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Human Capital: Determinants, Structural Change and Income Convergence in the Context of Economic Growth - Empirical Evidence

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Cluj-Napoca
2026

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Summary

Economic convergence has long been a central topic in growth theory and empirical macroeconomics. Since the early research of Solow (1956) and Swan (1956), the economic theory has suggested that economies starting from lower income levels tend to expand more quickly than wealthier ones, since the capital becomes less productive as it accumulates. This theoretical framework was afterwards formalized through the concepts of β-convergence and σ-convergence described by Barro and Sala-i-Martin (1992), which became widely used in growth studies. However, later research has shown that convergence is not automatic. Instead, it depends on structural characteristics, institutional quality, and the accumulation of human capital (Mankiw, Romer, & Weil, 1992; Quah, 1995).

Within the European Union, convergence has gained more significance due to successive waves of enlargement, the transition of post-socialist economies, and the deepening of economic and financial integration. Several empirical studies document substantial catch-up among Central and Eastern European economies after 2000 (Matkowski & Próchniak, 2007; Holobiuc, 2020; Monfort, 2020). However, researchers like Cieślik (2020) or Pina and Sicari (2021) draw attention to structural asymmetries and heterogeneous growth trajectories. In addition, recent geoeconomic challenges, including the COVID-19 pandemic and the geopolitical tensions generated by the war in Ukraine, alongside trade fragmentation and energy security risks, have significantly reshaped Europe's economic environment. In this context, we may ask whether convergence is sustainable and what factors influence it.

Human capital emerges as a key determinant, given its fundamental role in supporting productivity, structural transformation, and long-run economic performance. Traditional approaches have emphasized the quantity dimension of human capital, typically proxied by years of schooling or educational attainment (Barro & Lee, 2010). However, an increasing number of studies demonstrate that cognitive skills and education quality could have a stronger influence on productivity and economic growth than schooling inputs alone (Hanushek & Woessmann, 2008; Valente, Salavisa, & Lagoa, 2015). Despite this expanding evidence, the convergence literature rarely integrates both education quantity and education quality within a unified framework.

This dissertation investigates the degree to which economic convergence and growth is driven by human capital in advanced economies and whether education quality plays a more decisive role than education quantity in shaping long-run growth and structural

transformation. Although Eastern European economies have exhibited faster growth rates since the early 2000s, substantial income gaps relative to Western Europe persist. Moreover, convergence dynamics appear heterogeneous and sensitive to structural and geopolitical shocks. We therefore decided to bring together economic growth, structural change, and human capital, considered in both its qualitative and quantitative dimensions, within a single analytical framework.

The general objective of this thesis is to analyze the role of human capital, particularly its qualitative dimension, in shaping economic growth, structural transformation, and convergence dynamics. Given the multidimensional nature of these topics, the individual papers rely on different country samples, including EU countries, OECD countries, and the intersection between EU and OECD economies, as well as different time periods, depending on data availability and the specific empirical methodology employed. More specifically, the thesis examines long-run convergence patterns between Eastern and Western Europe, explores the relationship between human capital and structural transformation, evaluates the relative importance of education quality and education quantity for economic growth, and analyzes the main factors associated with human capital accumulation.

The empirical strategy combines several complementary methodologies. Convergence dynamics are analyzed using σ-convergence and β-convergence described by Barro and Sala-i-Martin (1992) and the Phillips–Sul (2007) club-convergence methodology. The impact of human capital on growth is analyzed using panel Autoregressive Distributed Lag (ARDL) models estimated through the Pooled Mean Group (PMG) estimator in order to distinguish between long-run equilibrium relationships and short-run dynamics. In addition, dynamic panel estimations are conducted using the Generalized Method of Moments (GMM) framework (1991) to address potential endogeneity and to model the determinants of human capital accumulation. This combination of techniques allows for a multidimensional assessment of convergence and growth processes.

