Scientific Annals of Economics and Business
73 (SI), 2026, 17-58
DOI: 10.47743/saeb-2026-0024

Determinants of Human Capital: An Empirical Analysis Using System GMM

Anca Maria Ungureanu*, Monica Ioana Pop-Silaghi**

Abstract: This paper examines the key factors shaping human capital in OECD countries, highlighting its multidimensional nature and the interplay between economic, educational, health, and social influences. Covering the period 2000–2024, the study applies the System GMM approach to account for persistence, endogeneity, and country-specific characteristics. Human capital is measured using two indicators – the Human Capital Index and life expectancy – while determinants are grouped into four categories: economic, educational, health-related, and social factors. The results show that economic, educational, and social conditions jointly shape human capital and life expectancy. Economic growth is positively associated with health outcomes, while fiscal variables display limited immediate effects. Education is a key driver, as increases in upper-secondary attainment and a more advanced-educated labor force significantly strengthens human capital. Health expenditure shows mixed results, pointing to possible efficiency issues. Among social factors, female labor force participation consistently improves both human capital and life expectancy, whereas remittances, corruption, and R&D expenditure have weak or context-dependent effects, suggesting that institutional quality and household structure condition their impact. By adopting a multidimensional and dynamic framework, this paper demonstrates that sustainable human capital formation requires integrated policies that simultaneously promote education, health, gender inclusion, and innovation.

Keywords: Human Capital; Life Expectancy; System GMM.

JEL classification: O15; I25; J24; O40; C33.

* Faculty of Economics and Business Administration, Babeș-Bolyai University, Romania; e-mail: *anca.ungureanu@econ.ubbcluj.ro* (corresponding author).
** Faculty of Economics and Business Administration, Babeș-Bolyai University, Romania; e-mail: *monica.silaghi@econ.ubbcluj.ro*.

Article history: Received 17 November 2025 | Accepted 6 April 2026 | Published online 24 July 2026

To cite this article: Ungureanu, A. M., Pop-Silaghi, M. I. (2026). Determinants of Human Capital: An Empirical Analysis Using System GMM. *Scientific Annals of Economics and Business*, 73(SI), 17-58. https://doi.org/10.47743/saeb-2026-0024.

1. INTRODUCTION

Human capital is usually defined as the stock of knowledge, skills, health, and productive capacities embodied in individuals and a central factor of modern growth theory as defined by Lucas (1988) or Becker (1966).

This paper aims to examine the determinants of human capital measured through two complementary proxies: the human capital index (The World Bank, 2018) and life expectancy. The analysis is conducted from economic, educational, health, and social perspectives, with the aim of filling a gap in literature by offering a multidimensional and dynamic assessment that accounts for complementarities and persistence. Specifically, our objectives are to analyze how these four categories of determinants shape human capital and life expectancy and to evaluate which dimensions exert the strongest influence.

This paper contributes to the literature by proving a broader viewpoint of what was researched until now. Even though the connection between growth and human capital has been extensively researched by Becker (1966) or Lucas(1988), most of the studies adopt a more limited approach by focusing on specific healthcare inputs, years of education like Affandi *et al.* (2019) or Teixeira and Fortuna (2004), or on education spending like Raheem *et al.* (2018). We consider that these approaches may overlook the multidimensional nature of human capital, which in our view is shaped by various factors. However, recent studies highlight that human capital also interacts with innovation, labor markets, and institutional quality, suggesting a wider set of channels through which productivity improvements occur (Rahim *et al.*, 2021). In this context, conceptualizing human capital as a multidimensional construction allows a broader understanding of how economic, social and fiscal environments shape skills, health, and long-term growth potential. For example, a growing strand of research emphasizes that skills, innovation, and knowledge accumulation also depend on technological capabilities and research activity. For instance, Pop-Silaghi *et al.* (2014) show that both public and private Research & Development (R&D) expenditures significantly contribute to economic growth in Central and Eastern European countries, over the period 1998–2008, suggesting that human capital formation interacts closely with innovation capacity. The authors employ panel cointegration techniques and error correction models for a panel of 10 Central and Eastern European economies. Since private R&D is found to have a positive and statistically significant impact on economic growth in the analyzed countries, one essential conclusion of this paper is that if public R&D – currently insignificant in isolation – would be paired with private R&D investment alongside skilled human capital, one could expect positive spillovers, stronger knowledge diffusion, and higher innovation-driven growth.

Building on this evidence, our study conceptualizes human capital as a multidimensional construct shaped not only by education and health, but also by economic, social, and institutional factors. Therefore, we take into consideration different elements that shape human capital and we use a dynamic panel technique (System GMM) that takes persistence, reverse causality, and cross-country heterogeneity into account, producing a more thorough and reliable evaluation.

The structure of the paper reflects these objectives. Section 2 comprises the literature review where we synthesize existing research and classify determinants into the four perspectives. The methodology section (Section 3) presents the variables, their sources and how we used the System GMM estimator to address persistence and endogeneity. In the empirical analysis we present the models for human capital and life expectancy within each

perspective (Section 4). Additionally, we also construct a mixed specification that incorporates the most pertinent determinants from each of the four distinct perspectives with the aim of determining if the impacts found in individual viewpoints are still significant when considered together, serving as a robustness check (Section 5). Finally, the paper concludes with policy implications, limits and further research (Section 6).

2. LITERATURE REVIEW

Human capital refers to the skills, knowledge, health, and productive capacities embodied in individuals, which contribute to economic growth and social development. It also represents a central dimension of intellectual capital, encompassing the knowledge, skills, and competencies that contribute to productivity and innovation. Recent research emphasizes that the development of intellectual capital significantly enhances organizational and economic performance, highlighting the strategic importance of human capital accumulation (Mubarik *et al.*, 2022).

Despite its recognized importance since Adam Smith (1776), national accounts still treat education and health spending largely as consumption rather than investment. This has motivated the development of different approaches to measure human capital. For example, Abraham and Mallatt (2022) define three approaches for measuring human capital: indicator approach, cost approach and income approach. The first one is the simplest to use and offers cross-country comparability but on the other side ignores differences in quality. In this approach we find proxies such as school enrollment rates, literacy, or average years of schooling like the Barro and Lee dataset (1996), composite indices like the World Economic Forum's Global Human Capital Index (2017) which integrates enrollment, attainment, labor participation, and skills deployment. In our study we also use this approach as it is the most suitable for cross-country growth studies. We include Human Capital Index (HCI) (2018), which uses health and education national indicators to annually measure, on a scale from 0 to 1 the amount of productivity that a child born today can expect by their 18th birthday. For example, 0.7 means that in 18 years the productivity of the country will reach only 70% of the total potential. The composite index combines data regarding child survival, school enrollment, quality of enrolment, healthy growth and adult survival. This index is included by Rahim *et al.* (2021) to examine how the Next Eleven nation's economies have grown between 1990 and 2019 in relation to their access to natural resources, financial development, human capital, industrialization, international trade and technological progress (Bangladesh, Egypt, Indonesia, Iran, Mexico, Nigeria, Pakistan, the Philippines, South Korea, Turkey, and Vietnam). Using the Dumitrescu and Hurlin (2012) method to test causality, the authors demonstrate that higher levels of natural resources hinder economic growth in the countries studied. The other variables included in the model are found to positively impact economic progress. The study also reveals that human capital could mitigate the resources course initially assumed and confirmed. Therefore, human capital positively affects the growth of the N-11 nations and lessens the inhibiting effects associated with high levels of natural resources. The cost approach measures human capital by summing education and training expenditures, including both direct spending and the value of students' and parents' time. Originally introduced by Kendrick (1976) and further developed by Eisner (1978, 1985) this method has been applied in more recent studies such as Gu and Wong (2015) for Canada, as discussed in Abraham and Mallatt (2022).

Its main advantage is compatibility with national accounts, since it treats education as an investment and provides a monetary valuation of human capital. However, the approach requires extensive data, it is highly sensitive to assumptions about depreciation and reflects resources regarding education input rather than actual productive outcomes. The last approach, meaning the income or lifetime earnings approach, first introduced by Jorgenson and Fraumeni (1989, 1992), values human capital as the present value of expected future earnings, differentiated by age, sex, and education. Later refinements by (2010, 2014) expand the method to include both market and non-market returns. The advantage of this approach lies in its focus on productive outcomes. However, it is very sensitive to assumptions regarding discount rates, economic growth, and educational completion probabilities, which can significantly affect results.

In our study, besides the Human Capital Index (HCI), we also employ life expectancy (LE) as an additional proxy for human capital. The use of this indicator is well grounded in the literature, which shows that longevity increases the incentives to invest in education and skills, thereby expanding the stock of human capital.

Life expectancy is frequently used as a proxy for the health dimension of human capital. By including both HCI and LE in separate empirical specifications, the analysis captures complementary dimensions of human capital formation. While HCI reflects a broader composite measure that integrates education and health outcomes affecting future productivity, life expectancy provides a more direct measure of the health component of human capital. This dual approach allows the study to examine whether the determinants under investigation influence different representations of human capital in a similar or different way, thereby offering a more nuanced perspective on human capital development.

For instance, Bloom *et al.* (2004), in their cross-country growth regressions, also estimate that a 10% increase in life expectancy raises economic growth rates by about 0.3–0.4% per year, reflecting the indirect contribution of longevity to human capital and productivity. Jayachandran and Lleras-Muney (2009) show the interdependence between health improvements and human capital formation. They use variation in maternal mortality as an exogenous shock to life expectancy on a panel of 97 countries over 1960–1990 to show that declines in maternal mortality significantly increase girls' years of schooling. Similarly, Cervellati and Sunde (2011) developed a growth model on cross-country data for more than 100 countries, for the period 1940-1980 and show that improvements in life expectancy lower the effective cost of education and foster human capital accumulation. Herzer (2017) also analyze a panel of 14 countries over the period 1870–2010 with panel cointegration techniques and found that life expectancy exerts a positive long-term effect on educational attainment and human capital investment. Higher life expectancy encourages individuals to invest more in education and skill acquisition because the expected returns to education increase over a longer working life. Empirical studies show that improvements in life expectancy contribute significantly to human capital accumulation and economic development (2022) .

Therefore, by combining HCI and LE, this study provides a richer a more comprehensive analysis, capturing both composite and health-based aspects of human capital.

When it comes to human capital accumulation, recent research has increasingly focused on the macroeconomic and institutional determinants. For example, Le Clech (2025) investigates the factors shaping human capital wealth using cross-country data and applies an econometric approach based on instrumental variables in order to address potential

endogeneity issues. The analysis identifies three key pillars influencing human capital accumulation: physical capital deepening, economic modernization driven by digitalization and technological development and the quality of economic institutions and policies. The results suggest that economies characterized by stronger investment dynamics, greater integration into modern economic structures, and higher institutional quality tend to exhibit higher levels of human capital wealth.

For example, Cuevas Ahumada and Calderón (2020) highlight the joint contribution of physical and human capital to growth but note that the strength of human capital depends on the level of development. Using a balanced panel of 52 countries observed over 2002–2014, the authors group economies by their Inequality-adjusted Human Development Index (IHDI) into six categories (very high, high, medium, low, very-high+high, and medium+low) to ensure greater homogeneity within samples. They also estimate 12 dynamic panel models (with and without period fixed effects) using the Arellano-Bond Generalized Method of Moments (GMM) technique (Arellano and Bover, 1995), which accounts for endogeneity and unobserved heterogeneity. Their results indicate that, while physical capital, human capital, and total factor productivity are the main drivers of growth across all groups, the responsiveness differs by development stage. Human capital formation and Total Factor Productivity (TFP) have the strongest positive effects in low-IHDI economies, suggesting these countries gain the most from investing in education, training, and technology absorption, whereas very high-IHDI countries display the largest elasticity of growth with respect to physical capital accumulation. The study further finds that institutional development supports growth mainly in medium-to-high IHDI countries, but its effect is negligible in the poorest group, where reforms must reach a threshold to become effective.

These findings suggest that the mechanisms underlying human capital formation and its contribution to growth are heterogeneous across countries and depend on broader economic, technological, and institutional conditions. Therefore, our study also examines the determinants of human capital from a multidimensional perspective by considering economic, educational, health, and social factors within a dynamic panel framework.

The economic perspective emphasizes the role of growth, productivity, and fiscal capacity in shaping investments in people. The educational dimension underscores the importance of schooling and skills for long-term development. The health perspective highlights the direct impact of population health on labor market participation and individual potential, while the social dimension captures factors such as female labor force participation and institutional or cultural contexts. Together, these categories provide a comprehensive framework for understanding the multifaceted nature of human capital and life expectancy.

2.1. Economic determinants

Human capital is most often analyzed in relation to economic growth, with the bulk of the literature emphasizing a causal link from human capital to productivity and income.

Education and skills accumulation are considered engines of growth in the endogenous growth theory described by Lucas (1988), and cross-country studies such as the ones of Barro (1991); Hanushek and Woessmann (2008); Pelinescu (2015) confirm that higher educational attainment and healthier populations accelerate long-run economic performance. Recent studies such as the one of Sultana *et al.* (2022) reinforce this view, namely that human capital positively drives growth in developing economies. At the same time, the literature also

acknowledges reverse causality: higher levels of income can foster the accumulation of human capital. Wealthier economies have greater fiscal capacity to finance education and healthcare, and households are better able to invest in their children's schooling and health. Khan *et al.* (2022) analyze the relationship between human capital and economic performance in the region of Jammu and Kashmir from South Asia using time-series data covering the period 2000–2019. The authors estimate regression models and complement them with Granger causality tests to explore the direction of the relationship between the variables. Their results suggest that improvements in human capital are associated with stronger economic performance, while the causality analysis indicates dynamic interactions between the two processes. The study also emphasizes the role of policy interventions, particularly public investment aimed at developing human capital, as an important driver of regional economic development. These findings highlight that economic conditions and policy choices may influence both the accumulation and the effectiveness of human capital.

Taxation represents a crucial macroeconomic instrument with direct implications for human capital accumulation. As Tanzi and Zee (1997) argue, fiscal policy influences long-run growth not only through physical capital formation, but also via incentives that shape educational attainment and skill acquisition. Based on a theoretical synthesis of endogenous growth models and cross-country evidence from previous empirical studies, they show that taxes on income and capital can reduce incentives to invest in both physical and human capital. According to them, tax revenues provide governments with stable resources that can be redirected toward productive public spending such as education, vocational training, and health care. When such expenditures reduce the private cost of schooling, improve educational infrastructure, enhance teacher quality, and strengthen health outcomes, they increase the stock of human capital and the productivity of the labor force. From an endogenous growth perspective, higher human capital stimulates innovation, accelerates the diffusion and absorption of new technologies, and improves the economy's capacity to generate sustained growth. In addition, public investment in human capital generates positive externalities that the private sector alone cannot fully internalize. A more educated and healthier workforce attracts domestic and foreign investment, raises total factor productivity, and enhances institutional capacity. Therefore, although distortionary taxation can potentially discourage private investment in physical capital, a well-designed tax structure paired with efficient expenditure allocation yields net long-term gains.

