizing growth potential. This work advances the understanding of the dynamic relationships between economic growth determinants and provides a framework for more effective policy interventions aimed at sustainable development.

Key words: Human Capital, Economic Growth, Investment, Urbanization

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History

- Received: 01/11/2024
- Revised: 11/12/2024
- Accepted: 28/12/2024
- Published Online:

DOI :

INTRODUCTION

The relationship between human capital and economic growth has long been a central theme in economic research, given its critical implications for policymaking and development strategies. Despite numerous studies, uncertainty remains regarding how various factors moderate this relationship, particularly in the context of varying investment levels and demographic dynamics. The complex interactions between human capital, investment, and demographic factors have not been thoroughly explored, leaving a significant gap in the literature. For example, while Barro and Han and Lee have extensively documented the positive impact of education and skills on economic productivity, the detailed ways in which investment in physical capital and demographic shifts influence these effects require further investigation [1,2]. Additionally, the role of health, as highlighted by He and Li, emphasizes the need to consider multiple aspects of human capital in growth models [3]. This research aims to address these gaps by examining the influence of human capital on economic growth, with a particular focus on the moderating effects of investment and demographic factors.

The positive impact of human capital on economic growth is well-established in the literature. Studies by Anyanwu, Adam et al. and Ogundari and Awokuse underscore the importance of education and skills in enhancing productivity and fostering long-term economic growth [4,5]. Similarly, Echevarria and Iza demonstrated that health, as a component of human capital, significantly contributes to economic performance [6]. More recent studies, such as those by Ogundari and Awokuse and Purnomo [7,8], Istiqomah, and Suharno, utilizing the System Generalized Method of Moments (SGMM), have further reinforced the importance of education and health in driving economic growth [5,9]. These studies often incorporate lagged GDP to address potential endogeneity issues, leading to more robust and accurate results [10,11].

Cite this article : Huy T P. **Global evidence on human capital and economic growth: The role of investment and demographics**. *Sci. Tech. Dev. J. - Eco. Law Manag.* 2025; ():1-14.

However, the literature also indicates that the relationship between human capital and economic growth is complex and may be influenced by additional factors. For instance, Echevarria and Iza and Ahmed, Asghar et al. stressed the importance of considering investment and demographic factors, which can either enhance or limit the effectiveness of human capital in promoting economic growth. These studies highlight the need for a more nuanced analysis that considers these moderating variables [6,12].

This research is particularly significant as it aims to deepen the understanding of the multifaceted relationship between human capital and economic growth. By integrating investment and demographic factors into the analysis, the study seeks to provide insights into how these variables interact with human capital to shape economic outcomes. The importance of this research lies in its potential to inform more effective development strategies and policymaking. Understanding the moderating effects of investment and demographic factors can help policymakers design targeted interventions that maximize the benefits of human capital investments. For example, identifying how demographic changes, such as aging populations or youth bulges, interact with human capital can guide resource allocation in education and healthcare to optimize economic growth. Additionally, recognizing the role of investment in amplifying the effects of human capital can lead to more integrated policies that promote both physical and human capital development simultaneously. Therefore, this research holds considerable promise for advancing the theoretical understanding of economic growth and providing practical solutions for sustainable development.

The primary goal of this research is to explore the direct impact of human capital on economic growth while examining how this relationship is moderated by investment and demographic factors. By using both GDP and GNI growth rates as indicators of economic growth, the study aims to offer a comprehensive analysis of these dynamics. The research will investigate the effects of human capital, specifically focusing on education and health, on economic growth, and evaluate how investment in physical capital and demographic shifts enhance or limit these effects. The structure of this research includes five parts: (i) introduction, (ii) literature review, (iii) methodology, (iv) results and discussion, and (v) conclusion and recommendations.

LITERATURE REVIEW

Background theories

The connection between human capital and economic growth is rooted in several prominent economic and sociological theories. Among the most relevant are human capital theory, endogenous growth theory, and the knowledge-based economy theory. Together, these theories form a comprehensive framework for understanding the influence of human capital on economic growth.

Human capital theory posits that investments in education, training, and health boost individual productivity, which in turn contributes to economic growth. According to Becker, human capital, much like physical capital, enhances a country's productive capacity and economic output [13]. This theory suggests that accumulating human capital creates a more skilled workforce, which drives innovation and efficiency. Besides, endogenous growth theory, developed by Romer and Lucas Jr., further elaborates on the role of human capital in economic growth [14,15]. This theory argues that economic growth is driven primarily by internal factors rather than external ones. It emphasizes the importance of knowledge, skills, and technological advancements, all of which are enhanced by human capital. Romer specifically identifies human capital as a crucial input in the production of new technologies, which stimulates economic growth [15]. This theory is particularly relevant in dynamic economies where rapid technological advancements and innovation are key drivers of growth.

The knowledge-based economy theory also highlights the crucial role of human capital. According to Powell and Snellman, a knowledge-based economy heavily relies on the production, distribution, and use of knowledge and information. In such economies, human capital becomes the foundation of economic growth, driving innovation, technological progress, and competitiveness [9]. This theory is especially pertinent to economies transitioning from manufacturing-based to knowledge-based models.

These theories complement each other by showcasing different aspects of how human capital contributes to economic growth. Human capital theory provides the foundational argument that education and skills development enhance productivity. Endogenous growth theory builds on this by explaining how these enhancements lead to technological innovation and sustained economic growth. The knowledge-based economy theory ties these elements together by emphasizing the increasing importance of knowledge and information in driving modern economies.