The thesis extends prior research through several key contributions. Firstly, it provides an updated and unified assessment of convergence among EU–OECD countries over the period 1980–2024, identifying structural breaks and convergence patterns. Secondly, it explicitly distinguishes between education quantity and education quality, showing that cognitive skills represent a more relevant determinant of growth and convergence than quantitative inputs alone. Thirdly, it integrates human capital within a broader perspective, taking also structural change into consideration and therefore the geoeconomic framework,

health conditions, trade openness, and energy dependence. Finally, by modeling the determinants of human capital, the thesis highlights the endogenous relationship between development and skill formation.

The structure of the thesis reflects this integrated approach. The first chapter analyzes income convergence among countries that are simultaneously members of the European Union and the OECD, distinguishing between Eastern and Western European groups within this sample. The second chapter investigates the relationship between education quality, health-related human capital, and structural transformation in the same economies. The third chapter evaluates the impact of human capital on economic growth through a dual approach that distinguishes between quantity-based and quality-based proxies and explores long-run dynamics and threshold effects. The fourth chapter analyzes the determinants of human capital using dynamic panel techniques. The thesis concludes with a synthesis of the main findings, policy implications, limitations, and directions for future research.

Paper 1: From Divergence to Convergence: Human Capital and Income Dynamics in Eastern and Western Europe (1980–2024)

The first paper examines the process of income convergence between Eastern and Western European economies over the period 1980–2024, with particular emphasis on the role played by human capital in shaping this process. The topic is highly relevant in the European context, given the successive waves of European integration, the transition from centrally planned to market economies and the persistent differences in income levels that continue to characterize the continent despite decades of economic convergence policies.

Understanding whether less developed economies are catching up with more advanced ones remains particularly important for evaluating the effectiveness of European integration and cohesion policies. Although substantial progress has been achieved since the accession of Central and Eastern European countries to the European Union, important disparities in income levels, productivity and living standards continue to persist. Furthermore, recent challenges, including the global financial crisis, the COVID-19 pandemic, increasing geopolitical tensions and growing geoeconomic fragmentation, have raised new questions regarding the sustainability of the convergence process and the factors that support long-run economic development. In this context, identifying the role of human capital in facilitating convergence becomes especially relevant, as investments in

education and skills are frequently regarded as key mechanisms through which less developed economies can improve productivity and accelerate the catching-up process.

The analysis is grounded in the neoclassical growth framework developed by Solow (1956) and later extended through the concepts of β-convergence and σ-convergence proposed by Barro and Sala-i-Martin (1992). While traditional convergence theory predicts that poorer economies should grow faster than richer ones and gradually reduce income disparities, more recent studies suggest that convergence is often heterogeneous and influenced by country-specific characteristics, institutional quality and structural conditions (Mankiw, Romer, & Weil, 1992; Quah, 1995). Human capital has long been recognized as a key driver of growth and convergence. Whereas earlier studies relied primarily on quantitative indicators such as educational attainment or years of schooling (Barro & Lee, 2010; Raheem, Isah, & Adedeji, 2018), recent contributions emphasize the superior explanatory power of cognitive skills and educational quality measured through international assessments such as PISA (Hanushek & Woessmann, 2008; Valente, Salavisa, & Lagoa, 2015).

To investigate these relationships, the first paper employs a harmonized sample of twenty-two countries that are simultaneously members of the European Union and the OECD. The analysis covers the period 1980–2024 and combines several complementary approaches to convergence analysis, including σ-convergence, unconditional and conditional β-convergence, gap-convergence analysis and the Phillips–Sul (2007) club convergence methodology. Human capital is examined from both a quantitative and a qualitative perspective, using educational expenditure as a proxy for educational investment and average PISA scores as a measure of educational quality. In addition, the analysis incorporates life expectancy, trade openness, and energy imports as a proxy for energy dependence in order to account for the broader structural and geoeconomic environment within which convergence takes place.

The empirical results reveal a structural break around the year 2000. While the transition period of the 1990s was characterized by increasing disparities between Eastern and Western Europe, the subsequent decades witnessed a sustained catching-up process among Eastern European economies. The σ-convergence analysis indicates a gradual reduction in income dispersion within Eastern Europe, whereas Western European countries display a more fragmented pattern characterized by weaker convergence dynamics. The unconditional β-convergence estimations confirm that poorer economies

generally grew faster than wealthier ones, providing evidence in support of the convergence hypothesis.