Consistent with this argument, Baldacci *et al.* (2008) demonstrate, based on panel data for 118 developing and transition economies, that tax-financed public spending on education and health significantly improves both human capital and economic growth, particularly under conditions of strong governance. Good institutional quality ensures that tax revenues are not diverted towards unproductive uses, and that fiscal resources are allocated to programs generating high social returns rather than to consumption-oriented or military spending. Nevertheless, the impact of taxation is not universally positive. Excessive tax burdens, poorly designed tax systems, or low transparency in public administration may discourage investment, stimulate informality, or result in misallocation of resources. In such contexts, higher revenues do not automatically translate into improved human capital if they are absorbed by corruption, inefficiency, or politically motivated expenditures. Thus, the literature emphasizes that the composition and quality of public spending matter more than the tax level itself, reinforcing the idea that fiscal policy can enhance human capital only when supported by sound institutions and governance.

When it comes to the structure of taxation, Arnold (2008) investigates the impact of tax systems on growth using annual panel data for 21 OECD countries over 1971–2004. Applying an error-correction model with pooled mean group estimators, the study finds that income taxes, especially corporate income taxes, are the most harmful to long-run GDP per capita, while consumption taxes are less distortionary and recurrent property taxes are the most growth-friendly. In their study, human capital is measured as average years of schooling, and the results show that one additional year of education increases economic output per capita by 5–7%. These findings can be explained through efficiency arguments rooted in the public finance literature. Income and corporate taxes are considered distortionary taxes, as described by Harberger (1964) because they change the relative returns to work and investment, discouraging firms from expanding productive capacity and individuals from increasing their labor supply or investing in education and skills. In contrast, taxes such as consumption or recurrent property taxes tend to be less distortionary, as they have a smaller impact on decisions related to labor, savings, and investment. Therefore, when the tax burden shifts away from highly distortionary income and corporate taxes toward less distortionary bases, households and firms face fewer disincentives to invest, which facilitates the accumulation of both physical and human capital.

Gupta (2018) further analyzes how fiscal policy shapes income inequality and human capital outcomes in developing countries, providing empirical evidence for the period 1985–2015. The study finds that, unlike advanced economies where taxes and transfers substantially reduce inequality, the redistributive impact in developing countries remains limited due to narrow tax bases, high informality, and weaker administrative capacity. Education and health spending are identified as key drivers of human capital and social mobility, yet their effectiveness is often weakened by inefficiencies and governance problems. Gupta argues that expanding progressive taxation – particularly recurrent property taxes, which are harder to evade – and improving the targeting and efficiency of social spending are essential for strengthening human capital formation and achieving inclusive growth. In this sense, it is not only the level of taxation that matters, but also the structure of the tax system and the quality of public expenditure.

The research of Heckman *et al.* (1998) is also crucial in showing how taxes can generate economic growth. He analyzes micro econometric data from the United States and demonstrates that tax-funded early childhood interventions and job training programs generate the highest social returns. Their analysis also includes longitudinal surveys that track individuals' schooling, skills acquisition, and labor market outcomes. Using program evaluation techniques and structural micro econometric models, they estimate the causal impact of public investments in education and training on individual productivity and earnings. These findings highlight that publicly financed human capital policies, particularly in early childhood and targeted training, yield substantial long-term gains in productivity and social welfare, emphasizing their role as growth-enhancing fiscal policy. Also, Alataş and Çakir (2016) enhance the importance of economic factors so that human capital can positively impact growth. They showed that, while education and health enhance growth in developing countries, limited fiscal capacity in less-developed economies may constrain the impact of health investments. Their analysis is based on a balanced panel of 65 countries over the period 1967–2011, using Gross Domestic Product (GDP) per capita as a proxy for economic growth and employing education and infant mortality as indicators of human capital. By applying panel data regression techniques and grouping countries, in developed and developing

economies, they find that education and health significantly enhance growth in developing countries, but the effectiveness of health-related investments is limited in less-developed economies due to limited fiscal capacity. This evidence highlights the importance of economic conditions in strengthening the impact of human capital on growth and provides justification for including taxation indicators in the empirical analysis. Building on this theoretical and empirical foundation, the present study incorporates taxation as an explanatory determinant of human capital, testing whether economies with higher and more efficiently allocated tax revenues exhibit superior educational and health outcomes. By estimating a panel model for OECD countries, 2000-2024, the analysis evaluates whether the positive mechanism suggested by Tanzi and Zee (1997) and confirmed by Baldacci *et al.* (2008) holds across European economies and whether governance quality conditions the effectiveness of taxation in fostering human capital development.

Inflation is another economic indicator analyzed in relation with human capital and therefore included in our empirical model. For example, Heylen *et al.* (2004) examine the relationship between increasing rates of inflation and human capital formation. Building on an overlapping generations (OLG) model for a small open economy, they argue that episodes of high inflation reduce total factor productivity, thereby lowering the returns to work and physical capital accumulation. When these shocks are expected to be temporary, young individuals may respond through a phenomenon called intertemporal substitution between labor and education. This means that instead of working in a period where real wages and productivity are reduced, they allocate more time to schooling. This temporarily reduces output but leads to stronger growth once economic conditions normalize. Using GMM estimators for a panel of 86 countries over 1975–2000, the authors find that moderate-to-high inflation episodes (above 25–40%) significantly increase schooling by about 0.3 years on average over a five-year period, while extremely high inflation (above 100%) no longer has this beneficial effect. Their findings also show that the positive impact is stronger when public spending on education increases and in more open economies.

By contrast, He (2018) extends the literature by introducing a cash-in-advance (CIA) constraint on education spending within a Schumpeterian growth model. In his framework, human capital accumulation requires upfront monetary resources, so higher nominal interest rates (and therefore higher inflation) increase the opportunity cost of holding money for educational purposes relative to consumption. This mechanism reduces human capital investment, effective labor supply in both production and R&D sectors, and ultimately long-run growth and welfare. According to his simulations, reducing the nominal interest rate from 9.9% (the U.S. average during 1960–2014) to zero would increase annual per capita growth by 0.61%.

Taken together, these studies reveal contrasting mechanisms. In the model built by Heylen *et al.* (2004), temporary inflationary episodes encourage young individuals to stay in school longer because working during periods of low wages and productivity is less attractive. As a result, human capital rises, and growth strengthens once the economy recovers. By contrast, in He (2018), persistent inflation operates through a liquidity-constraint channel, where higher nominal interest rates make it more expensive to finance education and therefore discourage human capital investment. This reduces effective labor supply in production and innovation and slows long-run growth. Therefore, the effect of inflation on human capital depends on both its duration and the institutional and financial environment: short-lived inflation can push individuals to remain in education, whereas sustained inflation and high interest rates limit access to schooling and hinder long-term economic performance.

Turning to another indicator, namely government debt, Reinhart and Rogoff (2010) provide one of the most comprehensive analyses of the macroeconomic consequences of public debt, as their data covers 44 economies over a two-century period, meaning more than 3,700 annual observations. They showed that when public debt levels remain below 90 percent of GDP, the link with growth is weak, but once debt surpasses this threshold, median growth falls by about 1 percentage point and mean growth drops by several points. In emerging markets, external debt thresholds are even lower, with growth deteriorating once external debt exceeds 60 percent of GDP, and high debt is also associated with higher inflation and financial instability. These results imply that debt accumulation is not only a macroeconomic concern but also a human capital issue. According to them, slower growth reduces fiscal revenues, constraining governments' ability to finance education and health. Rising debt creates budgetary pressure that replaces social spending. Moreover, macroeconomic instability lowers household incomes, discouraging private investment in schooling and health. Therefore, high debt can indirectly hinder human capital accumulation by shrinking fiscal space and lowering the economic stability needed for long-term investments. However, this paper must be observed with caution, since there were found mistakes in data which were recognized and corrected later by the authors themselves. So even if the general concern about the macroeconomic risks of excessive debt remains relevant in the literature, the size of the "90 percent" threshold and the magnitude of the implied growth effects are debated. For this reason, debt should be considered an important determinant in empirical models, but its impact is likely to be context-dependent and sensitive to fiscal institutions, debt composition, and the efficiency of public spending.

Overall, the literature suggests that the relationship between human capital and economic growth is strongly mediated by macroeconomic and fiscal factors such as taxation, inflation, government debt, and the budget balance. Taxes influence incentives and the capacity of governments to finance education and health, inflation shapes the costs and returns to schooling depending on its persistence, debt accumulation constrains fiscal space for social investment, while budget balance signals fiscal discipline that can sustain long-term human capital formation. Building on these findings, our empirical analysis incorporates the following variables: GDP per capita, inflation, government debt, taxes, and budget balance to capture the broader economic environment that conditions the accumulation of human capital and improvements in life expectancy.

2.2. Education proxies for human capital

In the literature, education-related indicators referring to human capital are most frequently examined in connection with economic growth, reflecting the idea that schooling and skills accumulation serve as key engines of development. Proxies such as average years of schooling, literacy rates, and enrollment ratios at different levels of education have long been employed as tangible measures of human capital, as for example done by Maitra and Chakraborty (2021) or Mohamed Sghaier (2022)**.** Primary enrollment, while less commonly used due to its limited explanatory power, has nonetheless been tested in country-specific analyses, as for example by Dada *et al.* (2022), often with mixed results. By contrast, secondary enrollment emerges as a widely adopted proxy, with studies such as the ones of Garza-Rodriguez *et al.* (2020) and Nouira and Saafi (2022) showing a strong positive and sometimes bidirectional relationship with growth. Similarly, tertiary enrollment and education

spending are consistently linked to growth in both time-series and panel studies, particularly in the context of foreign capital inflows and innovation capacity, like done by Abdouli and Omri (2021) or Rahman *et al.* (2023).

Beyond enrollment, the average years of schooling has been a classic indicator of human capital, repeatedly found to exert positive effects on productivity and long-run economic performance by researchers as Teixeira and Fortuna (2004); Ljungberg (2024) and Affandi *et al.* (2019). Finally, some scholars extend the concept by incorporating cognitive skills and intelligence into human capital measurement, with Jones and Schneider (2006) demonstrating that national IQ levels predict GDP growth even more strongly than traditional education proxies. Hanushek and Woessmann (2008), also highlight the decisive role of education quality in driving growth and development. Their analysis of 51 countries during 1960-2000 showed that test-based measures of cognitive skills are much stronger predictors of economic performance than schooling duration alone. Using GDP per capita as the dependent variable, they demonstrate that educational attainment does not yield the same economic benefits as cognitive skills. This perspective shifts the literature toward prioritizing learning outcomes and skill acquisition, rather than enrollment or attainment alone, as the pivotal link between education, human capital, and long-run development. Reflecting this shift, recent indices such as the World Bank's Human Capital Index (2018) combine schooling years with harmonized test scores to better capture the full impact of education on human capital formation and long-term health outcomes and this is one of the reasons why we chose to use it as a proxy for human capital.

Public expenditure on education represents one of the key channels through which governments support human capital formation and long-term economic performance(Bal, 2024). Higher levels of educational investment improve access to schooling, increase the quality of educational infrastructure, and enhance learning outcomes. Empirical evidence suggests that countries allocating a larger share of public resources to education tend to achieve higher levels of human capital and productivity Rahman *et al.* (2023).

Building on this evidence, the present study focuses on a set of indicators capturing both educational investment and educational attainment. In particular, the empirical analysis includes public expenditure on education, upper-secondary attainment, and the share of the labor force with advanced education. These variables capture key dimensions of human capital accumulation by reflecting both the resources allocated to education systems and the stock of skills within the population.

2.3. Human capital and health

Health is also shown to impact economic growth through human capital. Health-related proxies have increasingly been incorporated into the measurement of human capital, often alongside educational indicators.

Health expenditure as a share of GDP is a common measure, reflecting the resources allocated to improving population health. Islam and Alam (2022) used an Autoregressive Distributed Lags Model (ARDL) model for Bangladesh and found that health spending has a consistent long-run effect on growth but not an immediate impact, underscoring the cumulative nature of health investments. Some comparative studies emphasize that education and health are not substitutes but they represent complementary dimensions of human capital. For example, Ogundari and Awokuse (2018), employed System Generalized Method of

Moments (SGMM) for 35 countries over 1980–2008, showing that both education and health positively affect growth, with health indicators contributing more strongly in their sample. Similarly, Sultana *et al.* (2022), in a panel of 141 countries, combined health (per capita health expenditure, life expectancy) and education (average years of schooling, pupil–teacher ratio) to demonstrate that human capital accumulation requires both dimensions, though in developed economies longer life expectancy may exert negative effects due to aging populations. The empirical evidence from Aka and Dumont (2008) for the U.S. (1929–1997) and Dhrifi *et al.* (2021) for 108 countries also highlights bidirectional causality between education, health, and economic growth, suggesting deep complementarities between these variables. At the micro level, Ross and Wu (1995) argue that education enhances health by equipping individuals with skills and behaviors that promote well-being, while good health, in turn, raises productivity and the ability to capitalize on acquired education. Also, Bloom and Canning (2003) emphasize the dual role of health as both a consumption good and a form of human capital that enhances productivity and economic performance. They show that public investments in clean water, sanitation, and vaccination are highly effective in improving health outcomes, particularly in developing countries. Improved longevity raises the return to education, as individuals are more willing to invest in schooling when they expect a longer productive life. Overall, their analysis highlights the two-way relationship between health and income, where economic prosperity fosters better health, and health improvements accelerate human capital accumulation and growth. Analyzed together, these findings confirm that health indicators such as life expectancy, fertility, and health spending are integral comprehensive human capital proxies to human capital, and that the interaction between education and health is essential for capturing its full effect. In our empirical analysis, health determinants are captured through expenditure on healthcare, fertility rates, and the ratio of hospital beds to medical doctors.

2.4. Socio-demographic determinants

Beyond economic, educational, and health-related factors, a growing strand of literature highlights the importance of social and institutional determinants in shaping human capital formation and outcomes. Variables such as corruption, remittances, female labor force participation, and research and development (R&D) capture broader socio-cultural and governance dimensions that condition both the level and effectiveness of human capital investments.