Several empirical studies have applied these theories to explore the relationship between human capital and economic growth in various contexts. For example, Barro found a positive relationship between human capital (measured by schooling and life expectancy) and economic growth across a panel of countries. This supports human capital theory by showing that investments in human capital led to higher economic growth [1]. Benhabib and Spiegel applied endogenous growth theory to demonstrate that human capital significantly affects the rate of technological diffusion and economic growth [16]. Their findings suggest that countries with higher levels of human capital are better positioned to adopt and implement new technologies, leading to faster economic growth. Hanushek and Kimko corroborated these findings by showing that the quality of education, rather than just the quantity, is crucial for economic growth. This supports both human capital theory and endogenous growth theory by emphasizing the role of cognitive skills in driving economic performance [17].

Additional studies further substantiate these theories. For instance, Chen and Feng examined the role of human capital in China's economic growth and found that human capital accumulation significantly contributed to the country's rapid economic development [18]. Similarly, Park and Lee analyzed the impact of human capital on economic growth in South Korea and found strong evidence supporting the positive effects of human capital investment [19]. A more recent study by Klenow and Rodriguez-Clare investigated the role of human capital in explaining differences in economic growth rates across countries and concluded that variations in human capital investment are a major determinant of economic growth disparities [20]. Other studies, such as those by Lau, Jamison et al. and Krueger and Lindahl, also support these theories by demonstrating the significant impact of human capital on economic growth through improved productivity and innovation [21,22].

In summary, the integration of human capital theory, endogenous growth theory, and knowledge-based economy theory offers a robust theoretical framework for understanding the relationship between human capital and economic growth. The empirical evidence from previous studies strongly supports the fundamental arguments of these theories, underscoring the critical role of human capital in driving economic growth.

Empirical studies

The relationship between human capital and economic growth has been extensively studied, with numerous studies highlighting its importance across various regions and methodologies. For example, Keji explored the effect of human capital on economic growth in Nigeria, finding significant long-term impacts and emphasizing the need for greater investment in education and health [23]. Similarly, Ogundari and Awokuse showed that both health and education positively impact economic growth in Sub-Saharan Africa, with health having a relatively larger effect [5]. Health and education are complementary components of human capital that drive economic growth [4,24].

On a broader scale, Sultana, Dey et al. investigated the impact of human capital on economic growth in both developing and developed countries, finding that human capital has a positive influence on growth in developing nations, particularly through improvements in life expectancy [10]. However, in developed countries, increased life expectancy may hinder growth due to aging populations [6,25]. This highlights the varying effects of human capital at different stages of development and underscores the need for policies that are tailored to specific country contexts. Matousek and Tzeremes further support the positive role of human capital in economic growth through their nonparametric and semiparametric analyses, revealing nonlinear effects that depend on the level of development and other contextual factors [26]. This complexity is echoed in the findings of Goenka and Liu, who incorporated epidemiological dynamics to study the impact of infectious diseases on human capital and economic growth [27]. Their research found that health shocks significantly affect growth trajectories, emphasizing the importance of strong public health policies.

Additionally, the interaction between human capital and environmental factors has been a key area of research. Rahman, Nepal et al. analyzed the effects of economic growth, energy consumption, exports, and human capital on environmental quality in newly industrialized countries. Their findings showed that while economic growth and human capital improve environmental quality, energy consumption and exports have detrimental effects. This demonstrates the dual role of human capital in promoting economic growth and mitigating environmental degradation Shahbaz, Song et al. [28,29]. Similarly, Ahmed, Asghar et al. explored the dynamic relationship between natural resources, human capital, urbanization, economic growth, and ecological footprint in China, finding that human capital helps reduce environmental degradation [12].

Matousek and Tzeremes also demonstrated that human capital reduces CO2 emissions, supporting the

Environmental Kuznets Curve hypothesis, which suggests that economic growth initially leads to environmental degradation but eventually improves as income and human capital increase[26]. Uberti and Knutsen highlighted the role of institutions in enhancing the benefits of human capital, finding that both property rights institutions and human capital positively influence economic growth[30]. This suggests that strong institutional frameworks are essential for maximizing the returns on human capital investments.

In addition, Sulaiman, Saputra et al. examined the relationship between human capital, innovation capacity, and economic growth in ASEAN countries[31]. They found that while human capital had a significant positive effect on growth, innovation capacity did not, highlighting the need for policies that simultaneously enhance human capital and foster innovation to drive sustainable growth[2,32]. The impact of migration and workforce composition on economic growth was investigated by Purnomo, Istiqomah et al., who found that factors such as average years of schooling, life expectancy, and workforce size positively influenced economic growth in Indonesia[9]. This emphasizes the importance of improving human resource quality and managing migration effectively[33].

Moreover, Zhang and Wang highlighted the conditional role of human capital in economic convergence, showing that regions with lower initial income levels benefit significantly from human capital investments[11]. This finding is crucial for policymakers aiming to reduce regional disparities and promote inclusive growth. Ali, Egbetokun et al. noted that previous studies often overlook variables related to social capabilities, leading to inconclusive results and emphasizing the need for comprehensive models that include social capabilities[34].

The empirical evidence consistently demonstrates the critical role of human capital in driving economic growth across different regions and stages of development. Education and health emerge as complementary components that significantly enhance productivity and economic performance. However, the effectiveness of human capital investments can be influenced by factors such as institutional quality, innovation capacity, and environmental conditions. Studies like those by Uberti and Knutsen and Rahman, Nepal et al. underscore the importance of strong institutions and environmental policies in maximizing the benefits of human capital[30,35].