The conditional models offer additional insights into the mechanisms underlying this process. Educational expenditure does not appear to exert a statistically significant influence on convergence once other structural factors are taken into consideration. By contrast, educational quality measured through PISA scores is positively associated with the catching-up process, suggesting that cognitive skills contribute more effectively to productivity improvements and long-run growth than educational investment alone. The results further indicate that health conditions, captured through life expectancy, as well as geoeconomic factors such as energy dependence, play a significant role in explaining differences in convergence performance across countries.

Finally, the Phillips–Sul methodology (2007) rejects the existence of a single convergence path for all European economies and instead identifies multiple convergence clubs. This finding suggests that European countries continue to follow heterogeneous development trajectories and converge towards different long-run equilibria rather than a common steady state. Taken together, the results highlight the relevance of human capital quality in facilitating the catching-up process, while also pointing to the heterogeneous nature of convergence across Europe. By integrating educational quality, health indicators and geoeconomic variables within a unified convergence framework, the study contributes to a deeper understanding of the forces shaping income dynamics in contemporary Europe.

Paper 2: Sustainable Structural Change through Human Capital Quality: Evidence from EU–OECD Countries

The second paper investigates the relationship between human capital quality and structural transformation in EU–OECD countries over the period 2000–2024. Structural transformation is generally understood as the process through which economies shift resources towards more productive and technologically advanced activities, thereby improving their productive capacities and long-run development prospects (Andersson & Lindmark, 2008).

The theoretical framework combines insights from the human capital literature (Becker, 1964) and the structural transformation literature (Koschatzky & Hansmeier, 2026). Human capital theory emphasizes that investments in education and health increase workers' productivity and improve the ability of economies to absorb and generate technological

progress. In particular, Hanushek and Woessmann (2008) argue that cognitive skills are more relevant for economic performance than traditional measures of schooling because they better capture the actual competencies acquired through education. According to this perspective, higher-quality education enhances innovation capacity, facilitates technological adaptation and strengthens the ability of firms and workers to move toward more sophisticated economic activities.

The health dimension of human capital is equally important. Bloom, Canning and Sevilla (2004) demonstrate that healthier populations contribute to economic performance through higher labour productivity and greater efficiency in the use of resources. Similarly, Peng (2005) and Strulik (2009) emphasize the links between demographic conditions, health outcomes, and structural transformation processes. Improved health conditions may therefore support the reallocation of labour toward higher-productivity sectors and facilitate long-term economic modernization.

The structural transformation literature further suggests that productive upgrading depends on the ability of economies to diversify production structures and expand activities associated with greater productivity and technological sophistication. Studies such as Castro-Aldrete et al. (2021) and Genna et al. (2024) highlight the importance of education quality in supporting productive upgrading and economic complexity, while Thasni et al. (2025) emphasize the role of sectoral shifts in explaining long-term development outcomes. These contributions suggest that educational quality and health conditions may play an important role in facilitating structural transformation beyond their traditional contribution to economic growth.

The paper is motivated by the observation that despite substantial increases in educational attainment across Europe, significant differences persist in cognitive skills, productive capacities and economic complexity. Consequently, the study distinguishes between educational quantity and educational quality by focusing on PISA scores as a measure of cognitive skills rather than relying exclusively on traditional indicators of educational attainment. Furthermore, it incorporates life expectancy as a proxy for the health dimension of human capital, reflecting the idea that healthier populations are generally more productive and better able to support long-term structural transformation.

The main objective of the paper is therefore to evaluate whether educational quality and health-related human capital contribute to sustainable structural transformation after controlling for investment, sectoral composition, and migration-related income effects.

The empirical analysis is based on an unbalanced panel of EU–OECD countries covering the period 2000–2024. Structural transformation is measured through the Structural Change component of the UNCTAD Productive Capacities Index (United Nations Conference on Trade and Development, 2021). This indicator captures the extent to which economies diversify production, increase economic complexity, expand higher-productivity activities, and improve productive capacities. The index is constructed using Principal Component Analysis and ranges from 0 to 100, with higher values indicating more advanced productive structures.