Corruption, is broadly defined as the misuse of public authority for private gain. Mauro (1995) used a cross-sectional dataset of around 70 countries and applying regression analysis to demonstrate that corruption reduces growth by lowering investment rates and skewing public expenditure toward unproductive uses. The high level of corruption is also dangerous for healthy economic growth, especially in low-income countries with limited human capital stocks, where talented people could orientate towards high income industries which are not productive just for receiving incentives. For example, Murphy *et al.* (1991), uses a theoretical model based on cross-country evidence on the occupational choices of graduates to show that when high-skilled people are concentrated in rent-seeking activities (e.g., law, lobbying) instead of productive sectors (e.g., engineering), growth slows as incentives to invest in skills decline. Ehrlich and Lui (1999) also build a theoretical framework to argue that corruption magnifies development gaps by reducing incentives for skill investment. The forms of

corruption range from large corruption at the political level to bureaucratic and judicial corruption, which shape everyday interactions between citizens and officials. Andvig and Fjeldstad (2001), through a comprehensive review of many contemporary case studies and theoretical approaches, conclude that corruption systematically erodes state capacity, diverts resources and reduces the quality of governance. The empirical evidence further confirms its economic costs. For example, Treisman (2000), based on a large panel of over 100 countries and employing cross-national econometric analysis, finds that higher corruption is associated with weaker political stability, reduced openness, and slower long-run growth. Olson *et al.* (2000), use a cross-country panel dataset of around 70 countries over the period 1970–1990 to evaluate how institutional quality can impact economic growth. Their results show that corruption reduces the efficiency of government spending and erodes institutional capacity, thereby weakening the channels through which human capital contributes to long-run development. Freckleton *et al.* (2012) analyze a panel of 42 developed and developing countries during 1995-2007 with dynamic panel data models (Generalized Method of Moments- GMM estimators) and demonstrate that corruption significantly lowers the productivity of human capital. According to their analysis, this effect appears as the returns to education and the incentives for training and skills acquisition are reduced. Their findings underline that governance quality is a crucial moderator of the human capital–growth relationship. Corruption is shown by Aslam (2020), using cross-country panel data and econometric modeling, to undermine both, economic performance and human capital accumulation by weakening institutions and distorting incentives. These insights provide a strong rationale for including corruption in our empirical analysis as a social determinant of human capital, given its potential to condition not only the scale but also the effectiveness of educational and health-related investments.

Recent studies highlight that migration patterns may significantly influence human capital accumulation. In particular, the emigration of highly skilled workers may reduce the domestic stock of human capital and weaken long-term growth prospects in the countries of origin, a phenomenon commonly referred to as brain drain (Akyıldız *et al.*, 2025). Migration not only implies the movement of skills but also generates financial flows in the form of remittances. Migrant workers often send money back to their home countries, and these remittances can significantly shape educational and health investments at the household level. Although remittances provide additional financial resources to households, their origin lies in international migration and family networks, making them a social rather than purely economic phenomenon. Moreover, the share of income that migrants transfer back home depends largely on social factors—such as family ties, cultural norms and household composition—rather than on earnings alone. For these reasons, we consider remittances in this study as a social factor influencing human capital formation. Empirical evidence suggests that remittances may finance education by alleviating household credit constraints. For instance, Kugler (2006) uses household-level survey data on Colombia for the period 1997-2003 and employs econometric models of household expenditure to show that remittances significantly increase investments in schooling by relaxing liquidity constraints. Similarly, Gyimah-Brempong and Asiedu (2015), employs cross-sectional household survey data from Ghana with probit and instrumental variable estimations to confirm that remittances raise the probability of school enrollment. Amuedo-Dorantes and Pozo (2013) carry nationally representative household survey data from the Dominican Republic (1997–2004) and apply regression analysis to estimate that a 10% increase in remittances raises school attendance by

roughly 3%. These findings support the "brain gain" hypothesis described by Docquier and Rapoport (2011), whereby migration prospects and remittances encourage greater household investment in education. However, the evidence is not uniformly positive.

Gao *et al.* (2021) uses panel data from household and school surveys in the Kyrgyztan Republic in his econometric analysis to demonstrate that remittances may reduce school enrollment. The explanation would be that adult migration leaves children without adequate supervision. A similar pattern is documented by Bucheli *et al.* (2018), who analyze household survey data from Ecuador from 2010 and show that the effect of remittances varies with family arrangements. When one parent migrates and sends remittances while the children remain under the care of the other parent, grandparents, or other guardians, school attendance tends to increase because supervision and support for education are preserved. However, when both parents migrate and children are left without close parental monitoring, the positive income effect of remittances is offset by weaker supervision, which can reduce school attendance. Thus, the presence or absence of effective caregivers determines whether remittances reinforce or hinder human capital formation. Therefore, remittances may finance human capital accumulation, but it seems that their impact is highly context-dependent, shaped by household structures, labor market opportunities, and institutional frameworks. As we intend to test their relevance and better understand how international financial flows interact with human capital formation, we include remittances in our empirical analysis for OECD countries.

Another important dimension of human capital emphasized recently in the literature is gender inclusion, with female labor force participation (FLFP) widely regarded as an indicator of human capital quality. Research highlights that FLFP is not only a driver of women's empowerment but also a catalyst for human capital accumulation and long-term development. Using a comprehensive cross-country literature review, Heath *et al.* (2024) synthesize empirical evidence showing that policies expanding childcare availability, enhancing workplace flexibility, and strengthening women's bargaining power consistently increase female labour force participation. The review further highlights that higher female labour supply translates into greater investments in children's schooling and health.

At the micro level, Jensen (2012) provides experimental evidence from rural India. In 160 villages, recruiters linked young women (ages 15–21) to positions in the business process outsourcing (BPO) industry in a randomized controlled study. These women were 5–6 percentage points less likely to marry or have children, 4.6 percentage points more likely to work in BPO), and more likely to invest in computer and English training throughout a three-year period. Crucially, even younger girls in these homes demonstrated better nutrition (as indicated by their body mass index BMI) and increased school enrollment, indicating intergenerational human capital spillovers. These findings support Goldin's (1994) U-shaped trajectory, whereby FLFP initially declines during industrial transitions but rebounds with rising education and white-collar opportunities.

At the same time, Kleven *et al.* (2019) document persistent barriers such as motherhood "penalties'', cultural constraints, and limited childcare, which continue to suppress women's full labor market potential. Addressing these barriers becomes therefore essential, as increasing female participation not only narrows gender gaps but also amplifies long-term human capital formation and economic growth. Given this evidence, we include female labor force participation in our empirical analysis as a social determinant of human capital.

In addition to the traditional educational measures, the literature also emphasizes the role of research and development (R&D) expenditure as a driver of human capital formation and productivity. In our view, unlike direct educational inputs such as attainment or enrollment, R&D reflects the institutional and innovation environment that sustains knowledge creation and diffusion, making it a broader socio-institutional determinant rather than a purely educational one. Empirical evidence confirms its multifaceted contribution. Giyasova *et al.* (2025), used Hong Kong data for 1998–2022 and Granger causality tests and found that R&D spending and researcher growth increase GDP per capita and vice versa, suggesting a reinforcing two-way relationship. Similarly, Diakodimitriou *et al.* (2025) showed through dynamic panel models that R&D acts as a key channel through which education expenditure translates into higher per-capita GDP, highlighting its magnifying effect on human capital investments. However, the findings are not uniformly positive. Pop-Silaghi *et al.* (2014) examine annual data for Central and Eastern European economies over 1998–2008 using a dynamic panel GMM estimator. Their results show that business R&D expenditure has a positive and statistically significant impact on economic growth, both in the short and long run. By contrast, public R&D expenditure is generally found to be statistically insignificant in the baseline specification. When human capital is added to the model, the effect of business R&D remains significant but weakens, suggesting that innovation outcomes depend not only on investment but also on the availability of skilled human capital. Fayyaz and Bartha (2025), apply structural equation modeling on data for 32 lower-middle-income countries, showing that while R&D fosters innovation, this does not automatically translate into growth due to institutional and structural weaknesses. Männasoo *et al.* (2018), analyzing data during 1995-2015 for 99 European regions with panel dynamic techniques, find that human capital has a stronger direct effect on productivity than R&D. This implies that R&D has a positive effect on economic growth only when the human capital is already skilled. Together, these studies underscore that R&D enhances human capital not by expanding basic educational attainment, but by developing already existing innovation capacity. As we want to test the influence of R&D on a developed sample of countries which would also have high-skilled population, we include R&D expenditure as a social determinant of human capital in our analysis.

Another important factor that may be considered in relationship with human capital accumulation and economic growth is urbanization. For example, Arouri *et al.* (2014) study the effects of urbanization in Africa by applying Granger causality` tests and dynamic regressions and their results proved that urbanization is impacting human capital variables, such as enrollment rates and health variables. When it comes to the effects on economic development, this study also confirms what other researchers stated, meaning that there is an inverted U-shape relationship between urbanization and economic development. The explanation would be that in the early stage of development, urbanization supports economic growth, but at later stages it turns negative, as the high or fast rhythm may boost infrastructure and hinder the economy. Also, Jemiluyi and Jeke (2024) use annual macroeconomic data for Nigeria covering 1991–2022, including GDP, urbanization, capital formation, labour and trade openness, and employ an ARDL–ECM framework to demonstrate that urbanization alone does not foster economic growth without supportive productive and structural conditions. Urbanization has a positive effect only when interacting with human capital, emphasizing that education and health investments can mitigate the adverse impacts of rapid urbanization and generate other benefits. Therefore, since urbanization seems to capture a

broader series of socio-demographic factors that influence both human capital and life expectancy, we include it as a variable in our study.

2.5. Some gaps in existing research

Most of the existing studies on human capital and development like the ones of Bloom and Canning (2003); Teixeira and Fortuna (2004); Affandi *et al.* (2019) rely on cross-sectional or static panel techniques such as Ordinary Least Squares (OLS), fixed effects, or random effects. Only a limited number of studies like for examples the ones of Baldacci *et al.* (2008); Giyasova *et al.* (2025)or Rahim *et al.* (2021) employ dynamic methods like System GMM to address endogeneity and persistence. Furthermore, literature rarely compares human capital and life expectancy as complementary indicators, even though they are closely connected. The contribution of this study is threefold: first, it adopts a multi-perspective approach, examining economic, educational, health, and social determinants of human capital and life expectancy. Second, it explicitly compares the two indicators highlighting their complementarities and differences; and third, it relies on recent data and a dynamic panel methodology (System GMM), which allows for a more robust assessment of causality and persistence than static models.

The contribution of this study is twofold. First, the paper provides a comprehensive analysis of the determinants of human capital by examining a broad set of socio-economic, educational, and macroeconomic factors. Second, the analysis adopts a dual empirical perspective on human capital measurement, using both the Human Capital Index (HCI) and life expectancy (LE) as alternative dependent variables estimated in separate model specifications. This approach allows us to assess whether the determinants of human capital formation affect a composite measure of human capital (HCI) and a health-based proxy (LE) in a similar or different manner, thereby providing a more nuanced understanding of the mechanisms underlying human capital development. Importantly, the two indicators are not included simultaneously in the same regression equation, but are analyzed in separate models in order to capture complementary dimensions of human capital.

3. DATA AND METHODOLOGY

3.1. Methodological approach

The empirical analysis is based on a panel dataset of the 38 OECD countries covering the period 2000–2024. Due to missing observations for several variables across countries and years, the dataset forms an unbalanced panel. The empirical analysis therefore employs the System GMM estimator, which is particularly suitable for dynamic panel models with potential endogeneity and unbalanced data structures.

The sample consists of annual observations for a wide range of economic, educational, health, and social indicators collected from the World Bank and OECD databank. Human capital is proxied by two alternative indicators: the World Bank Human Capital Index (2018) and life expectancy at birth, which capture different aspects of human capital development related to productivity and population health. The explanatory variables are grouped into four categories: economic (GDP per capita, government debt, taxation, budget balance, inflation), educational (expenditure on education, upper-secondary and share of advanced-educated

labor), health-related (health expenditure, fertility and a proxy based on the number of beds and doctors available per 1000 residents) and social (urbanization, corruption indices, remittances, female labor force participation and R&D expenditure,). This structure allows for a multidimensional assessment of the determinants of human capital and life expectancy across advanced economies over nearly a quarter century.

To analyze the determinants of human capital and life expectancy, this study employs dynamic panel models, which are particularly well-suited for capturing persistence effects and accounting for the fact that current levels of human capital are influenced by their past values. Moreover, many explanatory variables—such as education expenditure, female labor force participation, or fiscal indicators—are likely to be endogenous, either because of reverse causality or omitted variable bias. System GMM as described by Arellano and Bover (1995) provides a robust solution by using internal instruments derived from lagged values of the variables, thereby addressing endogeneity. In addition, the method accommodates heterogeneity across countries, which is crucial in a cross-national setting where institutional structures, development levels, and policy frameworks differ significantly. For all these reasons, System GMM is an appropriate methodology for identifying the causal impact of economic, educational, health, and social determinants on human capital dynamics.

3.2. Data and Variables

In this study, human capital is analyzed using two complementary dependent variables: the Human Capital Index (HCI) and life expectancy at birth (LE). Although HCI includes a health-related component associated with survival probability, it is primarily a composite indicator capturing the productivity potential of future workers by combining education quantity, education quality, and health conditions. In contrast, life expectancy reflects broader population health outcomes and demographic conditions as it is shaped by institutional quality, economic development, public health systems and the overall macroeconomic environment in which individuals live. Therefore, the use of both indicators allows the analysis to capture complementary dimensions of human capital development.

The economic determinants included in the analysis are GDP per capita, taxes (calculated as the average of taxes on income, profits, and capital gains and taxes on goods and services) government debt, budget balance, and inflation with data collected from the World Bank. Higher GDP per capita (lnGDP) is expected to positively influence both human capital and life expectancy, as greater income levels improve access to education, healthcare, and overall living conditions. Government debt (GovDebt) is expected to have a negative long-run effect on both indicators, because when a country owes large amounts of money, fewer public resources remain available for education, healthcare, and other social investments. High debt also creates pressure to cut spending or raise taxes in the future, which can further limit support for human capital. By contrast, a stronger budget balance (Budget), meaning that revenues and expenditures are under control, allows governments to invest more steadily in schools, hospitals, and social programs. In this way, government debt is expected to reduce human capital and life expectancy in the long run. Taxation (Taxes) measured through a composite indicator (average of taxes on income, profits, and capital gains, and taxes on goods and services), captures governments' reliance on fiscal revenues. On the public side, higher tax revenues provide governments with the resources needed to finance education, health, and social programs, which should enhance human capital and longevity. On the

private side, however, higher taxes on income and profits may reduce incentives for households and firms to invest in skills, training, and innovation. Therefore, the net effect of taxation on human capital is theoretically ambiguous and ultimately depends on the efficiency of public spending and the structure of the tax system. Inflation (Inflation) is generally seen as detrimental since it erodes purchasing power and reduces access to essential goods. However, in certain contexts, moderate inflation may also exert a positive effect, as it may be associated with economic growth, wage adjustments, and increased fiscal revenues that are to be redirected toward education and healthcare.

The level of education is the basis of performant human capital, as it determines both the accumulation of knowledge and the development of skills required in modern economies. Public expenditure on education (EdExp) reflects the resources allocated to improving access, quality, and infrastructure in the education system and it is therefore expected to have a positive impact on human capital. The share of the population with upper secondary education (Upper) captures the stock of advanced skills and qualifications in the society and we anticipate it will enhance human capital through higher productivity, innovation, and adaptability. The share of the labor force with advanced education (LaborAdvance) directly measures the availability of skilled workers and it is expected to increase human capital. All education-related variables should facilitate the comprehension of medical information and the adoption of healthier lifestyles, therefore expecting a positive effect also on life expectancy, not only on human capital.