Despite these robust findings, several limitations and research gaps remain. Omitted variable bias, as noted by Ali, Egbetokun et al., can lead to inconclusive results, highlighting the need for comprehensive models that include social capabilities[34]. Additionally, the dynamic nature of the relationship between human capital and economic growth is often not fully captured, as emphasized by Goenka and Liu[27]. Future research should incorporate health shocks and other dynamic factors to provide a more nuanced understanding of this relationship.

Furthermore, the varying effects of human capital across different development stages and contexts, as identified by Sultana, Dey et al., suggest that tailored policies are essential for maximizing growth. The role of migration and workforce composition, highlighted by Purnomo, Istiqomah et al., further emphasizes the need for targeted interventions to improve human resource quality and manage demographic changes effectively[9,10]. In conclusion, while human capital is undoubtedly a key driver of economic growth, its impact is shaped by a complex interplay of institutional, environmental, and contextual factors.

In summary, while examining the direct impact of human capital on economic growth, we propose that this relationship may be moderated by investment and demographic factors. Specifically, the interaction between human capital and economic growth may vary depending on the levels of investment and demographic conditions within a country. This leads to the following testable hypotheses:

- Hypothesis 1: Human capital is positively associated with economic growth.
- Hypothesis 2: Investment sharing strengthens the positive influence of human capital on economic growth.
- Hypothesis 3: Urban population strengthens the positive influence of human capital on economic growth.

METHODOLOGY

Data

This study employs data sourced from the Global Financial Development dataset, which is available through the World Bank DataBank. This extensive dataset covers a broad array of financial development indicators and provides detailed information across 167 countries. The dataset spans a substantial timeframe from 2010 to 2022, allowing for a robust longitudinal analysis of financial development and its associated impacts. By leveraging this comprehensive dataset, the research can capture trends and variations over time, offering valuable insights into the evolving

dynamics of financial development on a global scale. The inclusion of data from a diverse range of countries also ensures that the findings are both globally relevant and applicable to different economic contexts, making the study's conclusions more generalizable.

Models

This study aims to empirically analyze the determinants of economic growth using the regression model as below:

$$EG_{i,t} = \beta_1 EG_{i,t-1} + \beta_2 HC_{i,t} + \beta_3 EDU_{i,t} + \beta_4 HEA_{i,t} + \beta_5 INV_{i,t} + \beta_6 TRADE_{i,t} + \beta_7 IQ_{i,t} + \beta_8 DE_{i,t} + \beta_9 ICT_{i,t} + \beta_{10} FDI_{i,t} + \varepsilon \quad (1)$$

$$EG_{i,t} = \beta_1 EG_{i,t-1} + \beta_2 HC_{i,t} + \beta_3 HCxINV + \beta_4 EDU_{i,t} + \beta_5 HEA_{i,t} + \beta_6 INV_{i,t} + \beta_7 TRADE_{i,t} + \beta_8 IQ_{i,t} + \beta_9 DE_{i,t} + \beta_{10} ICT_{i,t} + \beta_{11} FDI_{i,t} + \varepsilon \quad (2)$$

$$EG_{i,t} = \beta_1 EG_{i,t-1} + \beta_2 HC_{i,t} + \beta_3 HCxDE + \beta_4 EDU_{i,t} + \beta_5 HEA_{i,t} + \beta_6 INV_{i,t} + \beta_7 TRADE_{i,t} + \beta_8 IQ_{i,t} + \beta_9 DE_{i,t} + \beta_{10} ICT_{i,t} + \beta_{11} FDI_{i,t} + \varepsilon \quad (3)$$

where: $EG_{i,t}$ and $\beta_1 EG_{i,t-1}$ represent the economic growth of country i in year t and t-1 coressponding. In line with previous studies, such as Ogundari and Awokuse and Zhang and Wang, the GDP growth rate and GNI growth rate are used to measure the economic growth[5,11]. Model 1 is used to examine hypothesis 1, the interaction terms HCxINV and HCxDE are introduced in model 2 and 3 to examine hypothesis 2 and 3. Also, to tackle the engogeneity problem, this reseach employ the system GMM regression with control for robust standard error, this is inline with (2022)[2,10,31].

The details of variables measurement are present in Table 1 as followed:

In this research, economic growth is assessed using both the growth rate of Gross Domestic Product (GDP) and Gross National Income (GNI). According to Ali, Egbetokun et al., GDP serves as a fundamental metric for evaluating economic performance and development, as it reflects the total output produced by all economic agents within a country[34]. In contrast, the GNI growth rate incorporates GDP along with net income from abroad, such as dividends, interest, and profits from international investments. Human capital, which encompasses the skills, knowledge, and experience of individuals or populations, is viewed in terms of its value or cost to an organization or nation. The Human Capital Index integrates indicators such as years of schooling and the quality of education. Research has demonstrated that human capital is a key driver of economic growth by enhancing labor productivity and fostering innovation[9,23].

The education rate, often represented by enrollment rates in primary, secondary, and tertiary education, is a direct measure of a country's investment in education. Education boosts human capital by enhancing individuals' skills and productivity, which subsequently drives economic growth[23]. Health expenditure serves as a proxy for a population's health status. Improved health contributes to higher labor productivity by reducing absenteeism and extending the working lifespan[12]. Numerous studies have underscored the role of health in economic growth, showing that increased health expenditure is linked to better health outcomes and higher economic growth[4,24].

Investment is measured through gross capital formation, which refers to net investment in physical assets such as infrastructure, machinery, and buildings. These variable captures investment in physical capital, which is vital for economic growth as it enhances productive capacity and efficiency[16,24]. Trade openness, quantified as the sum of exports and imports as a percentage of GDP, reflects a country's integration into the global economy. Openness to trade can stimulate economic growth by providing access to larger markets, fostering competition, and facilitating the diffusion of technology[32].