Human capital is represented through two complementary dimensions. Educational quality is measured using average PISA scores, reflecting students' cognitive skills and learning outcomes. Health-related human capital is proxied through life expectancy at birth. In addition, the analysis includes gross fixed capital formation as an indicator of investment and the share of services in value added as a measure of economic structure and sectoral composition. A robustness specification also incorporates remittances to capture migration-related income effects.

The empirical strategy is implemented in three stages. First, pooled Ordinary Least Squares models are estimated to provide a static benchmark of the relationship between human capital and structural transformation. Second, dynamic fixed-effects models are employed to account for persistence in structural outcomes and to control for unobserved country-specific heterogeneity. The inclusion of the lagged dependent variable allows the analysis to capture the gradual and path-dependent nature of structural transformation processes. Finally, robustness checks are performed through alternative model specifications that include remittances.

The use of dynamic fixed-effects models is particularly important because structural transformation is inherently persistent over time. Productive structures evolve gradually, and current levels of structural development are strongly influenced by previous economic conditions. The dynamic specification therefore provides a more realistic representation of within-country adjustment processes than a purely static model.

The empirical results provide strong evidence that educational quality represents a significant determinant of structural transformation. Across the estimated specifications, PISA scores exhibit a positive and statistically significant relationship with the structural change indicator. This finding suggests that countries characterized by stronger cognitive skills tend to achieve higher levels of productive upgrading, greater economic complexity, and more advanced productive structures. The results therefore support the argument advanced by Hanushek and Woessmann (2008) that cognitive skills are more important for economic performance than traditional educational quantity indicators.

Life expectancy also demonstrates a positive contribution to structural transformation, particularly within the dynamic specifications. This result confirms the importance of the health dimension of human capital and indicates that healthier populations contribute to economic modernization and productive upgrading. The finding is consistent with previous literature emphasizing the role of health in labour productivity and long-run economic development (Peng, 2005; Strulik, 2009).

Regarding the control variables, investment measured through gross fixed capital formation displays a positive association with structural transformation, confirming the central role of capital accumulation in supporting productive upgrading. The service-sector share exhibits a weaker and less robust relationship, suggesting that the mere expansion of services does not necessarily guarantee structural modernization unless accompanied by improvements in human capital quality and productive capacities.

The robustness analysis incorporating remittances indicates that migration-related income flows do not fundamentally alter the relationship between human capital quality and structural transformation. The positive effect of educational quality remains stable across alternative specifications, reinforcing confidence in the robustness of the main findings.

The paper concludes that educational quality represents a key driver of structural transformation within EU–OECD countries. While traditional indicators of educational expansion capture the quantity of education, cognitive skills measured through PISA scores appear to be more closely associated with productive upgrading and economic modernization. The results therefore highlight the importance of focusing not only on increasing access to education but also on improving learning outcomes and educational effectiveness.

The main contribution of the paper lies in integrating educational quality and health-related human capital into the analysis of structural transformation using the UNCTAD Structural Change Index (Development, 2025) for EU–OECD countries. By combining insights from the human capital and structural transformation literatures, the study provides new evidence that cognitive skills and health conditions are important determinants of productive upgrading and long-run economic modernization.

Paper 3: Assessing the Impact of Human Capital on Economic Growth in the European Union: A Dual Approach Using Quantity and Quality Proxies

The third paper investigates the long-run relationship between human capital and economic growth in European Union countries, with particular emphasis on the distinction between educational quantity and educational quality. Human capital has long been recognized as one of the fundamental drivers of economic development, as it enhances labour productivity, facilitates technological adoption and supports innovation and knowledge creation. Despite the well-established relationship between human capital and economic performance, the empirical literature continues to employ numerous proxies for human capital.

Traditionally, empirical studies have relied on quantity-based indicators such as years of schooling (Barro & Lee, 2010), educational attainment (Maitra & Chakraborty, 2021) or educational expenditure (Raheem, Isah, & Adedeji, 2018), assuming that a larger stock of education automatically translates into higher productivity and stronger economic performance. However, despite substantial improvements in educational participation across Europe over recent decades, significant differences persist in both economic outcomes and growth trajectories. Countries with similar levels of educational attainment often display markedly different levels of productivity and income, suggesting that educational quantity alone may not fully capture the productive dimension of human capital.