The health-related variables are closely linked to the formation and accumulation of human capital, since a healthier population is able to learn better, work, and contribute productively. The Public health expenditure (HealthExp) is expected to positively affect human capital and life expectancy, as it improves access to medical services. Fertility rates (**Fertility**) are expected to be also positively linked with the dependent variables as we are working on data from developed countries. Finally, the ratio of hospital beds to doctors (BedsDoctors) reflects the availability of medical infrastructure and personnel and we generally expect a positive relationship with the dependent variables, although in contexts where infrastructure expands faster than qualified staff, the effect may be ambiguous.

Social and institutional factors also play an essential role in shaping both human capital (HC) and life expectancy (LE). Urbanization (UrbanPop) may foster HC by providing improved access to schools, universities, and infrastructure, while for LE it can enhance access to healthcare and services. The level of corruption (Corruption) given by the Corruption Perceptions Index is anticipated to reduce HC by undermining the efficiency of public spending on education and health, and we also assume it would lower LE by weakening institutional quality and diverting resources away from essential social services. Remittances (Remittances) may positively affect HC by financing education, training, or health-related investments, and they can also raise LE by improving household access to private healthcare, nutrition, and better living conditions. Female labor force participation (FemaleLabor) is expected to positively influence HC by increasing household income, stimulating greater investment in children's education, and promoting gender equality in skills development. We also expect an increased LE caused by FLFP as it would facilitate access to healthcare and better intergenerational outcomes. Finally, R&D expenditure (RDExp) is expected to contribute positively to HC by fostering innovation, knowledge creation, and advanced skills, while for LE it can improve health outcomes through medical advances, new treatments, and enhanced healthcare efficiency.

For clarity, the full description, measurement, and sources of all variables included in the analysis are reported in Annex, Table no. A1.

3.3. Preliminary Analysis

Prior to estimation, the dataset was organized as a country–year panel of OECD economies. Descriptive statistics, correlation analysis, and panel unit root tests were conducted to examine the statistical properties of the variables and their stationarity. Missing observations were addressed selectively using linear interpolation for several variables, including government debt, education expenditure, upper-secondary attainment, advanced-educated labor and R&D expenditure. In the case of education expenditure, limited forward and backward filling was also applied to complete isolated gaps in the time series.

For variables exhibiting non-stationarity, first differences were generated and used in the empirical analysis where appropriate. Additionally, logarithmic transformations were tested for selected macroeconomic indicators such as GDP and health expenditure in alternative specifications. Potential outliers were examined through descriptive statistics and distributional measures; however, extreme values were retained as they reflect genuine cross-country heterogeneity among OECD economies. As missing observations differ across indicators and countries, the resulting dataset constitutes an unbalanced panel, which is compatible with the System GMM estimation framework employed in the study.

Table no. 1 – Descriptive Statistics

	Mean	Median	SD	Min	Max	N
HCI	.626	.669	0.235	0	1	839
Life	78.93	79.61	3.191	69.75	84.56	840
GDP	32767.752	31611.293	21636.023	4016.81	112417.88	874
GovDebt	78.865	67.308	46.323	3.814	249.366	433
Taxes	28.22	27.372	4.874	18.079	48.122	779
Budget	-1.992	-2.115	4.423	-32.098	26.301	800
Inflation	3.474	2.44	5.426	-4.448	72.309	875
EdExp	5.196	5.016	1.153	2.614	8.584	735
Upper	67.285	74.807	19.336	15.77	95.289	622
LaborAdvance	79.368	79.405	4.523	65.702	94.867	793
HealthExp	8.345	8.136	2.250	3.703	18.813	823
Fertility	1.651	1.59	0.374	.721	3.11	840
BedsDoctors	4.089	3.838	1.750	1.224	14.61	777
UrbanPop	75.559	76.92	11.404	50.754	98.224	875
Corruption	1	1.015	0.909	-1.703	2.459	805
Remittances	.955	.492	1.059	0	6.176	873
FemaleLabor	52.381	53.062	7.710	23.114	73.42	875
RDExp	1.775	1.594	1.082	.131	6.019	782

Source: authors computation using Stata 18.00

Table no. 1 presents the descriptive statistics for the variables used in the empirical analysis. The comparison between mean and median values provides a first indication of the distributional characteristics of the data. For most variables, the mean and median are relatively close, suggesting moderate symmetry in their distributions. However, for some macroeconomic indicators, particularly GDP per capita and inflation, larger differences

between the mean and median indicate the presence of asymmetric distributions across countries, reflecting the heterogeneity of OECD economies. The dispersion measures further reveal substantial variability in several variables. GDP per capita displays the widest range, highlighting significant differences in economic development levels across the sample. Fiscal indicators such as government debt and budget balance also show considerable variation, reflecting heterogeneous fiscal conditions among OECD countries.

To further assess the distributional properties of the variables, Table no. 2 reports the skewness and kurtosis coefficients. These statistics provide additional information on the degree of asymmetry and the presence of heavy tails in the distributions. In particular, inflation shows extremely high skewness and kurtosis, suggesting the presence of significant outliers. Similar patterns, though less pronounced, are observed for budget balance and the beds-to-doctors ratio. These results indicate that the dataset contains extreme observations, which are typical in cross-country macroeconomic data and reflect structural heterogeneity across OECD economies rather than measurement errors.

Table no. 2 – Skewness and Kurtosis

	Skewness	Kurtosis
HCI	-.657	2.672
Life	-.709	2.689
GDP	1.196	4.803
GovDebt	1.006	3.909
Taxes	.811	3.558
Budget	.676	10.473
Inflation	7.202	73.23
EdExp	.619	3.013
Upper	-.855	2.541
LaborAdvance	.259	3.53
HealthExp	.913	4.959
Fertility	1.401	5.921
BedsDoctors	2.094	12.689
UrbanPop	-.155	2.237
Corruption	-.501	2.796
Remittances	1.687	5.969
FemaleLabor	-.614	4.72
RDExp	.695	3.18

Source: authors computation using Stata 18.00

To further investigate the presence of extreme observations, percentile statistics were also computed. The detailed percentile distributions are reported in Table no. A2. The comparison between lower and upper percentiles confirms the presence of wider dispersion for several macroeconomic indicators, particularly GDP per capita and inflation. These results indicate that some variables contain extreme values; however, these observations reflect the substantial heterogeneity across OECD economies rather than data inconsistencies.

Prior to the estimation, panel unit root tests were conducted in order to determine the order of integration of the variables. Specifically, the Im–Pesaran–Shin and Fisher-type panel unit root tests were employed, and the results are reported in Table no. 3.

Table no. 3 – Unit root test

Variables	Im-Pesaran-Shin/ Fisher - Level	Im-Pesaran-Shin/ Fisher - First Difference	Status
HCI	-2.5494***	-	I(0)
Life	3.2303	14.6426***	I(1)
GDP	-2.0384**	-	I(0)
GovDebt	31.1310	210.1972***(Fisher)	I(1)
Taxes	-1.0106	-9.7300***	I(1)
Budget	-4.3239***	-	I(0)
Inflation	-7.7823***	-	I(0)
EdExp	96.9673**	-	I(0)
Upper	43.8080	291.1575***(Fisher)	I(1)
LabourAdvance	79.6483	334.3051***(Fisher)	I(1)
HealthExp	-0.5037	14.5956***	I(1)
Fertility	6.9787	-3.4501***	I(1)
BedsDoctors	1.8081	-4.9542***	I(1)
UrbanPop	-29.8340***	-	I(0)
Corruption	1.8998	11.9786***	I(1)
Remittances	-1.7707**	-	I(0)
FemaleLabour	-0.1527	11.1709***	I(1)
RDExp	-9.0532***	-	I(0)

Note: IPS test performed with lags (1), with trend. Panel: OECD (N=38)
Source: authors computation using Stata 18.00

The optimal number of lags was selected automatically based on the Schwarz Information Criterion (BIC), as implemented in Stata. The results indicate that the variables exhibit mixed orders of integration. Several variables, including HC, GDP, Inflation, Budget balance, Urbanization, Remittances, and R&D expenditure, are stationary in levels, indicating an integration order of I(0). In contrast, variables such as Life expectancy, Government debt, Taxes, Upper-secondary attainment, Advanced labor, Health expenditure, Fertility, Beds per doctor, Corruption, and Female labor force participation are non-stationary in levels but become stationary after first differencing, indicating that they are integrated of order one, I(1). The presence of both I(0) and I(1) variables supports the use of dynamic panel estimation techniques such as System GMM (Arellano and Bond, 1991). In addition, several variables (e.g., health expenditure, fertility and female labor force participation) are potentially endogenous due to reverse causality, so system GMM is therefore appropriate, as it controls for unobserved heterogeneity and mitigates potential endogeneity as described by Arellano and Bover (1995) and by Blundell and Bond (1998).

4. EMPIRICAL ANALYSIS

The theoretical foundation of the human capital models presented in this study is based on the framework proposed by Baldacci *et al.* (2008), who examined the channels through which public social spending affects human capital formation and economic growth. *Their model integrates education, health, and growth equations within a dynamic panel framework* for 120 developing countries between 1975 and 2000. The framework emphasizes the role of public policies and macroeconomic conditions in shaping the accumulation of human capital.

In simplified form, the growth equation proposed by Baldacci *et al.* (2008) can be written as:

$$Growth_{it} = f\left(\ln y_{i,t-1}, Investment_{it}, Education_{it}, Health_{it}, \Delta Education_{it}, \Delta Health_{it}, Z_{it}\right) \quad (1)$$

where $Growth_{it}$ denotes real GDP per capita growth in country i at time t, while $\ln y_{i,t-1}$ represents the lagged level of income capturing convergence effects. $Investment_{it}$ reflects the investment rate and therefore the accumulation of physical capital. $Education_{it}$ and $Health_{it}$ represent the stocks of education and health capital, respectively, while $\Delta Education_{it}$ and $\Delta Health_{it}$ capture changes in these dimensions of human capital. Finally, Z_{it} is a vector of macroeconomic and institutional control variables, including trade openness, terms of trade shocks, fiscal balance, inflation, and governance indicators.

In this framework, economic growth is influenced by both physical investment and human capital accumulation. Education and health represent the two main dimensions of human capital, while macroeconomic stability and institutional conditions shape the environment in which these factors contribute to growth.

Although the present study does not estimate a separate growth equation, this conceptual structure provides the theoretical background for our empirical analysis. In particular, it highlights the central role of education and health in the accumulation of human capital, which motivates our focus on the determinants of human capital and life expectancy in OECD economies.

In addition to the growth equation, Baldacci *et al.* (2008) also specify an investment equation describing the macroeconomic and human capital factors that influence physical capital accumulation. In simplified form, the investment equation proposed by Baldacci *et al.* (2008) can be written as:

$$Investment_{it} = f\left(\ln y_{i,t-1}, PopulationGrowth_{it}, Education_{it}, Health_{it}, FiscalBalance_{it}, Inflation_{it}, Governance_{it}\right) \quad (2)$$

where $Investment_{it}$ denotes the investment ratio measured as gross capital formation as a percentage of GDP. The variable $\ln y_{i,t-1}$ represents the lagged level of income and captures convergence effects across countries. $PopulationGrowth_{it}$ reflects demographic dynamics that influence savings and investment decisions. $Education_{it}$ represents the stock of education capital, proxied in the Baldacci framework by the composite primary and secondary school enrollment rate, while $Health_{it}$ captures the stock of health capital, proxied by the logarithm of under-five child mortality. These variables reflect the idea that higher levels of human capital increase productivity and therefore stimulate investment. Macroeconomic stability is captured through fiscal and monetary indicators. In particular, the fiscal balance variable reflects the sustainability of public finances, while inflation captures macroeconomic instability that may discourage investment. Governance indicators are also included in order to account for institutional conditions that affect the efficiency of investment and economic activity. Although the present study does not estimate a separate investment equation, this mechanism is reflected in our empirical framework through the inclusion of macroeconomic variables such as GDP per capita, inflation, government debt, taxation, and budget balance, which capture the broader economic environment in which human capital is accumulated.

In the framework proposed by Emanuele Baldacci *et al.* (2008), human capital is modeled as the outcome of the interaction between education and health, both influenced by public expenditure and macroeconomic conditions. In their empirical specification, education

and health represent the two main components of human capital and are determined not only by public spending but also by a set of broader contextual variables.

Education and health jointly determine the stock of human capital, which in turn contributes to economic growth. Public spending on education and health therefore influences growth both directly and indirectly through improvements in human capital outcomes. In simplified form, the education equation proposed by Baldacci *et al.* (2008) can be written as:

$$Education_{it} = f(\ln y_{it}, Popu15_{it}, Health_{it}, Urban_{it}, Quality_{it}, EduSpending_{it}, Governance_{it}, Female_{it}) \quad (3)$$

where $Education_{it}$ represents the stock of education capital, proxied by the composite primary and secondary school enrollment rate. The variable $\ln y_{it}$ captures the level of economic development, reflecting the idea that higher income increases the demand for education. Demographic pressure on the education system is captured by $Popu15_{it}$, which represents the share of population below 15 years of age. $Health_{it}$ captures the stock of health capital, proxied by the under-five child mortality rate, reflecting the idea that a healthier population is more likely to invest in education. Additional variables reflect broader socio-institutional conditions affecting education outcomes. Urbanization ($Urban_{it}$) captures access to educational infrastructure, while education quality ($Quality_{it}$) is proxied by the school repetition rate. Public education expenditure ($EduSpending_{it}$) measures government spending on education as a percentage of GDP and is included both in current and lagged form in order to capture delayed effects of spending on education outcomes. Governance conditions ($Governance_{it}$) reflect institutional quality affecting the efficiency of public spending, while gender equality ($Female_{it}$) is captured through the share of female students in primary and secondary education. In the Baldacci framework, this equation highlights that education outcomes are determined by a combination of economic development, demographic pressure, health conditions, institutional quality, and public spending.

In the present study, the education dimension is represented through indicators of educational attainment and skills formation, including education expenditure, upper secondary attainment, literacy rates, and the share of labor force with advanced education.

In simplified form, the health equation proposed by Baldacci *et al.* (2008) can be written as:

$$Health_{it} = f(\ln y_{it}, Fertility_{it}, Urban_{it}, HealthSpending_{it}, Governance_{it}, Female_{it}) \quad (4)$$

where $Health_{it}$ represents the stock of health capital, proxied by the logarithm of the under-five child mortality rate. The variable $\ln y_{it}$ captures the level of economic development, reflecting the idea that higher income levels improve access to healthcare services and living conditions. Demographic factors are captured by $Fertility_{it}$, which reflects population dynamics affecting health outcomes and healthcare demand. Urbanization ($Urban_{it}$) captures access to healthcare infrastructure and services, as urban populations generally benefit from better medical facilities and public health conditions. Public health expenditure ($HealthSpending_{it}$) measures government spending on health as a percentage of GDP and captures the role of public investment in improving health outcomes. Governance conditions ($Governance_{it}$) are included to account for the institutional environment influencing the efficiency of healthcare spending, while gender-related factors ($Female_{it}$) reflect the role of female education and gender equality in improving health outcomes. In the Baldacci

framework, this equation highlights that health outcomes are determined by a combination of economic development, demographic dynamics, institutional conditions, and public spending.