Additionally, other macroeconomic factors, such as institutional quality, are critical for economic growth, as they influence resource allocation efficiency, investment decisions, and overall economic stability. Institutional quality can be measured through indicators like the rule of law and the effectiveness of institutions in supporting economic activities[2,30]. Population growth also impacts the labor supply and can either positively or negatively influence economic growth, depending on how well the growing population is integrated into productive activities. While rapid population growth can strain resources, moderate growth can support economic expansion[6].

Demographic factors are associated with higher productivity and economic growth due to agglomeration effects, improved access to services, and better infrastructure. In this study, demographic factors are measured by the percentage of the population residing in urban areas. Urban areas typically offer better access to education, healthcare, and employment opportunities, which drive economic growth. Furthermore, Information and Communication Technology (ICT) penetration enhances economic growth by improving access to information, promoting innovation, and increasing efficiency in various economic activities. Research has shown that higher ICT penetration correlates with improved economic performance[29,31].

Table 1: Variables mesaurement

Variables	Symbol	Proxies	References
Economic Growth	EG	GDP growth (annual %)	9,23,30
		GNI growth (annual %)	
Human Capital	HC	Human capital index (HCI) (scale 0-1)	9,26
Investment	INV	Gross capital formation (% of GDP)	10,31
Demographic	DE	Urban population (% of total population)	2,25,33
Education	EDU	Current education expenditure, total (% of total expenditure in public institutions)	5,21
Health	HEA	Current health expenditure (% of GDP)	3,25
Trade openess	TRADE	Trade (% of GDP)	22,32
Institutional Quality	IQ	Rule of Law: Estimate	30,35
ICT Penetration	ICT	Individuals using the Internet (% of population)	31
Foreign Direct Investment	FDI	Foreign direct investment, net inflows (% of GDP)	10,29

Source: by authors

RESULTS & DISCUSSION

Descriptive analysis

Table 2 provides a detailed descriptive analysis of the key variables utilized in the study, including GDP growth (gdp), GNI growth (gni), the Human Capital Index (hc), Gross Capital Formation (inv), Urban Population (de), Education Expenditure (edu), Health Expenditure (hea), Trade (trade), Rule of Law (iq), Internet Usage (ict), and Foreign Direct Investment (fdi). Both GDP growth (gdp) and GNI growth (gni) exhibit substantial standard deviations (6.35 and 6.18, respectively), indicating considerable variability in economic growth rates among the countries analyzed. The average growth rates for gdp and gni are 3.69% and 3.65%, respectively, reflecting moderate economic growth overall. However, the wide range of values (from -64.05% to 153.49% for gdp and -58.46% to 187.39% for gni) points to the presence of both extreme economic contractions and expansions within the dataset. The Human Capital Index (hc) shows a mean of 0.57 and a relatively low standard deviation of 0.15, indicating less variability compared to other variables. The range of values, with a minimum of 0.29 and a maximum of 0.89, highlights the diversity in human capital levels across different countries.

Gross Capital Formation (inv) has an average of 23.59% of GDP, with a standard deviation of 8.18%. The minimum value of -15.92% and the maximum value of 76.78% indicate significant variation in investment levels, possibly reflecting different stages of economic development and varying investment climates across countries. The Urban Population (de) variable shows an average of 50.37%, indicating that, on average, half of the population resides in urban areas. The standard deviation of 24.77% and the range from 2.08% to 100% highlight the diversity in urbanization levels among the countries analyzed.

Education Expenditure (edu) has a notably high mean of 90.78% of total expenditure in public institutions, with a relatively narrow range from 32.81% to 100%. This suggests a strong focus on education spending, though the data may be skewed by the high minimum value. Health Expenditure (hea) as a percentage of GDP shows an average of 6.2%, with a standard deviation of 2.79%, reflecting moderate variability. The range from 1.11% to 24.28% indicates differences in health spending priorities among the countries studied.

Trade (trade) as a percentage of GDP has a mean of 73.1% and a high standard deviation of 50.98%, indicating significant variability in trade openness. The broad range from 0.02% to 863.2% underscores the diverse trade dynamics within the sample. The Rule of Law (iq) variable, with an average value of -0.03 and a standard deviation of 1, reflects varying degrees of legal and institutional quality, ranging from -2.59 to 2.12, indicating a wide spectrum of governance quality across countries.

Internet Usage (ict) has a mean of 24.51% and a standard deviation of 29.81%, showing substantial variation in digital connectivity. The range from 0% to

Table 2: Descriptive Analysis

	gdp	gni	hc	inv	de	edu	hea	trade	iq	ict	fdi
count	13,851	6,614	601	10,443	16,832	1,967	5,167	10,978	4,873	8,045	11,179
mean	3.69	3.65	0.57	23.59	50.37	90.78	6.2	73.1	-0.03	24.51	4.68
std	6.35	6.18	0.15	8.18	24.77	7.34	2.79	50.98	1	29.81	39.34
min	-64.05	-58.46	0.29	-15.92	2.08	32.81	1.11	0.02	-2.59	0	-1303.11
25%	1.41	1.36	0.44	18.86	30.1	88.86	4.24	41.78	-0.8	0.23	0.44
50%	3.81	3.73	0.57	23.16	48.93	92.19	5.44	61.07	-0.17	8.41	1.52
75%	6.11	6.06	0.69	27.54	69.72	95.05	7.79	92.09	0.79	44.92	3.59
max	153.49	187.39	0.89	76.78	100	100	24.28	863.2	2.12	100	1709.83

Source: by authors

100% emphasizes the digital divide among countries. Lastly, Foreign Direct Investment (fdi) has an average of 4.68% of GDP and an extremely high standard deviation of 39.34%, indicating significant variability. The range from -1303.11% to 1709.83% suggests that some countries experience dramatic fluctuations in FDI inflows, which may be due to volatile economic or political conditions.