This observation has led to increasing interest in educational quality as an alternative measure of human capital. Recent research argues that cognitive skills and learning outcomes provide a more accurate representation of the knowledge and competencies that ultimately drive productivity, innovation and long-run economic growth (Hanushek & Woessmann, 2008). Consequently, an important question emerges regarding whether improvements in educational quality generate stronger economic benefits than increases in educational quantity alone.

The theoretical framework builds upon endogenous growth theory, which emphasizes the role of human capital in facilitating knowledge accumulation, technological innovation and productivity growth (Lucas, 1988). Human capital contributes to economic performance by increasing workers' productivity, enhancing the diffusion of technology and strengthening the capacity of economies to generate new knowledge. However, while theoretical models consistently predict a positive relationship between human capital and economic growth, empirical evidence remains mixed. Some studies identify strong growth effects associated with educational attainment (Mankiw, Romer, & Weil, 1992), whereas others argue that cognitive skills and educational quality provide a more accurate representation of productive human capital and therefore exert a stronger influence on long-run economic performance (Hanushek & Woessmann, 2008). This debate provides the foundation for the dual approach adopted in this paper.

The empirical analysis relies on a panel of European Union countries covering the period 2000–2024. Human capital is examined from both a quantity and a quality perspective. Educational expenditure is used as a proxy for educational quantity, reflecting investments in the educational system, while average PISA scores capture educational quality by measuring students' cognitive skills and learning outcomes. Economic growth is represented by GDP per capita, while gross fixed capital formation and labour force participation are incorporated as additional explanatory variables in order to account for the contribution of physical capital accumulation and labour market dynamics. The analysis begins with tests for cross-sectional dependence and panel unit roots to determine the statistical properties of the variables. Given the mixed orders of integration identified across the dataset, Pedroni cointegration tests are subsequently employed to examine whether a stable long-run equilibrium relationship exists among the variables. The main empirical framework is based on panel Autoregressive Distributed Lag models estimated through the Pooled Mean Group estimator, allowing the distinction between long-run equilibrium effects and short-run adjustment dynamics. In addition, Dumitrescu–Hurlin (2012) panel Granger causality tests are implemented to investigate the direction of causality between human capital and economic growth.

The empirical results provide strong evidence of a long-run relationship between human capital and economic growth in European Union countries. Across the estimated specifications, educational quality exhibits a positive and statistically significant effect on GDP per capita, indicating that countries characterized by stronger cognitive skills tend to

achieve higher levels of economic performance. The magnitude and robustness of this relationship remain stable across alternative model specifications, suggesting that educational quality represents a key driver of long-run growth.

By contrast, the results associated with educational expenditure are considerably weaker. Although educational investment contributes positively to growth in certain specifications, its effects are less robust and generally smaller than those observed for educational quality. This finding suggests that increasing financial resources allocated to education does not automatically generate higher economic growth unless these investments translate into measurable improvements in learning outcomes and skill formation. The evidence therefore highlights the importance of educational effectiveness rather than educational expenditure alone.

The estimated long-run coefficients further indicate that physical capital remains an important determinant of economic growth, confirming the relevance of investment for economic development. However, the results also demonstrate that the productivity of physical capital is enhanced when combined with higher levels of human capital quality. In this respect, educational quality appears to complement other growth factors by improving the capacity of individuals and firms to adopt new technologies and utilize productive resources more efficiently.

The short-run dynamics reveal a slower adjustment process toward the long-run equilibrium, suggesting that the benefits of human capital investments materialize gradually over time. This finding is consistent with the notion that improvements in education require substantial periods before they are translated into higher productivity and economic performance. Consequently, the economic returns associated with educational quality should be viewed primarily as long-term benefits rather than immediate outcomes.

The causality analysis provides additional insights into the relationship between human capital and economic growth. The results indicate the presence of bidirectional causal relationships, suggesting that economic growth and human capital accumulation reinforce one another. Higher levels of economic development create additional resources that can be invested in education, while improvements in educational quality subsequently contribute to stronger productivity growth and higher incomes. This mutually reinforcing relationship supports long-run development in countries that maintain sustained investments in human capital.