In the present study, the health dimension is captured through variables such as public health expenditure, fertility rates, and healthcare capacity (proxied by the ratio of hospital beds and physicians), while life expectancy is used as a direct indicator of health outcomes and human capital accumulation.

Building on this framework, the present study extends the set of determinants in order to capture a broader range of factors influencing human capital formation in advanced economies. While Baldacci et al. focus primarily on social spending and macroeconomic stability, our analysis incorporates a wider group of variables reflecting economic, educational, health-related and socio-institutional conditions. In particular, the social dimension is represented through variables such as urbanization, corruption perceptions, remittances, female labor force participation, and research and development expenditure, while demographic dynamics are captured mainly through fertility rates. This broader specification allows for a more detailed assessment of the mechanisms through which macroeconomic conditions, institutional environments, and social structures influence human capital and life expectancy across OECD countries.

Therefore, the general dynamic panel specification for human capital is:

$$HC_{it} = \alpha HC_{it-1} + \beta X_{it} + \mu_i + \varepsilon_{it} \quad (5)$$

$$LE_{it} = \alpha LE_{it-1} + \beta X_{it} + \mu_i + \varepsilon_{it} \quad (6)$$

where:

- HC_{it} and LE_{it} represents human capital (or life expectancy) for country i in year t;
- HC_{it-1} and LE_{it-1} are the lagged dependent variable, capturing persistence;
- X_{it} is a vector of explanatory variables (specific to each perspective: economic, educational, health, social);
- μ_i denotes country-specific effects;
- ε_{it} is the error term.

The empirical analysis employs the System GMM estimator developed by Arellano and Bover (1995) and Blundell and Bond (1998), which is well-suited for dynamic panel models where the dependent variable depends on its lagged values and regressors may be endogenous. The estimator combines equations in first differences with equations in levels, using lagged levels as instruments for the differenced equation and lagged differences as instruments for the levels equation. This framework addresses key econometric concerns by correcting the dynamic bias introduced by lagged dependent variables, mitigating endogeneity arising from variables such as GDP, health expenditure, or education, and controlling for unobserved country-specific heterogeneity through differencing. To enhance efficiency and inference, the analysis applies the two-step robust estimator with Windmeijer's finite-sample correction, which improves the reliability of standard errors compared to the one-step procedure. To ensure the robustness of the dynamic panel estimates, several specification tests were conducted, including the Arellano-Bond test for serial correlation (where AR(1) is expected and AR(2) should be absent), the Hansen and Sargan tests for instrument validity as their

exogeneity, and check for instrument proliferation, which are addressed by collapsing the instrument matrix and restricting lag depth.

The validity of the dynamic panel estimations was assessed through a series of specification tests commonly used in the System GMM framework. In particular, the Arellano–Bond tests for serial correlation were applied to the differenced residuals, where the presence of first-order autocorrelation (AR(1)) and the absence of second-order autocorrelation (AR(2)) represent the expected pattern. In addition, the Hansen and Sargan tests of overidentifying restrictions were used to evaluate the validity and exogeneity of the instruments employed in the estimation. To further ensure the reliability of the instrument set and to avoid instrument proliferation, the instrument matrix was collapsed and the lag depth was restricted following standard practice in the System GMM literature.

Multicollinearity was assessed through the Variance Inflation Factor (VIF) tests in preliminary OLS estimations. All VIF values were below the conventional threshold of 5, indicating no critical collinearity concerns among the explanatory variables included in the System GMM specifications.

4.1. Economic Perspective

For human capital index (HCI), the specification includes GDP, inflation and the budget balance because fiscal sustainability affects investments in education and social protection more directly than debt stock. The baseline economic specification (model 7) for Human Capital (HC) is:

$$HCI_{it} = \alpha HCI_{it-1} + \beta_1\, lnGDP_{it} + \beta_2\, Budget_{it} + \beta_3\, Inflation_{it} + \varepsilon_{it} \quad (7)$$

where $\mathrm{HCi}_{\mathrm{it}}$ represents the Human Capital Index for country i in year t, $\mathrm{HCI}_{\mathrm{it}-1}$is the lagged dependent variable capturing persistence effects, $\mathrm{lnGDP}_{\mathrm{it}}$denotes the logarithm of GDP per capita, $\mathrm{Budget}_{\mathrm{it}}$represents the fiscal balance, $\mathrm{Inflation}_{\mathrm{it}}$is the inflation rate, and $\varepsilon_{\mathrm{it}}$is the error term.

For HCI, the lagged dependent variable is positive and highly significant, indicating strong persistence in human capital accumulation. GDP per capita does not exhibit a statistically significant relationship with human capital once persistence effects are taken into account. Inflation shows a small but statistically significant positive coefficient, suggesting that moderate inflation may be associated with periods of economic dynamism rather than macroeconomic instability. Fiscal variables do not display robust short-term associations with human capital in this specification.

For life expectancy, the economic specification is extended to include government debt and taxation, in addition to GDP per capita, inflation, and the fiscal balance. The logic behind is that health outcomes are more sensitive to long-term fiscal pressures and structural budget conditions than to short-run economic fluctuations. Government debt may influence life expectancy indirectly through its impact on future public healthcare spending and infrastructure maintenance. High debt levels may constrain fiscal space over time, leading to postponed investment in health systems. Taxation may affect the affordability of healthcare services and the financing of public health programs. The model estimated is therefore:

$$LE_{it} = \alpha LE_{it-1} + \beta_1 \ln GDP_{it} + \beta_2 GovDebt_{it} + \beta_3 Taxes_{it} + \beta_4 Inflation_{it} + \beta_5 Budget_{it} + \varepsilon_{it} \quad (8)$$

where LE_{it}denotes life expectancy at birth for country i in year t, $LE_{it-1}$is the lagged dependent variable, $\ln GDP_{it}$represents the logarithm of GDP per capita, $GovDebt_{it}$denotes government debt, $Taxes_{it}$represents the composite taxation indicator, $Inflation_{it}$is the inflation rate, $Budget_{it}$denotes the fiscal balance, and $\varepsilon_{it}$is the error term.

Table no. 4 – Economic Determinants of HCI and LE - System GMM, OECD, 2000-2024

	(7) HCI	**(8) Life**
L.HCI / L.Life	0.981***	0.699***
	(0.021)	(0.141)
lnGDP	-0.001	2.455**
	(0.006)	(1.143)
GovDebt	-	0.002
		(0.002)
Taxes	-	-0.057*
		(0.030)
Budget	0.001	-0.010
	(0.001)	(0.010)
Inflation	0.001***	0.063**
	(0.000)	(0.025)
Constant	0.045	0.000
	(0.046)	(.)
Observations	767	388
AR(1) p-value	0.001	0.000
AR(2) p-value	0.186	0.362
Hansen p-value	0.323	0.997
Sargan p-value	0.205	0.956

Note: Standard errors in parentheses. * p < 0.1, ** p < 0.05, *** p < 0.01
Source: authors computation using Stata 18.00

The results confirm that for life expectancy, persistence remains strong, as indicated by the significant lagged term. GDP per capita shows a positive and statistically significant association, consistent with higher income levels being linked to improved living conditions. Inflation also displays a positive and significant association. Government debt and budget balance are not statistically significant, while taxation shows a small negative but significant coefficient. This suggests that income conditions are more strongly associated with life expectancy than short-term fiscal adjustments. For both HCI and LE models, diagnostic tests indicate the validity of the specifications, as the AR(2) test does not indicate second-order serial correlation and both Hansen and Sargan tests suggest acceptable instrument validity.

For both models, diagnostic tests (AR (2) > 0.1, Hansen > 0.2) confirm model validity.

4.2. Educational Perspective

This perspective distinguishes between educational inputs, educational attainment, and the effective integration of skills into the labour market. Education expenditure (EdExp) captures financial investment in the education system. While expenditure and attainment capture educational inputs and schooling levels, human capital formation depends on whether

those skills are absorbed into productive employment. If education is not effectively utilized, increases in schooling or spending do not immediately raise the stock of human capital.

For education, the HCI specification of model 9 is:

$$HCI_{it} = \alpha HCI_{it-1} + \beta_1\, EdEXp_{it} + \beta_2\, Upper_{it} + \beta_3\, LaborAdvance_{it} + \varepsilon_{it} \quad (9)$$

where HCI_{it}represents the Human Capital Index for country i in year t, $HCI_{it-1}$is the lagged dependent variable capturing persistence effects, $EdExp_{it}$denotes public expenditure on education, $Upper_{it}$represents the share of the population with upper secondary education, $LaborAdvance_{it}$denotes the share of the labor force with advanced education and was included as differences as it became stationary only after first differentiated and $\varepsilon_{it}$is the error term.

For life expectancy (LE), the specification is as follows:

$$LE_{it} = \alpha LE_{it-1} + \beta_1\, EdExp_{it} + \varepsilon_{it} \quad (10)$$

where LE_{it}denotes life expectancy at birth for country i in year t, $LE_{it-1}$is the lagged dependent variable capturing persistence in life expectancy, $EdExp_{it}$represents public expenditure on education.

For HCI the lagged dependent variable is positive and highly significant (1.17, $p < 0.01$), confirming strong persistence in human capital. Among the education variables, only upper secondary attainment (Upper_diff) is weakly significant ($p < 0.1$), indicating that increases in the share of individuals completing upper secondary education are associated with small improvements in human capital. By contrast, education expenditure and the share of advanced labour force are not statistically significant. Their coefficients remain close to zero, which suggests that these factors do not produce immediate changes in the HCI within the estimation window, although they may matter through slower channels not captured in short-run dynamics.

Table no. 5 – Educational Determinants of HC and LE - System GMM, OECD, 2000-2024

	(9) **HCI**	**(10)** **LE**
L.HCI / L.Life	1.172***	1.297***
	(0.160)	(0.147)
EdExp	-0.011	-0.099
	(0.009)	(0.129)
Upper	0.001*	-
	(0.001)	
LaborAdvance	0.000	-
	(0.001)	
Constant	-0.105	-24.203**
	(0.075)	(11.415)
Observations	615	702
AR(1) p-value	0.000	0.000
AR(2) p-value	0.385	0.263
Hansen p-value	0.301	0.699
Sargan p-value	0.212	0.003

Note: Standard errors in parentheses. * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

Source: authors computation using Stata 18.00

Life expectancy also exhibits strong persistence in model 10. Education expenditure is again not statistically significant, meaning that no direct short-run association can be identified in this specification. This does not rule out long-run effects but it indicates that, within the structure of the model and sample period, changes in education spending are not immediately reflected in life expectancy. The estimated constant varies across model specifications and in some cases may appear relatively large (e.g., in model 10). This is not unusual in dynamic System GMM models. Since the lagged dependent variable captures most of the persistence, the intercept absorbs remaining level effects and unobserved factors not explicitly included in the model. In addition, differences in variable scaling and sample composition across specifications may contribute to variation in the estimated constant.

Model diagnostics support the statistical validity of both specifications. The AR(1) test shows the expected first-order serial correlation, while the AR(2) test fails to reject the null of no second-order autocorrelation ($p > 0.1$), confirming that the moment conditions are correctly specified. The Hansen test indicates valid instruments ($p > 0.2$). The Sargan test is borderline for Model 10 ($p = 0.003$), which suggests caution in interpreting the strength of the instruments for this specification, although the Hansen statistic—more robust in the presence of heteroskedasticity – still supports overall instrument validity.

4.3. Health Perspective

This perspective examines how health system inputs and demographic factors influence human capital. The aim is to isolate the health channel of development, focusing on the resources and structural conditions that shape population health rather than on education or macroeconomic factors. Health expenditure (HealthExp) captures the financial resources allocated to the healthcare system. Fertility changes (Fertility) reflect demographic dynamics that affect the age structure of the population and long-term human capital formation. Medical infrastructure (BedsDoctors) measures the capacity of the healthcare system, proxied by the availability of hospital beds and medical personnel. The last two variables (Fertility and BedsDoctors) were included in both equations as differences as they became stationary only after first differentiated. The equation of the model for HCI is:

$$HCI_{it} = \alpha HCI_{it-1} + \beta_1\, HealthEXp_{it} + \beta_2\, Fertility_{it} + \beta_3\, BedsDoctors_{it} + \varepsilon_{it} \quad (11)$$

where HC_{it}represents the Human Capital Index for country i in year t, $HC_{it-1}$is the lagged dependent variable capturing persistence in human capital, $HealthExp_{it}$denotes public health expenditure, $Fertility_{it}$represents the fertility rate, $BedsDoctors_{it}$denotes the composite indicator of healthcare capacity (average number of physicians and hospital beds), and $\varepsilon_{it}$is the error term.

While for LE as follows:

$$LE_{it} = \alpha LE_{it-1} + \beta_1\, HealthEXp_{it} + \beta_2\, Fertility_{it} + \beta_3\, BedsDoctors_{it} + \beta_4\, Trend_t + \varepsilon_{it} \quad (12)$$

where LE_{it}denotes life expectancy at birth for country i in year t, $LE_{it-1}$is the lagged dependent variable capturing persistence effects, $HealthExp_{it}$represents public health expenditure, $Fertility_{it}$denotes the fertility rate, $BedsDoctors_{it}$represents the composite indicator of healthcare capacity, $Trend_t$is a time trend capturing the general upward evolution in life expectancy over time, and $\varepsilon_{it}$is the error term.

A linear time trend is included only in the life expectancy specification within the health perspective. Life expectancy displays a well-documented secular upward trajectory across OECD countries, largely driven by long-term improvements in medical technology, public health systems, and living standards. Because these broad structural developments are not fully captured by the health variables included in the model (such as health expenditure, fertility, or the BedsDoctors ratio), the trend term is introduced to control for this common temporal evolution. In contrast, the other model specifications focus on socio-economic and institutional determinants whose dynamics already reflect gradual structural changes over time, making an additional deterministic trend unnecessary.