Figure 1 illustrates a correlation heatmap that shows the relationships between various economic and social indicators used in this study. The color intensity and annotations in each cell represent the correlation coefficient between variable pairs, with positive correlations shown in shades of red and negative correlations in shades of blue. The heatmap reveals several notable relationships. For instance, GDP growth (gdp) and GNI growth (gni) display a very high positive correlation (0.81), which is expected since both are proxies for overall economic performance and typically exhibit similar trends. This high correlation is understandable and does not significantly affect the model results since they are used alternately in the analysis.

Another notable correlation exists between the Human Capital Index (hc) and Urban Population (de), with a coefficient of 0.66. This suggests that countries with higher levels of human capital tend to have larger urban populations. The correlation indicates that urbanization may play a role in enhancing human capital through improved access to education, healthcare, and other social services. Additionally, Health Expenditure (hea) and Rule of Law (iq) exhibit a moderate positive correlation (0.49), indicating that countries with stronger governance and legal frameworks are more likely to invest in health. This relationship highlights the importance of institutional quality in promoting better public health outcomes.

Trade (trade) and Internet Usage (ict) also display a positive correlation (0.41), underscoring the connection between a country's openness to trade and its level of digital connectivity. This relationship suggests that increased trade activities may contribute to higher internet penetration, thereby facilitating more robust economic interactions and access to global markets. Foreign Direct Investment (fdi) shows significant variability in its correlations with other variables, reflecting the complex interplay of economic, social, and institutional factors that influence investment flows. Of particular interest is the negative correlation between FDI and Rule of Law (iq) (-0.59), which suggests that higher levels of perceived corruption may deter foreign investment.

Regression results

The normality tests, including Shapiro-Wilk, D'Agostino's K^2, and Anderson-Darling, reveal that all variables significantly deviate from a normal distribution, as evidenced by the extremely low p-values. Despite this, the Variance Inflation Factor (VIF) values for all variables are below 10, indicating that multicollinearity is within acceptable limits. However, the data exhibits heteroskedasticity, as confirmed by the Breusch-Pagan test. Given the presence of both heteroskedasticity and non-normality, using robust standard errors is an appropriate method to ensure reliable and valid inference in the regression models.

Table 3 displays the results of the robust regression analysis across three models, each of which assesses the impact of various economic indicators on GDP and GNI. The inclusion of lagged dependent variables (gdp_lag1 and gni_lag1) in all models highlights the persistence of economic growth, as reflected by the significant positive coefficients observed in most instances.

Table 3 presents the results from the robust regression analysis across three models, each evaluating the impact of various economic indicators on GDP and GNI, with a particular emphasis on human capital (hc), investment (inv), and their interaction term (hc*inv). The inclusion of lagged dependent variables (gdp_lag1 and gni_lag1) across all models confirms the persistence of economic growth, as shown by the consistently significant positive coefficients.

In Model 1, inv has a positive and significant effect on both GDP and GNI, highlighting the critical role of investment in promoting economic growth. The inv variable reflects that greater investment in physical assets such as infrastructure, machinery, and technology enhance economic performance. Meanwhile, the hc variable, representing human capital, shows a positive and significant effect on GDP but a negative and significant effect on GNI. This result suggests that while human capital contributes positively to economic productivity as measured by GDP, its impact on GNI may vary due to differences in income distribution or other factors. These findings partially align with classical economic theories that emphasize the importance of both human and physical capital in driving growth but also highlight potential complexities in the relationship between human capital and broader economic metrics.

Model 2 introduces the interaction term hc*inv, revealing a more complex relationship between human capital and investment. In this model, both the direct effect of inv and the interaction term hc*inv are

Table 3: Robust regression results

	Model 1		Model 2		Model 3	
dependent variables	gdp	gni	gdp	gni	gdp	gni
const	8.568***	6.506***	3.001***	6.249***	10.13***	9.42***
lag1	0.146***	0.148***	0.124***	0.137***	0.146***	0.148***
hc	0.317*	-0.65*	4.237*	3.183*	2.115*	5.19*
inv	0.021*	0.023*	0.23*	0.001*		
hc*inv			0.196*	0.096***		
de	0.001*	0.003*			0.045*	0.083*
hc*de					0.014*	0.028*
edu	-0.04**	-0.01*	-0.038**	-0.007*	-0.04**	-0.009*
hea	-0.267**	-0.264***	-0.214***	-0.231***	-0.268***	-0.266***
trade	0.006**	0.003**	0.005***	0.003**	0.006***	0.003**
iq	-0.142*	0.08	-0.207**	0.046*	-0.148**	0.068*
ict	-0.025***	-0.022***	-0.027***	-0.023***	-0.025***	-0.022***
fdi	0.005***	0.003**	0.005***	0.003***	0.005***	0.003***
*, **, *** indicate the significant level at 10%, 5% and 1% corresponding						