An additional contribution of the paper concerns the identification of threshold effects associated with educational quality. The results suggest that the growth-enhancing effects of human capital become stronger once countries reach sufficiently high levels of cognitive skills. In other words, educational quality not only contributes directly to economic growth but may also increase the effectiveness of other production factors by facilitating innovation, technological diffusion and productivity improvement This result helps explain why countries with similar levels of educational attainment may nevertheless experience substantially different economic outcomes due to differences in education quality and cognitive skills.

Overall, the paper demonstrates that educational quality constitutes a more important determinant of long-run economic growth than educational quantity within the European Union. By explicitly comparing quantity-based and quality-based measures of human capital within a unified econometric framework, the study contributes to the growing literature emphasizing the importance of cognitive skills for economic performance. The findings suggest that educational policies should focus not only on expanding access to education but also on improving the quality of learning outcomes, strengthening cognitive competencies and enhancing the effectiveness of educational systems. Such improvements appear essential for supporting sustainable economic growth and increasing the long-run productive capacity of European economies.

Paper 4: Determinants of Human Capital in OECD Countries: An Empirical Analysis Using System GMM

While the previous papers examine the contribution of human capital to convergence, structural transformation and economic growth, the fourth paper focuses on the factors that drive human capital accumulation itself. Despite the extensive literature highlighting the importance of human capital for economic development, less attention has been paid to understanding the conditions that foster its formation. Most empirical studies concentrate on individual determinants, such as educational attainment (Garza-Rodriguez, Almeida-Velasco, Gonzalez-Morales, & Leal-Ornelas, 2020; Nouira & Saafi, 2020), health outcomes (Sultana, Dey, & Tareque, 2022) or economic prosperity (Cuevas & Calderón, 2020), without considering the broader set of economic, educational and socio-demographic factors that jointly influence human capital development. As a result, the mechanisms underlying human capital accumulation remain only partially understood. The last paper addresses this gap by adopting a multidimensional perspective and examining a broad set of determinants across OECD countries during the period 2000–2024.

The study is motivated by the need to develop a more integrated and multidimensional perspective on human capital. In an environment characterized by rapid technological change, demographic ageing and growing international competition, understanding the factors that foster human capital accumulation is essential for designing effective development strategies. Moreover, while previous chapters demonstrated the importance of human capital for economic growth and structural transformation, it is necessary to identify the policies and socio-economic conditions that contribute to the development of human capital itself.

The theoretical framework is grounded in the human capital theory developed by Becker (1964) according to which investments in education, health and skills increase individual productivity and contribute to economic development. The majority of the studies highlight the importance of educational attainment, advanced skills, literacy (Sghaier, 2022), healthcare conditions (2004) and public investment in education and health as key drivers of human capital development. In the last decades, many contributions expanded this perspective by emphasizing the role of economic prosperity (Alataş & Çakir, 2016), institutional conditions such as corruption (Aslam, 2020), labour market characteristics (Heath, et al., 2024) and demographic factors such as migration (Xin, Aiko, & Jong, 2021) in facilitating human capital accumulation. However, the relative importance of these determinants remains subject to empirical debate, particularly in advanced economies characterized by high educational attainment and significant differences in labour market structures.

The empirical analysis employs an unbalanced panel of OECD countries covering the period 2000–2024. In order to capture the multidimensional nature of human capital, the paper estimates two complementary sets of models. The first uses the Human Capital Index (2017), while the second employs life expectancy at birth. HCI captures more the educational and productive dimension of the human capital, while life expectancy reveals the health dimension of human development. This dual approach allows the analysis to investigate whether the determinants of educational and health-related human capital differ across specifications and whether similar factors contribute to both dimensions of human capital accumulation.

The explanatory variables are grouped into several categories reflecting the main channels identified in the literature. Economic determinants include GDP per capita, inflation, government debt, budget balance and taxation indicators. Educational determinants

comprise educational expenditure, upper-secondary attainment and the share of the labour force with advanced education. Health-related factors are represented by healthcare expenditure, fertility rate and an indicator referring to the medical infrastructure, more specifically an average between the number of beds and doctors available. The socio-demographic variables: share of urban population, corruption, remittances or the share of the female labour. This broad framework makes it possible to evaluate the relative contribution of different categories of determinants and to identify the most important factors associated with long-run human capital development.