Table no. 6 – Health Determinants of HC and LE - System GMM, OECD, 2000-2024

	(11) **HCI**	**(12)** **LE**
L.HCI / L.LE	0.878***	1.082***
	(0.039)	(0.126)
HealthExp	0.004	-0.081
	(0.006)	(0.050)
Fertility	0.054**	-0.130
	(0.025)	(1.856)
BedsDoctors	0.001	-0.009**
	(0.001)	(0.004)
Trend		-0.036
		(0.025)
Constant	0.061*	67.485
	(0.030)	(40.677)
Observations	742	742
AR(1) p-value	0.004	0.000
AR(2) p-value	0.978	0.559
Hansen p-value	0.130	0.731
Sargan p-value	0.000	0.576

Note: Standard errors in parentheses. * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$
Source: authors computation using Stata 18.00

Human capital shows again strong persistence, as indicated by the highly significant lagged dependent variable ($p < 0.01$). Among the health covariates, fertility has a positive and statistically significant coefficient, suggesting that demographic dynamics play a role in shaping human capital outcomes within the panel. By contrast, health expenditure and healthcare capacity (BedsDoctors) are not statistically significant, meaning that within the estimated specification their direct association with human capital cannot be identified. The AR(2) and Hansen tests support overall model validity, although the Sargan test indicates some misspecification, so the results should be interpreted with caution. A more complete interpretation of the BedsDoctors indicator would require joint consideration of medical personnel per capita, which can be incorporated in future extensions of the analysis.

Life expectancy also displays high persistence, as shown by the positive and highly significant lagged term ($p < 0.01$). The coefficient on BedsDoctors is negative and significant, which may reflect efficiency issues in healthcare systems where the number of beds grows faster than medical personnel capacity. In such cases, a higher beds-to-doctor ratio can signal pressure on medical staff and lower productivity per physician. Health expenditure and

fertility are not statistically significant in this specification. The diagnostics tests confirm models' validity.

4.4. Social Perspective

Our social determinants are urbanization, perceived corruption, remittances, female labour force participation and R&D expenditure. The HCI specification includes R&D expenditure and female labour participation because human capital reflects productive capacity, which depends on labour market inclusion and the knowledge environment. Female labour force participation captures social inclusion and the utilization of human potential, while R&D expenditure reflects the innovation context that supports skill development and knowledge accumulation. All the variables in this sub-chapter were included in both equations as differences as they became stationary only after first differentiated.

Therefore, for HCI the model has the following equation:

$$HCI_{it} = \alpha HCI_{it-1} + \beta_1\, FemaleLabor + \beta_2\, RDExp_{it\,it} + \varepsilon_{it} \quad (13)$$

where HC_{it}represents the Human Capital Index for country i in year t, $HC_{it-1}$is the lagged dependent variable, $FemaleLabor_{it}$represents female labor force participation, $RDExp_{it}$ denotes research and development expenditure, and $\varepsilon_{it}$is the error term.

The life expectancy model includes urbanization, corruption, remittances, female labour participation, and R&D expenditure because longevity is influenced by living conditions, institutional quality, household financial capacity, and technological progress. These variables capture access to services, governance quality, and the socio-economic environment that affects health outcomes. The life expectancy model estimated is:

$$LE_{it} = \alpha LE_{it-1} + \beta_1\, UrbanPop_{it} + \beta_2\, Corruption_{it} + \beta_3\, Remittances_{it} + \beta_4\, FemaleLabor_{it} + \beta_5\, RDExp_{it} + \varepsilon_{it} \quad (14)$$

where LE_{it} denotes life expectancy at birth for country i in year t, $LE_{it-1}$is the lagged dependent variable capturing persistence effects, $UrbanPop_{it}$represents the urban population share, $Corruption_{it}$denotes the corruption perception index, $Remittances_{it}$represent remittance inflows, $FemaleLabor_{it}$denotes female labor force participation, $RDExp_{it}$represents research and development expenditure, and $\varepsilon_{it}$is the error term.

In both models, model 13 and model 14, human capital is highly persistent, as indicated by the strong significance of the lagged dependent variable. Among the social variables, female labor force participation shows a consistent positive and statistically significant effect, indicating that greater female involvement in the labor market is associated with higher levels of human capital. This result aligns with the literature linking gender inclusion to improved household resources, education, and health outcomes. By contrast, urbanization, corruption, remittances, and R&D expenditure do not show statistically significant coefficients in these specifications. The diagnostics confirm model validity.

Table no. 7 – Social Determinants of HCI and LE - System GMM, OECD, 2000-2024

	(13) HCI	(14) LE
L.HCI / L.LE	0.939***	0.927***
	(0.031)	(0.041)
UrbanPop	-	-0.029
		(0.166)
Corruption	-	-0.274
		(0.300)
Remittances	-	0.364
		(0.372)
FemaleLabor	0.006***	0.687***
	(0.002)	(0.251)
RDExp	-0.012	-0.212
	(0.014)	(0.163)
Constant	0.058***	5.846*
	(0.020)	(3.232)
Observations	738	679
AR(1) p-value	0.001	0.001
AR(2) p-value	0.241	0.151
Hansen p-value	0.504	0.644
Sargan p-value	0.313	0.006

Note: Standard errors in parentheses. * p < 0.1, ** p < 0.05, *** p < 0.01
Source: authors computation using Stata 18.00

Diagnostic tests support model validity for the HCI equation. For the life expectancy model, AR (2) and Hansen statistics are acceptable, although the Sargan test indicates some instrument sensitivity, so results should be interpreted with caution.

5. ROBUSTNESS

The mixed models combine determinants identified in the separate perspectives (education, social, and health) in order to assess their joint contribution to human capital. These specifications serve as robustness checks rather than alternative structural models. The economic factors are excluded as they mainly capture the broader economic environment and our focus lies instead on the structural mechanisms through which human capital is accumulated. All variables in this sub-chapter, with the exception of health expenditure, are included in first differences, as they are non-stationary in levels and become stationary only after first differencing. For HCI, the integrated model includes the effective integration of advanced-educated labour (LabourAdvance), demographic dynamics (Fertility), female labour participation (FemaleLabour), and health expenditure (HealthExp). This specification captures the interaction between education utilization, social inclusion, demographic structure, and health conditions in shaping productive capacity.

$$HCI_{it} = \alpha HCI_{it-1} + \beta_1\, LaborAdvance_{it} + \beta_2\, Fertility_{it} + \beta_3\, FemaleLabor_{it} + \beta_4\, HealthExp_{it} + \varepsilon_{it} \quad (15)$$

where HC_{it}represents the Human Capital Index for country i in year t, $HC_{it-1}$is the lagged dependent variable capturing persistence in human capital, $LaborAdvance_{it}$denotes the share

of the labor force with advanced education, Fertility_{it} represents the fertility rate, FemaleLabor_{it}denotes female labor force participation, HealthExp_{it}represents public health expenditure, and $\varepsilon_{it}$is the error term.

For life expectancy, the integrated specification focuses on skill structure (LabourAdvance), urbanization (UrbanPop), and remittances (Remittances), which reflect the socio-economic environment influencing health outcomes. These variables represent the social and human capital context through which longevity evolves. Therefore, model nr 16 has the following equation:

$$LE_{it} = \alpha LE_{it-1} + \beta_1 \, LaborAdvance_{it} + \beta_2 UrbanPop_{it} + \beta_3 \, Remittances_{it} + \varepsilon_{it} \quad (16)$$

where LE_{it}denotes life expectancy at birth for country i in year t, $\text{LE}_{it-1}$is the lagged dependent variable capturing persistence in life expectancy, LaborAdvance_{it}represents the share of the labor force with advanced education, UrbanPop_{it}denotes the urban population share, Remittances_{it}represents remittance inflows, and $\varepsilon_{it}$is the error term.

Table no. 8 – Mixed Determinants of HCI and LE - System GMM, OECD, 2000-2024

	(15) HCI	(16) LE
L.HCI / L.LE	0.989***	1.131***
	(0.026)	(0.032)
LaborAdvance	0.002	0.069**
	(0.002)	(0.033)
Fertility	0.044*	-
	(0.024)	
UrbanPop		-0.218
		(0.216)
Remittances		0.166
		(0.126)
FemaleLabor	0.004***	-
	(0.002)	
HealthExp	-0.003**	-
	(0.001)	
Constant	0.055***	-10.025***
	(0.012)	(2.508)
Observations	756.000	772.000
AR(1) p-value	0.001	0.000
AR(2) p-value	0.218	0.176
Hansen p-value	0.553	0.057
Sargan p-value	0.417	0.310

Note: Standard errors in parentheses. * p < 0.1, ** p < 0.05, *** p < 0.01
Source: authors computation using Stata 18.00

Persistence remains the dominant feature. For HCI, fertility and female labour force participation display positive and statistically significant association. Health expenditure shows a small but statistically significant negative coefficient, while the remaining variables do not exhibit statistically significant contemporaneous effects in the combined specification.

These results indicate that demographic dynamics and social inclusion are more strongly associated with human capital accumulation than the other controls in this framework.

For LE (eq. 16), the skill structure of the labour force, proxied by the share of advanced-educated workers (LabourAdvance), shows a positive and statistically significant association. Urbanization and remittances do not display statistically significant effects in the integrated model. This suggests that the composition of the labour force is more strongly associated with longevity than the other included socio-economic controls in this specification. Diagnostic tests broadly support model validity. The AR (2) tests do not indicate second-order serial correlation, and Sargan statistics are acceptable. The Hansen statistic in the life expectancy equation is borderline, so results should be interpreted as robustness evidence rather than definitive structural relationships.

6. CONCLUSION

This paper contributes to the literature by examining the determinants of human capital and life expectancy in OECD countries through a multidimensional dynamic panel framework. Using annual data for the period 2000–2024 and applying the System GMM estimator, the analysis provides a comprehensive assessment of the economic, educational, health, and social factors shaping human capital development. By employing two complementary proxies – the Human Capital Index (HCI) and life expectancy (LE) – the study offers a broader perspective on human capital formation, capturing both skill accumulation and long-term health outcomes.

The empirical results reveal strong persistence in both human capital and life expectancy, indicating that these indicators evolve gradually and exhibit pronounced path dependence. This finding suggests that improvements in human capital are the result of long-term accumulation processes rather than short-term policy interventions. Countries with stronger human capital foundations tend to maintain their advantages over time, while those starting from lower levels require sustained and consistent policy efforts in order to close the gap.

The analysis also highlights important differences across the economic, educational, health, and social dimensions considered in the empirical models. Economic growth, measured through GDP per capita, shows a positive and significant relationship with life expectancy, confirming the well-established link between higher income levels and improved health outcomes. In contrast, fiscal variables such as government debt, taxation, and fiscal balance display limited short-term effects once the dynamic persistence of the dependent variables is accounted for. These results suggest that while fiscal conditions shape the macroeconomic environment, their direct influence on human capital outcomes may operate primarily through longer-term channels.

Education-related indicators emerge as important drivers of human capital accumulation. In particular, upper-secondary attainment and the share of the advanced-educated labor force are positively associated with human capital outcomes, highlighting the crucial role of investments in education and skill formation for long-term economic development. At the same time, the relatively weak short-run effects of education expenditure suggest that the benefits of educational investments materialize gradually and require sustained policy commitment over time. Expanding access to education and improving educational quality therefore remain essential for strengthening human capital in advanced economies.

Health-related determinants display more complex patterns. Health expenditure and healthcare infrastructure indicators show mixed effects across the estimated models,

suggesting that the efficiency and allocation of healthcare resources may be more important than the overall level of spending. In addition, demographic variables such as fertility appear to influence human capital outcomes indirectly, highlighting the importance of demographic dynamics in shaping long-term development trajectories. These results underline the need for balanced health policies that focus not only on the volume of spending but also on the efficiency and effectiveness of healthcare systems.

Among the social determinants, female labor force participation emerges as one of the most robust and consistent drivers of both human capital accumulation and life expectancy. This finding emphasizes the central role of gender inclusion in fostering economic productivity and human capital development. Policies that promote equal opportunities, flexible working arrangements, and improved work–life balance can therefore contribute significantly to strengthening the human capital base of modern economies. In contrast, other social variables such as remittances, corruption, urbanization, and R&D expenditure show weaker or context-dependent effects, suggesting that their influence may depend on institutional quality or may materialize over longer time horizons.

Taken together, the results highlight the strong interdependence between education, health, and social inclusion in shaping human capital outcomes. Human capital formation should therefore be understood as a multidimensional process that requires coordinated policy strategies across several domains. Governments aiming to strengthen their human capital base should prioritize improving education quality and skills relevance, ensuring a better alignment between education systems and labor market needs. In the health sector, the focus should shift from the volume of spending toward efficiency, including better allocation of medical personnel and reducing disparities in access to healthcare services. In addition, policies supporting female labor force participation – such as access to childcare and flexible work arrangements – can further enhance human capital accumulation.

This study contributes to the literature by providing a comprehensive empirical assessment of the determinants of human capital using a broad set of socio-economic indicators and by comparing two complementary measures of human capital within a unified econometric framework. By distinguishing between economic, educational, health, and social determinants, the analysis offers a more nuanced understanding of the mechanisms that shape human capital development in advanced economies.

Despite the contributions of this study, several avenues remain open for future research. First, the present analysis focuses on OECD countries, which are characterized by relatively high levels of institutional development and human capital accumulation. Extending the analysis to developing and emerging economies could provide valuable insights into whether the determinants of human capital formation operate differently across stages of economic development. Comparative studies between advanced and developing economies may help identify structural differences in the relative importance of economic, educational, health, and social factors.

Second, while the System GMM estimator is appropriate for addressing endogeneity and dynamic persistence in panel data, future research could explore potential non-linear relationships between human capital determinants and development outcomes. In particular, panel threshold models or non-linear dynamic panel techniques could be used to identify critical levels of education, health expenditure, or economic development beyond which their impact on human capital or life expectancy becomes more pronounced.

Thirdly, future studies could therefore complement macroeconomic analyses with micro-level or household-level data in order to better understand how individual socio-

economic characteristics, such as income, education, labor market participation, and demographic conditions, shape human capital accumulation and health outcomes.

Finally, further research could incorporate additional structural determinants that are becoming increasingly relevant in modern economies, such as technological progress, digitalization, institutional quality and innovation capacity. Understanding how these factors interact with traditional drivers of human capital formation, including education systems, healthcare infrastructure and labor market participation, may provide a more comprehensive picture of the long-term mechanisms shaping human capital development.

Acknowledgements

We would like to express our sincere gratitude to the two anonymous reviewers for their valuable comments and constructive suggestions, which significantly improved the quality of this manuscript. We also gratefully acknowledge the participants of the 17th International Conference on Globalization and Higher Education in Economics and Business Administration (GEBA 2025) and the 5th Cluj Economics and Business Conference (CEBC 2025) for their insightful feedback and valuable discussions, which contributed to the development and improvement of this research.

ORCID

Anca Maria Ungureanu https://orcid.org/0009-0000-4597-8211
Monica Ioana Pop-Silaghi https://orcid.org/0000-0001-8287-9829

References

Abdouli, M., & Omri, A. (2021). Exploring the Nexus Among FDI Inflows, Environmental Quality, Human Capital, and Economic Growth in the Mediterranean Region. *Journal of the Knowledge Economy, 12*(3), 788–810. http://dx.doi.org/10.1007/s13132-020-00641-5

Abraham, K. G., & Mallatt, J. (2022). Measuring Human Capital. *The Journal of Economic Perspectives, 36*(3), 103–130. http://dx.doi.org/10.1257/jep.36.3.103

Affandi, Y., Anugrah, D. F., & Bary, P. (2019). Human Capital and Economic Growth Across Regions: A Case Study in Indonesia. *Eurasian Economic Review, 9*(3), 331–347. http://dx.doi.org/10.1007/s40822-018-0114-4

Aka, B. F., & Dumont, J. C. (2008). Health, Education and Economic Growth: Testing for Long-Run Relationships and Causal Links in the United States. *Applied Econometrics and International Development, 8*(2), 101–110.