Source: by authors

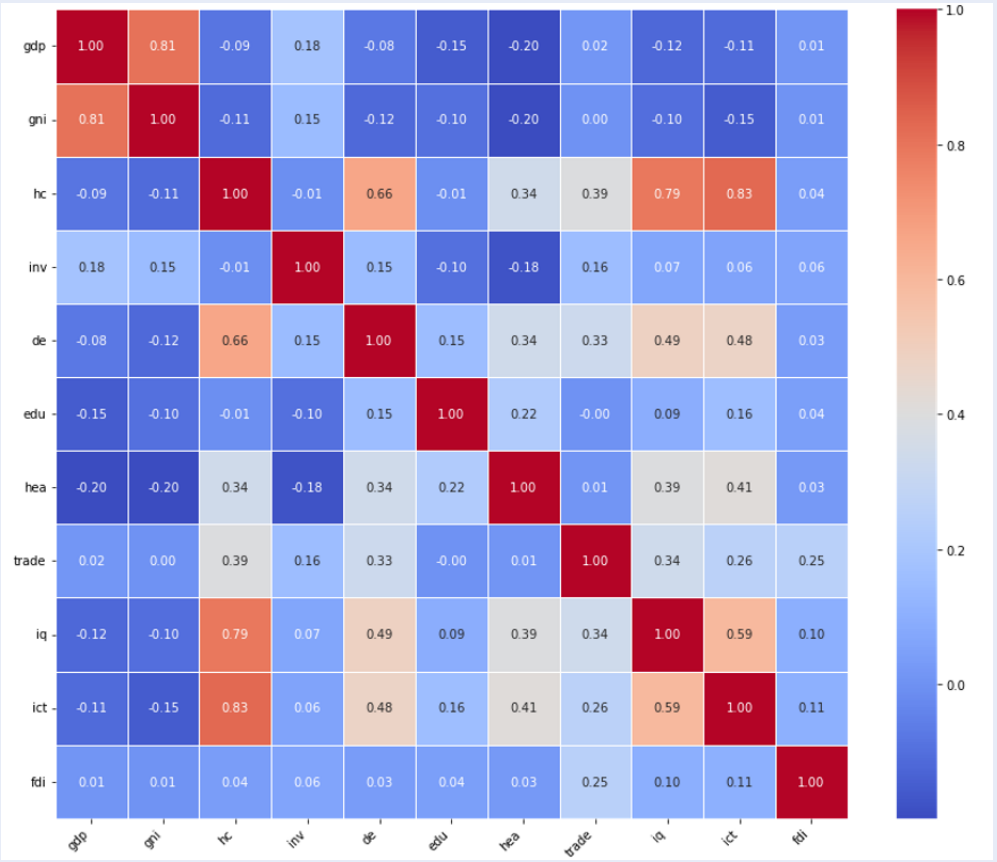

Figure 1: Correlation heatmap between variables[a]

[a]Source: by authors

positive and significant for both GDP and GNI, at significant levels of 10% and 1%, respectively. These results indicate that while investment in physical capital directly contributes to economic growth, its effectiveness is further amplified when combined with a skilled and educated workforce. This finding highlights the synergistic effect between human capital and investment, suggesting that countries with higher levels of human capital can leverage investments in physical capital more effectively to stimulate growth. The results emphasize the importance of balanced and coordinated investments in both human and physical capital to foster sustainable economic development.

Model 3 further explores the interaction between human capital and urbanization ('hc*de'). The significant positive coefficients for this interaction term in both GDP and GNI models indicate that the benefits of human capital are amplified in more urbanized environments. Urban areas typically provide better access to education, healthcare, and infrastructure, which enhances the productivity of human capital. This finding suggests that urbanization not only concentrates economic activities but also optimizes the use of human capital, thereby boosting economic growth. Policies aimed at improving urban infrastructure and services could therefore have a multiplier effect on human capital productivity.

Other variables, such as education expenditure ('edu'), health expenditure ('hea'), trade openness ('trade'), institutional quality ('iq'), internet usage ('ict'), and foreign direct investment ('fdi'), also show significant relationships with economic growth. Notably, education and health expenditures have negative coefficients, suggesting that while these are essential for long-term development, their short-term effects may be associated with higher costs. Trade openness and foreign direct investment positively influence economic growth, emphasizing the importance of globalization and external investments. The negative coefficients for institutional quality ('iq') in some

models may reflect the complexities of governance, where improvements in quality could lead to short-term disruptions or costs.

Regression results highlight varying impacts of key variables on economic growth. Education expenditure (EDU) and health expenditure (HEALTH) both exhibit negative and statistically significant effects on GDP and GNI across all models. These results suggest that while investments in education and health are crucial for long-term human capital development, they may impose short-term fiscal burdens or reflect inefficiencies in resource allocation. Policymakers need to address structural issues in these sectors, focusing on improving quality and ensuring efficient use of resources to realize their potential benefits for economic growth in the long run. Meanwhile, trade openness (TRADE) has a positive and significant effect, underscoring its role in providing access to larger markets, fostering competition, and enabling technology transfer. To maximize these benefits, policymakers should enhance trade infrastructure and liberalize trade policies, particularly in developing economies.

Institutional quality (IQ) also demonstrates significant, albeit mixed, effects on economic growth, suggesting that stronger governance and legal frameworks can create a stable environment for investment and resource allocation. However, the complexity of institutional reforms may lead to short-term disruptions. ICT penetration (ICT), contrary to expectations, shows a negative impact on growth, potentially due to the costs of digital adoption without adequate infrastructure or equitable access. Addressing digital literacy and infrastructure gaps could unlock its potential benefits. Finally, foreign direct investment (FDI) has a robust positive effect, highlighting its role in enhancing technological capabilities, creating jobs, and stimulating domestic investment. Governments should continue to attract FDI by ensuring macroeconomic stability, reducing bureaucratic hurdles, and providing incentives for foreign investors.

Overall, the robust regression results emphasize the critical role of human capital and investment in driving economic growth, particularly when these factors interact. The synergistic effects of human capital with both investment and urbanization highlight the need for integrated policies that enhance education, infrastructure, and urban development to maximize economic growth.

CONCLUSION & RECOMMENDATIONS

Conclusion

The primary goal of this research was to explore the direct impact of human capital on economic growth while examining how this relationship is influenced by investment and demographic factors. The findings offer valuable insights into the role of these variables in promoting economic development. The robust regression results highlight the critical importance of human capital, investment, and their interactions in driving economic growth. The positive and significant effects of human capital (hc) across all models demonstrate that higher levels of education and skills within the workforce are essential for boosting economic productivity and growth. This finding supports Hypothesis 1, which proposed a positive relationship between human capital and economic growth. Investment (inv) also showed positive effects, although its significance was more pronounced when analyzed in conjunction with human capital.

The results indicate that the combined effect of human capital and investment is greater than their individual contributions. This interaction suggests that investments in physical capital are more effective when paired with a skilled and educated workforce, underscoring the importance of balanced investments in both areas. This finding supports Hypothesis 2, which posited that investment enhances the positive impact of human capital on economic growth.

Furthermore, the results revealed that the benefits of human capital are amplified in more urbanized environments. This suggests that urban areas, with their better access to education, healthcare, and infrastructure, enhance the productivity of human capital, thereby promoting economic growth. This finding supports Hypothesis 3, which proposed that urban population strengthens the positive influence of human capital on economic growth. Other variables, such as education expenditure (edu), health expenditure (hea), trade openness (trade), institutional quality (iq), internet usage (ict), and foreign direct investment (fdi), also demonstrated significant relationships with economic growth. Notably, education and health expenditures had negative effects, indicating that while these are crucial for long-term development, their short-term effects might be associated with higher costs.

The results of this study are consistent with and extend the findings of previous research. For instance, Barro and Sulaiman, Saputra et al. emphasized the positive effects of education and skills on economic productivity, which is confirmed by the significant role of human capital identified in this study [1,31]. Similarly,

Goenka and Liu highlighted the importance of health as a component of human capital, a finding supported by the significant impact of health expenditure observed in this study[27]. The interaction between human capital and investment aligns with the findings of Shahbaz, Song et al., who showed that human capital significantly influences the rate of technological diffusion and economic growth [31]. Additionally, this study's results resonate with Ogundari and Awokuse, who found that both education and health positively impact economic growth in Sub-Saharan Africa [25]. Moreover, the findings of this study are consistent with the conclusions of Sulaiman, Saputra et al. on the impact of human capital on economic growth in both developing and developed countries, providing a broader context for understanding the varying effects of human capital across different stages of development[31]. The significant interaction terms in this study underscore the importance of tailored policies that take these interactions into account. Finally, the results regarding the roles of institutional quality and trade openness align with the research of Uberti and Knutsen[30].

In summary, this research provides strong evidence of the significant impact of human capital on economic growth, particularly when moderated by investment and urbanization. The findings emphasize the need for integrated policies that enhance education, infrastructure, and urban development to maximize economic growth. The interactions between these factors suggest that balanced and synergistic investments are essential for promoting sustainable economic development.

Recommendations

Investors should prioritize funding educational programs and training initiatives that bolster human capital. The strong positive relationship between human capital and economic growth highlights the critical importance of a skilled workforce. Investing in education, particularly in STEM fields, vocational training, and ongoing professional development, can lead to significant returns by enhancing workforce productivity and fostering innovation. Additionally, the interaction between human capital and urbanization indicates that investments in urban infrastructure can further amplify the benefits of human capital. Investors should consider supporting projects that improve urban amenities, transportation, and housing, as these can attract a skilled workforce and provide better access to education and healthcare, thereby promoting economic growth.

Managers should prioritize enhancing the skills and capabilities of their employees through targeted training programs and professional development opportunities. Given the positive influence of human capital on economic growth, organizations should invest in continuous learning that keeps the workforce abreast of the latest industry trends and technological advancements. Additionally, managers should create a supportive work environment that fosters innovation and productivity. This includes implementing policies that promote work-life balance, health, and well-being. While health expenditure shows a negative impact on economic growth in the short term, as evidenced by this study, it remains an essential investment for long-term human capital development and workforce productivity. Managers should consider balancing immediate cost constraints with strategies that prioritize sustainable health initiatives, which can contribute to overall economic and organizational resilience in the long run. Managers should also focus on strategic planning that takes into account the broader economic context, including investments in technology and infrastructure that can improve operational efficiency and competitiveness.

Government agencies play a vital role in fostering an environment conducive to human capital development and economic growth. Policymakers should prioritize education and healthcare in national budgets, ensuring sufficient funding for schools, universities, and healthcare facilities. The research underscores the significant impact of education and health expenditure on economic growth, making it essential for governments to invest in these areas. Furthermore, the positive interaction between human capital and urbanization suggests that urban planning and development policies should aim to create cities that are conducive to learning and innovation. Governments should invest in infrastructure projects that enhance access to education and healthcare in urban areas, thereby maximizing the productivity of human capital. Additionally, policymakers should implement regulatory frameworks that support investment in technology and innovation, which are crucial drivers of economic growth. By creating a stable and predictable regulatory environment, governments can attract both domestic and foreign investments, fostering a more dynamic and competitive economy.

Limitations & Further research

While this study presents robust findings, several limitations need to be acknowledged. Firstly, the study

relies on secondary data from the World Bank, which may introduce biases due to varying data collection and reporting standards across different countries. Inconsistencies in data quality and potential measurement errors could affect the precision of the estimates. Moreover, although the study includes a wide range of economic indicators, it does not account for all possible factors that might influence economic growth, such as political stability, cultural dynamics, and technological advancements. The exclusion of these variables may result in omitted variable bias, potentially skewing the findings and limiting the overall comprehensiveness of the analysis.