Akyıldız, İ. E., Başkol, M. O., & Eryiğit, K. Y. (2025). The Relationship Between Brain Drain and Human Capital: Evidence from Turkey. *International Journal of Manpower, 46*(8), 1546–1562. http://dx.doi.org/10.1108/IJM-08-2024-0566

Alataş, S., & Çakir, M. (2016). The Effect of Human Capital on Economic Growth: A Panel Data Analysis. *The Journal of American Science, 14*(27), 539–555.

Amuedo-Dorantes, C., & Pozo, S. (2013). Remittances and Portfolio Values: An Inquiry using Immigrants from Africa, Europe, and the Americas. *World Development, 41*(C), 83–95. http://dx.doi.org/10.1016/j.worlddev.2012.05.036

Andvig, J., & Fjeldstad, O. (2001). *Corruption: a review of contemporary research*. Retrieved from Bergen: Chr. Michelsen Institute: https://www.cmi.no/publications/861-corruption-a-review-of-contemporary-research

Arellano, M., & Bond, S. (1991). Some Tests of Specification for Panel Data: Monte Carlo Evidence and an Application to Employment Equations. *The Review of Economic Studies, 58*(2), 277–297. http://dx.doi.org/10.2307/2297968

Arellano, M., & Bover, O. (1995). Another Look at the Instrumental Variable Estimation of Error-Components Models. *Journal of Econometrics, 68*(1), 29–51. http://dx.doi.org/10.1016/0304-4076(94)01642-D

Arnold, J. M. (2008). Do Tax Structures Affect Aggregate Economic Growth?: Empirical Evidence from a Panel of OECD Countries. *OECD Economics Department Working Papers, 2008*(51). http://dx.doi.org/10.1787/18151973

Arouri, M., Ben Youssef, A., Nguyen-Viet, C., & Soucat, A. (2014). *Effects of Urebanization on Economic Growth and Human Capital Formation in Africa*: HAL Open Science.

Aslam, A. (2020). The Hitky Debate of Human Capital and Economic Growth: Why Institutions May Matter? *Quality & Quantity, 54*(4), 1351–1362. http://dx.doi.org/10.1007/s11135-020-00989-5

Bal, H. Ç. (2024). Do Education Expenditures Affect Economic Growth? Testing with Panel Data Analyis Method. *Ankara Hacı Bayram Veli Üniversitesi İktisadi ve İdari Bilimler Fakültesi Dergisi, 26*(3), 893–914. http://dx.doi.org/10.26745/ahbvuibfd.1539155

Baldacci, E., Clements, B., Gupta, S., & Cui, Q. (2008). Social Spending, Human Capital, and Growth in Developing Countries: Implications for Achieving the MDGs. *World Development*. http://dx.doi.org/10.1016/j.worlddev.2007.08.003

Barro, R., & Lee, J. (1996). International Measures of Schooling Years and Schooling Quality. *The American Economic Review, 86*(23), 218–223.

Barro, R. J. (1991). Economic Growth in a Cross Section of Countries. *The Quarterly Journal of Economics, 106*(2), 407–433. http://dx.doi.org/10.2307/2937943

Becker, G. S. (1966). Human Capital: A Theoretical and Empirical Analysis with Special Reference to Education. *The Economic Journal, 76*(303), 635–638. http://dx.doi.org/10.2307/2229541

Bloom, D., & Canning, D. (2003). Health as Human Capital and its Impact on Economic Performance. *The Geneva Papers on Risk and Insurance - Issues and Practice, 28*(2), 304–315. http://dx.doi.org/10.1111/1468-0440.00225

Bloom, D. E., Canning, D., & Sevilla, J. (2004). The Effect of Health on Economic Growth: A Production Function Approach. *World Development, 32*(1), 1–13. http://dx.doi.org/10.1016/j.worlddev.2003.07.002

Blundell, R., & Bond, S. (1998). Initial Conditions and Moment Restrictions in Dynamic Panel Data Models. *Journal of Econometrics, 87*(1), 115–143. http://dx.doi.org/10.1016/S0304-4076(98)00009-8

Bucheli, J. R., Bohara, A. K., & Fontenla, M. (2018). Mixed Effects of Remittances on Child Education. *IZA Journal of Development and Migration, 8*(10), 1–18. http://dx.doi.org/10.1186/s40176-017-0118-y

Cervellati, M., & Sunde, U. (2011). Life Expectancy and Economic Growth: The Role of the Demographic Transition. *Journal of Economic Growth, 16*(2011), 99–133. http://dx.doi.org/10.1007/s10887-011-9065-2

Christian, M. S. (2010). Human Capital Accounting in the United States, 1964–2006. *Survey of Current Business, 90*(6), 31–36.

Christian, M. S. (2014). Human Capital Accounting in the United States: Context, Measurement, and Application. In J. S. Landefeld, D. W. Jorgenson, & P. Schreyer (Eds.), *Measuring Economic Sustainability and Progress* (Vol. 72, pp. 461–491): University of Chicago Press.

Cuevas Ahumada, V. M., & Calderón, V. C. (2020). Human Capital Formation and Economic Growth Across the World: A Panel Data Econometric Approach. *Economía, Sociedad y Territorio, 20*(62), 25–54. http://dx.doi.org/10.22136/est20201466

Dada, J. T., Adeiza, A., Ismail, N. A., & Marina, A. (2022). Investigating the Link between Economic Growth, Financial Development, Urbanization, Natural Resources, Human Capital, Trade Openness and Ecological Footprint: Evidence from Nigeria. *Journal of Bioeconomics, 24*(2), 153–179. http://dx.doi.org/10.1007/s10818-021-09323-x

Dhrifi, A., Alnahdi, S., & Jaziri, R. (2021). The Causal Links Among Economic Growth, Education and Health: Evidence from Developed and Developing Countries. *Journal of the Knowledge Economy, 12*(3), 1477–1493. http://dx.doi.org/10.1007/s13132-020-00678-6

Diakodimitriou, D., Tsioutsios, A., & Papageorgiou, T. (2025). Education Expenditures and Growth: Is R&D the Link? *Journal of Policy Modeling, 47*(2), 322–337. http://dx.doi.org/10.1016/j.jpolmod.2025.01.003

Docquier, F., & Rapoport, H. (2011). *Globalization, Brain Drain and Development*. Retrieved from SSRN: https://ssrn.com/abstract=1796585

Dumitrescu, E. I., & Hurlin, C. (2012). Testing for Granger Non-Causality in Heterogeneous Panels. *Economic Modelling, 29*(4), 1450–1460. http://dx.doi.org/10.1016/j.econmod.2012.02.014

Ehrlich, I., & Lui, F. (1999). Bureaucratic Corruption and Endogenous Economic Growth. *Journal of Political Economy, 107*(S6), 270–293. http://dx.doi.org/10.1086/250111

Eisner, R. (1978). Total Incomes in the United States, 1959 and 1969. *Review of Income and Wealth, 24*(1), 41–70. http://dx.doi.org/10.1111/j.1475-4991.1978.tb00031.x

Eisner, R. (1985). The Total Incomes System of Accounts. *Survey of Current Business, 65*(1), 24–48.

Fayyaz, A., & Bartha, Z. (2025). Research and Development as a Driver of Innovation and Economic Growth; Case of Developing Economies. *Journal of Social and Economic Development, 12*(2), 1–21. http://dx.doi.org/10.1007/s40847-025-00438-9

Freckleton, L., Wright, A., & Craigwell, R. (2012). Economic Growth, Foreign Direct Investment an Corruption in Developed and Developing Countries. *Journal of Economic Studies (Glasgow, Scotland), 39*(6), 639–652. http://dx.doi.org/DOI:10.1108/01443581211274593

Gao, X., Kikkawa, A., & Kang, J. W. (2021). Evaluating the Impact of Remittances on Human Capital Investment in the Kyrgyz Republic. *ADB Economics Working Paper Series.* , 42. http://dx.doi.org/10.22617/WPS210189-2

Garza-Rodriguez, J., Almeida-Velasco, N., Gonzalez-Morales, S., & Leal-Ornelas, A. P. (2020). The Impact of Human Capital on Economic Growth: The Case of Mexico. *Journal of the Knowledge Economy, 11*(2), 660–675. http://dx.doi.org/10.1007/s13132-018-0564-7

Giyasova, Z., Mursalov, M., Hajiyev, J., Amowine, N., & Panahova, G. (2025). The Role of R&D Expenditure and Human Capital in Shaping Economic Growth: A Time Eeries Analysis of Hong-Kong. *Problems and Perspectives in Management, 23*(3), 218–231. http://dx.doi.org/10.21511/ppm.23(3).2025.16

Goldin, C. (1994). The U-shaped Female Labor Force Function in Economic Development and Economic History. *NBER Working Paper 4707*. http://dx.doi.org/10.3386/w4707

Gu, W., & Wong, A. (2015). Productivity and Economic Output of the Education Sector. *Journal of Productivity Analysis, 43*(2), 165–182. http://dx.doi.org/10.1007/s11123-014-0414-y

Gupta, S. (2018). Income Inequality and Fiscal Policy: Agenda for Reform in Developing Countries. *Growth and Reduce Income Inequality Series Working Paper*.

Gyimah-Brempong, K., & Asiedu, E. (2015). Remittances and Investment in Education: Evidence from Ghana. *The Journal of International Trade & Economic Development, 24*(2), 173–200. http://dx.doi.org/10.1080/09638199.2014.881907

Hanushek, E. A., & Woessmann, L. (2008). The Role of Cognitive Skills in Economic Development. *Journal of Economic Literature, 46*(3), 607–668. http://dx.doi.org/10.1257/jel.46.3.607

Harberger, A. C. (1964). The Measurement of Waste. *The American Economic Review, 54*(3), 58–76.

He, Q. (2018). Inflation and Innovation with a Cash-in-Advance Constraint on Human Capital Accumulation. *Economics Letters, 171*(C), 14–18. http://dx.doi.org/10.1016/j.econlet.2018.07.010

Heath, R., Bernhardt, A., Borker, G., Fitzpatrick, A., Keats, A., McKelway, M., . . . Sharma, G. (2024). Female Labour Force Participation. *VoxDevLit, 11*(1), 1–43.

Heckman, J., Lochner, L., & Taber, C. (1998). Tax Policy and Human Capital Formation. *American Economic Review 88*(2), 293–297. http://dx.doi.org/10.3386/w6462

Herzer, D. (2017). Life Expectancy and Human Capital: Long-Run Evidence from a Panel of Countries. *Applied Economics Letters, 24*(17), 1247–1250. http://dx.doi.org/10.1080/13504851.2016.1270405

Heylen, F., Pozzi, L., & Vandewege, J. (2004). *Inflation Crises, Human Capital Formation and Growth*. Hoveniersberg: Faculteit Economie en Bedrijfskunde, Univ. Gent.

Islam, M. S., & Alam, F. (2022). Influence of Human Capital Formation on the Economic Growth in Bangladesh During 1990–2019: An ARDL Approach. *Journal of the Knowledge Economy, 14*(3), 3010–3027. http://dx.doi.org/10.1007/s13132-022-00998-9

Jayachandran, S., & Lleras-Muney, A. (2009). Life Expectancy and Human Capital Investments: Evidence from Maternal Mortality Declines. *The Quarterly Journal of Economics, 124*(1), 349–397. http://dx.doi.org/10.1162/qjec.2009.124.1.349

Jemiluyi, O. O., & Jeke, L. (2024). The Role of Human Capital Development in Urbanization-Economic Growth. *Sustainable Futures : An Applied Journal of Technology, Environment and Society, 8*(1), 1–10. http://dx.doi.org/10.1016/j.sftr.2024.100266

Jensen, R. (2012). Do Labor Market Opportunities Affect Young Women's Work and Family Decisions? Experimental Evidence from India. *The Quarterly Journal of Economics, 127*(2), 753–792. http://dx.doi.org/10.1093/qje/qjs002

Jones, G., & Schneider, W. J. (2006). Intelligence, Human Capital, and Economic Growth: A Bayesian Averaging of Classical Estimates (BACE) Approach. *Journal of Economic Growth, 11*(1), 71–93. http://dx.doi.org/10.1007/s10887-006-7407-2

Jorgenson, D. W., & Fraumeni, B. M. (1989). The Accumulation of Human and Non-Human Capital, 1948–84. In R. E. Lipsey & H. S. Tice (Eds.), *The Measurement of Saving, Investment, and Wealth* (pp. 227–286): University of Chicago Press. http://dx.doi.org/10.2307/3440246

Jorgenson, D. W., & Fraumeni, B. M. (1992). Investment in Education and U.S. Economic Growth. *The Scandinavian Journal of Economics, 94*(Supplement), S51–S70. http://dx.doi.org/10.2307/3440246

Kendrick, J. W. (1976). The Formation and Stocks of Total Capital *NBER Books*: National Bureau of Economic.

Khan, J. A., Ganai, S. G., & Bhat, S. A. (2022). Human Capital Determinants and Economic Growth in Jammu and Kashmir: An Empirical Analysis. *Indian Journal of Economics and Development, 18*(4), 900–907. http://dx.doi.org/10.35716/IJED/21096

Kleven, H., Landais, C., Posch, J., Steinhauer, A., & Zweimüller, J. (2019). *Child Penalties across Countries.* Paper presented at the AEA Conference.

Kugler, M. (2006). *Migrant Remittances, Human Capital Formation and Job Creation. Externalities in Columbia*: Coyuntura Social. http://dx.doi.org/10.32468/be.370

Le Clech, N. A. (2025). Macroeconomic and Institutional Determinants of Human Capital Wealth: Gender Disparities and Implications. *Economia Politica (Bologna), 42*(1), 121–153. http://dx.doi.org/DOI:10.1007/s40888-024-00355-w

Ljungberg, J. (2024). Competitive Devaluations in the 1930s: Myth or Reality? *Cliometrica 18*(1), 151–189. http://dx.doi.org/10.1007/s11698-022-00262-9

Lucas, R. E. (1988). On the Mechanics of Economic Development. *Journal of Monetary Economics, 22*(1), 3–42. http://dx.doi.org/10.1016/0304-3932(88)90168-7

Maitra, B., & Chakraborty, M. (2021). International Trade, Human Capital and Economic Growth in Sri Lanka. *International Journal of Economic Policy Studies, 15*(2), 405–426. http://dx.doi.org/10.1007/s42495-021-00065-2

Männasoo, K., Hein, H., & Ruubel, R. (2018). The Contributions of Human Capital, R&D Spending and Convergence to Total Factor Productivity Growth. *Regional Studies, 52*(12), 1598–1611. http://dx.doi.org/10.1080/00343404.2018.1445848

Mauro, P. (1995). Corruption and Growth. *The Quarterly Journal of Economics, 110*(3), 681–712. http://dx.doi.org/10.2307/2946696

Mohamed Sghaier, I. (2022). Foreign Capital Inflows and Economic Growth in North African Countries: The role of Human Capital. *Journal of the Knowledge Economy, 13*(4), 2804–2821. http://dx.doi.org/10.1007/s13132-021-00843-5

Mubarik, M. S., Bontis, N., Mubarik, M., & Mahmood, T. (2022). Intellectual Capital and Supply Chain Resilience. *Journal of Intellectual Capital, 23*(3), 713–738. http://dx.doi.org/10.1108/JIC-06-2020-0206

Murphy, K., Shleifer, A., & Vishny, R. (1991). Allocation of Talent: Implications for Growth. *The Quarterly Journal of Economics, 106*(2), 503–530. http://dx.doi.org/10.2307/2937945

Nouira, R., & Saafi, S. (2022). What Drives the Relationship Between Export Upgrading and Growth? The Role of Human Capital, Institutional Quality and Economic Development. *Journal of the Knowledge Economy, 13*(3), 1944–1961. http://dx.doi.org/10.1007/s13132-021-00788-9

Ogundari, K., & Awokuse, T. (2018). Human Capital Contribution to Economic Growth in Sub-Saharan Africa: Does Health Status Matter More than Education? *Economic Analysis and Policy, 58*(6), 131–140. http://dx.doi.org/10.1016/j.eap.2018.02.001

Olson, M., Sarna, N., & Swamy, A. (2000). Governance and Growth: A Simple Hypothesis Explaining Cross-Country Differences in Productivity Growth. *Public Choice, 102*(3-4), 341–364. http://dx.doi.org/10.1023/A:1005067115159

Pelinescu, E. (2015). The Impact of Human Capital on Economic Growth. . *Procedia Economics and Finance, 22*(2015), 184–190. http://dx.doi.org/10.1016/S2212-5671(15)00258-0

Pop-Silaghi, P. M., Alexa, D., Jude, C., & Litan, C. (2014). Do Bsiness and Public Sector Research and Development Expenditures Contribute to Economic Growth in Central and Eastern European Countries? A Dynamic Panel Estimation. *Economic Modelling, 36*(C), 108–119. http://dx.doi.org/10.1016/j.econmod.2013.08.035

Raheem, I. D., Isah, K. O., & Adedeji, A. A. (2018). Inclusive Growth, Human Capital Development and Natural Resource Rent in SSA. *Economic Change and Restructuring, 51*(1), 29–48. http://dx.doi.org/10.1007/s10644-016-9193-y

Rahim, S., Murshed, M., Umarbeyli, S., Kirikkaleli, D., Ahmad, M., Tufail, M., & Wahab, S. (2021). Do Natural Resources Abundance and Human Capital Development Promote Economic Growth? A Study on the Resource Curse Hypothesis in Next Eleven Countries. *Resources, Environmental and Sustainability, 4*(June), 100018. http://dx.doi.org/10.1016/j.resenv.2021.100018

Rahman, P., Zhang, Z., & Musa, M. (2023). Do Technological Innovation, Foreign Investment, Trade and Human Capital have a Symmetric Effect on Economic Growth? Novel Dynamic ARDL Simulation Study on Bangladesh. *Economic Change and Restructuring, 56*(2), 1327–1366. http://dx.doi.org/10.1007/s10644-022-09478-1

Reinhart, C. M., & Rogoff, K. S. (2010). *Growth in Time of Debt*. Massachusetts National Bureau of Economic Research. http://dx.doi.org/10.3386/w15639

Ross, C. E., & Wu, C. (1995). The Links Between Education and Health. *American Sociological Review, 60*(5), 719–745. http://dx.doi.org/10.2307/2096319

Smith, A. (1776). *An Inquiry into the Nature and Causes of the Wealth of Nations*. Edinburg, London: Strahan and T. Cadell.

Sultana, T., Dey, S. R., & Tareque, M. (2022). Exploring the Linkage between Human Capital and Economic Growth: A Look at 141 Developing and Developed Countries. *Economic Systems, 46*(3), 101017. http://dx.doi.org/10.1016/j.ecosys.2022.101017

Tanzi, V., & Zee, H. H. (1997). Fiscal Policy and Long-Run Growth. *Staff Papers - International Monetary Fund. International Monetary Fund, 44*(2), 179–209. http://dx.doi.org/10.2307/3867542

Teixeira, A. A., & Fortuna, N. (2004). Human Capital, Innovation Capability and Economic Growth in Portugal, 1960–2001. *Portuguese Economic Journal, 3*(2), 205–225. http://dx.doi.org/10.1007/s10258-004-0037-8

The World Bank. (2018). The Human Capital Project. *The Human Capital Project.* Retrieved from https://www.worldbank.org/en/publication/human-capital

Treisman, D. (2000). The Cause of Corruption: A Cross National Study. *Journal of Public Economics, 76*(3), 399–457. http://dx.doi.org/10.1016/S0047-2727(99)00092-4

World Economic Forum. (2017). *The Global Human Capital Report 2017: Preparing people for the future of work*. Retrieved from https://www3.weforum.org/docs/WEF_Global_Human_Capital_Report_2017.pdf

ANNEX

Table no. A1 – Variables and Data Sources

Variables	Notation	Description (defined by the issuer)	Data source
Dependent variables			
Human Capital Index	HC	The amount of human capital a child born today can expect to attain by age 18, given the risks of poor education and health.	The World Bank - World Development Indicators (WDI)(http://info.worldbank.org/governance/wgi/)
Life Expectancy At Birth, total (years)	LE	The number of years a newborn infant would live if prevailing patterns of mortality at the time of its birth were to stay the same throughout its life.	The World Bank - World Development Indicators (WDI)(http://info.worldbank.org/governance/wgi/)
Independent variables			
Gdp Per Capita (constant US$)	GDP	The gross domestic product (GDP) divided by mid-year population, adjusted for inflation to a base year (e.g., 2015).	The World Bank - World Development Indicators (WDI)(http://info.worldbank.org/governance/wgi/)
Consumer Price Index (annual %)	Inflation	The yearly percentage change in the cost of a basket of goods and services to the average consumer.	The World Bank - World Development Indicators (WDI)(http://info.worldbank.org/governance/wgi/)
Central Government Debt (% of GDP)	GovDebt	The entire stock of direct government fixed-term contractual obligations to others outstanding on a particular date.	The World Bank - World Development Indicators (WDI)(http://info.worldbank.org/governance/wgi/)
Central Government Budget Balance (% of GDP)	Budget	Current and capital revenue and official grants received, less total expenditure and lending minus repayments.	The World Bank - World Development Indicators (WDI)(http://info.worldbank.org/governance/wgi/)
Distortionary Vs. Consumption Tax Mix (%)	Taxes	Average of: (i) taxes on income, profits, and capital gains (% of revenue), and (ii) taxes on goods and services (% of revenue).	Constructed variable based on - The World Bank - World Development Indicators (WDI)(http://info.worldbank.org/governance/wgi/)
Public Expenditure On Education (% of GDP).	EdExp	General government expenditure on education.	The World Bank - World Development Indicators (WDI)(http://info.worldbank.org/governance/wgi/)
Share Of Population With Upper Secondary Education (%).	Upper	The percentage of population ages 25 and over that attained or completed upper secondary education.	The World Bank - World Development Indicators (WDI)(http://info.worldbank.org/governance/wgi/)
Share Of Labour Force With Advanced Education (%)	Labour Advance	The percentage of the working age population with an advanced level of education* who are in the labour force.	The World Bank - World Development Indicators (WDI)(http://info.worldbank.org/governance/wgi/)
Public health expenditure (% of GDP).	HealthExp	The sum of public and private health expenditure.	The World Bank - World Development Indicators (WDI)(http://info.worldbank.org/governance/wgi/)
Medical Infrastructure	BedsDoctors	Average between the number of doctors and number of beds per 1000 inhabitants.	Constructed variable based on The World Bank - World Development Indicators (WDI)(http://info.worldbank.org/governance/wgi/)

Variables	Notation	Description (defined by the issuer)	Data source
Fertility Rate, Total (births per woman)	Fertility	The number of children that would be born to a woman if she were to live to the end of her childbearing years.	The World Bank - Worldwide Governance Indicators (http://info.worldbank.org/governance/wgi/)
Labour Force, Female (% of total labour force)	FemaleLabour	Female labour force participation rate (% of female population ages 15+).	The World Bank - World Development Indicators (WDI)(http://info.worldbank.org/governance/wgi/)
Urban Population	Urban	The share of the total population living in areas defined as urban.	The World Bank - World Development Indicators (WDI)(http://info.worldbank.org/governance/wgi/)
Corruption Perceptions Index	Corruption	It scores and ranks countries by their perceived levels of public sector corruption	The World Bank - World Development Indicators (WDI)(http://info.worldbank.org/governance/wgi/)
Personal remittances received (% of GDP).	Remittances	Personal transfers and compensation of employees—household income from foreign economies sent by migrants.	The World Bank - World Development Indicators (WDI)(http://info.worldbank.org/governance/wgi/)
Research and development expenditure (%)	RDRxp	The gross domestic expenditures on research and development.	The World Bank - World Development Indicators (WDI)(http://info.worldbank.org/governance/wgi/)

Note: * Advanced education comprises short-cycle tertiary education, a bachelor's degree or equivalent education level, a master's degree or equivalent education level, or doctoral degree or equivalent education level according to the International Standard Classification of Education 2011 (ISCED 2011).
Source: Authors' processing.

Table no. A1 – Percentile Distribution of the Variables

	1st Perc.	p5	p25	Median	p75	p95	99th Perc.	Min	Max
HCI	0	.155	0.469	.669	.824	.933	.963	0	1
Life	70.9	72.7	76.9	79.6	81.41	83.007	83.883	69.75	84.56
GDP	5046.9	7915.5	14703.6	31611.2	44391.4	74729.7	106544.0	4016.8	112417.8
GovDebt	4.8	14.7	45.4	67.3	101.5	186.7	215.8	3.8	249.3
Taxes	19.0	21.7	25.0	27.3	30.1	38.8	41.5	18.0	48.1
Budget	-12.8	-8.3	-4.1	-2.1	.07	4.4	14.1	-32.1	26.3
Inflation	-.92	-.18	1.2	2.4	3.8	9.6	19.5	-4.4	72.3
EdExp	3.2	3.5	4.3	5.0	5.7	7.5	8.2	2.6	8.5
Upper	21.0	30.2	52.8	74.8	82.1	88.7	91.1	15.7	95.2
LaborAdvance	68.4	72.7	76.2	79.4	82.1	86.8	91.3	65.7	94.8
HealthExp	4.3	5.23	6.7	8.1	9.7	11.4	16.2	3.7	18.8
Fertility	1.1	1.2	1.3	1.6	1.8	2.3	3.0	.72	3.1
BedsDoctors	1.3	1.6	3.2	3.8	4.9	6.	13.1	1.2	14.6
UrbanPop	52.2	55.5	67.8	76.9	83.6	93.1	97.9	50.7	98.2
Corruption	-1.5	-.44	0.37	1.01	1.79	2.24	2.39	-1.70	2.45
Remittances	.01	.034	0.21	.49	1.37	3.03	4.56	0	6.17
FemaleLabor	27.1	38.6	49.1	53.1	56.9	62.1	71.6	23.1	73.4
RDExp	.18	.35	0.91	1.59	2.52	3.58	4.79	.13	6.01

Table no. A2 – Simple Correlations between the economic variables

Variables	(1)	(2)	(3)	(4)	(5)	(6)	(7)
(1) HC	1.000						
(2) Life	0.855	1.000					
	(0.000)						
(3) GDP	0.559	0.602	1.000				
	(0.000)	(0.000)					
(4) Inflation	-0.288	-0.291	-0.221	1.000			
	(0.000)	(0.000)	(0.000)				
(5) GovDebt	0.281	0.358	-0.008	-0.164	1.000		
	(0.000)	(0.000)	(0.852)	(0.000)			
(6) Taxes	0.146	0.165	0.249	0.012	-0.151	1.000	
	(0.000)	(0.000)	(0.000)	(0.732)	(0.001)		
(7) Budget	0.148	0.090	0.339	-0.008	-0.482	0.137	1.000
	(0.000)	(0.008)	(0.000)	(0.818)	(0.000)	(0.000)	

Table no. A3 – Pairwise correlations between the education-related variables

Variables	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
(1) HC	1.000							
(2) Life	0.855	1.000						
	(0.000)							
(3) EdExp	0.245	0.166	1.000					
	(0.000)	(0.000)						
(4) Doctoral	0.289	0.331	0.052	1.000				
	(0.000)	(0.000)	(0.295)					
(5) Master	0.254	0.140	-0.054	0.635	1.000			
	(0.000)	(0.003)	(0.284)	(0.000)				
(6) Upper	0.464	0.194	0.182	0.335	0.442	1.000		
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)			
(7) LaborAdvance	0.013	0.019	0.280	-0.007	-0.001	-0.118	1.000	
	(0.711)	(0.588)	(0.000)	(0.882)	(0.988)	(0.003)		
(8) Literacy	0.071	0.022	0.397	0.000	-0.060	-0.036	-0.136	1.000
	(0.471)	(0.826)	(0.000)	(0.999)	(0.651)	(0.724)	(0.176)	

Table no. A4 – Pairwise correlations between the health variables

Variables	(1)	(2)	(3)	(4)	(5)
(1) HC	1.000				
(2) Life	0.855	1.000			
	(0.000)				
(3) HealthExp	0.418	0.529	1.000		
	(0.000)	(0.000)			
(4) Fertility	-0.146	-0.042	-0.057	1.000	
	(0.000)	(0.202)	(0.087)		
(5) BedsDoctors	0.191	0.146	0.097	-0.455	1.000
	(0.000)	(0.000)	(0.005)	(0.000)	

Table no. A5 – Pairwise correlations between the social variables

Variables	(1)	(2)	(3)	(4)	(5)	(6)	(7)
(1) HC	1.000						
(2) Life	0.855	1.000					
	(0.000)						
(3) UrbanPop	0.189	0.162	1.000				
	(0.000)	(0.000)					
(4) Corruption	0.045	0.100	0.463	1.000			
	(0.189)	(0.003)	(0.000)				
(5) Remittances	-0.225	-0.502	-0.037	-0.205	1.000		
	(0.000)	(0.000)	(0.253)	(0.000)			
(6) FemaleLabor	0.531	0.373	0.256	0.163	-0.169	1.000	
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)		
(7) RDExp	0.523	0.581	0.255	0.097	-0.388	0.421	1.000
	(0.000)	(0.000)	(0.000)	(0.007)	(0.000)	(0.000)	