To address these limitations, future research should consider incorporating primary data collection methods to improve data reliability and validity. Expanding the model to include a broader set of variables, such as political stability indices, cultural factors, and specific technological advancements, could provide a more comprehensive understanding of the determinants of economic growth. Additionally, longitudinal studies that observe changes over extended periods could offer more in-depth insights into the dynamic relationships between human capital, investment, and economic growth. Comparative studies across different regions or income levels could further clarify how contextual factors influence these relationships, leading to more tailored policy recommendations. By addressing these aspects, future research can build upon the findings of this study and contribute to a deeper and more nuanced understanding of the drivers of economic growth.

ACKNOWLEDGEMENT

This research was conducted as part of the doctoral dissertation project under Decision No. 2108/QĐ-ĐHKTL dated September 05, 2024, issued by University of Economics and Law.

FUNDING

The research is funded by the University of Economics and Law, Vietnam National University, Ho Chi Minh City, Vietnam.

ABBREVIATIONS

GDP - Gross Domestic Product
GNI - Gross National Income
HCI - Human Capital Index
HC - Human Capital
INV - Investment
DE - Demographics (Urban Population)
EDU - Education Expenditure
HEA - Health Expenditure
TRADE - Trade Openness
IQ - Institutional Quality
ICT - Information and Communication Technology
FDI - Foreign Direct Investment
VIF - Variance Inflation Factor
GMM - Generalized Method of Moments
NICs - Newly Industrialized Countries
SGMM - System Generalized Method of Moments

CONFLICT OF INTEREST STATEMENT

The authors declare that they have no conflicts of interest.

AUTHOR CONTRIBUTIONS

Phan Huy Tam: research idea formation, background theories, data processing, results, discussion, conclusion, recommendations, writing.

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Tạp chí Phát triển Khoa học và Công nghệ – Economics-Law and Management 2025, ():1-1

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Vốn nhân lực và phát triển kinh tế, vai trò của đầu tư và nhân khẩu học với bằng chứng thực nghiệm toàn cầu

Phan Huy Tâm*

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TÓM TẮT

Nghiên cứu này phân tích mối quan hệ giữa vốn nhân lực, đầu tư và các yếu tố nhân khẩu học trong việc định hình tăng trưởng kinh tế ở 167 quốc gia giai đoạn 2010-2022. Sử dụng dữ liệu từ bộ dữ liệu Phát triển Tài chính Toàn cầu của Ngân hàng Thế giới, nghiên cứu nhấn mạnh đóng góp quan trọng của vốn nhân lực trong việc nâng cao năng suất và tăng trưởng kinh tế. Phân tích xác định đầu tư và đô thị hóa là những yếu tố điều tiết chính làm gia tăng tác động tích cực của vốn nhân lực đối với tăng trưởng kinh tế. Cụ thể, sự tương tác giữa vốn nhân lực và đầu tư vào tài sản vật chất, cũng như vốn nhân lực và đô thị hóa, mang lại lợi ích kinh tế lớn hơn so với từng yếu tố độc lập. Những phát hiện này nhấn mạnh sự kết hợp giữa lao động có kỹ năng và phát triển cơ sở hạ tầng trong việc thúc đẩy tăng trưởng bền vững. Kết quả nghiên cứu cũng chỉ ra vai trò phức tạp của chi tiêu cho giáo dục và y tế, dù rất cần thiết cho phát triển dài hạn, nhưng cho thấy tác động chi phí trong ngắn hạn. Nghiên cứu cũng nhấn mạnh tầm quan trọng của mức độ mở cửa thương mại, đầu tư trực tiếp nước ngoài, và chất lượng thể chế trong việc hỗ trợ hiệu quả kinh tế, đồng thời ghi nhận sự khác biệt về tác động của những yếu tố này trong các bối cảnh kinh tế khác nhau. Đô thị hóa nổi lên như một yếu tố quan trọng, giúp cải thiện khả năng tiếp cận dịch vụ và tối ưu hóa việc sử dụng vốn nhân lực. Nghiên cứu này đóng góp vào tài liệu hiện có bằng cách tích hợp các yếu tố đầu tư và nhân khẩu học vào phân tích tác động của vốn nhân lực đối với tăng trưởng. Nghiên cứu cung cấp những hiểu biết thực tiễn cho các nhà hoạch định chính sách, nhà đầu tư, và nhà quản lý, khuyến nghị các chiến lược tích hợp ưu tiên giáo dục, chăm sóc sức khỏe, cơ sở hạ tầng, và phát triển đô thị. Những phát hiện cho thấy rằng các khoản đầu tư cân bằng và kết hợp vào vốn nhân lực và vật chất là rất quan trọng để tối đa hóa tiềm năng tăng trưởng. Công trình này góp phần nâng cao hiểu biết về mối quan hệ động giữa các yếu tố quyết định tăng trưởng kinh tế và cung cấp một khuôn khổ cho các can thiệp chính sách hiệu quả hơn nhằm phát triển bền vững.

Từ khoá: Vốn nhân lực, Tăng trưởng kinh tế, Đầu tư, Đô thị hóa

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Lịch sử

- Ngày nhận: 01/11/2024
- Ngày sửa đổi: 11/12/2024
- Ngày chấp nhận: 28/12/2024
- Ngày đăng:

DOI :

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Trích dẫn bài báo này: Tâm P H. **Vốn nhân lực và phát triển kinh tế, vai trò của đầu tư và nhân khẩu học với bằng chứng thực nghiệm toàn cầu** . *Sci. Tech. Dev. J. - Eco. Law Manag.* 2025; ():1-1.