Given the dynamic nature of human capital accumulation and the potential endogeneity between human capital and its determinants, the empirical analysis relies on the System GMM estimator developed by Arellano and Bover (1995) and Blundell and Bond (1998). This methodology is particularly suitable because it allows for the inclusion of lagged dependent variables while controlling for reverse causality, omitted variable bias and unobserved country-specific effects. Prior to estimation, panel unit root tests are performed to examine the stationarity properties of the variables, ensuring the appropriateness of the empirical framework. The validity of the estimated models is also assessed through standard specification tests, the Arellano–Bond AR(1) and AR(2) tests for serial correlation in the residuals and the Hansen and Sargan (1982) tests of overidentifying restriction were used to evaluate the validity and exogeneity of the instruments.

The empirical results reveal a high degree of persistence in both measures of human capital, indicating that current levels of human capital are strongly influenced by past achievements. This finding confirms the cumulative nature of human capital accumulation and suggests that investments undertaken in previous periods continue to generate benefits over time. Among the economic determinants, GDP per capita emerges as one of the most important explanatory variables, indicating that economically developed countries possess greater capacity to invest in education and health. This result supports the existence of a mutually reinforcing relationship between economic development and human capital formation, whereby higher income levels facilitate investments in human capital, which subsequently contribute to future economic performance.

The findings reveal clear differences across determinant dimensions. Economic growth, measured by GDP per capita, has a positive effect on life expectancy, while fiscal indicators appear to have a more limited short-run impact. The results suggest that broader economic conditions are more important than temporary fiscal fluctuations. In addition, moderate

inflation does not seem to negatively affect the results as long as fiscal revenues and social expenditures are maintained.

The education perspective displays modest direct associations. Upper-secondary attainment shows a limited but positive link with human capital, while education expenditure does not display strong effects. This suggests that the contribution of education operates gradually and may depend on broader structural and labor-market mechanisms rather than immediate changes in schooling indicators. Direct links between education variables and life expectancy are weaker, indicating that the effects of education on health are more visible in the long run.

Health expenditure exhibits mixed associations, implying that the impact of healthcare resources depends on demographic conditions and system efficiency rather than spending volume alone. Among social determinants, female labor force participation emerges as the most consistent factor linked to human capital, highlighting the role of gender inclusion in strengthening household resources and intergenerational skill formation. Other social variables such as remittances, corruption, and R&D expenditure show weaker or context-dependent associations.

Overall, the paper demonstrates that human capital accumulation is a cumulative and multidimensional process influenced by economic prosperity, educational development and health conditions. By employing a dynamic panel framework and considering both the Human Capital Index and life expectancy as dependent variables, the study provides a comprehensive assessment of the determinants of human capital in OECD countries. The findings suggest that policies aimed at strengthening human capital should adopt an integrated approach that combines investments in education, healthcare and broader socio-economic development. Such policies are likely to generate long-term benefits not only for human capital accumulation itself but also for economic growth, structural transformation and convergence processes, thereby reinforcing the broader conclusions of the doctoral thesis.

General Conclusions and Policy Recommendations

This doctoral thesis analyzed the relationship between human capital, economic growth, income convergence, structural transformation, and the determinants of human capital using different samples of EU countries, OECD countries, and EU–OECD economies. The analyses cover different time periods, depending on data availability and the methodological requirements of each study.

The empirical findings demonstrate that convergence in Europe is neither automatic nor uniform. A structural break around 2000 marks a shift from divergence to convergence at the aggregate level, largely driven by the accelerated catch-up of Eastern European economies following EU integration and institutional reforms. However, convergence remains asymmetric. While Eastern Europe exhibits sustained internal σ-convergence and strong growth dynamics, Western Europe shows weaker and less stable convergence patterns. Importantly, although Eastern European economies grow faster in relative terms, the absolute income gap relative to Western Europe remains substantial and broadly stable, indicating that convergence occurs primarily within groups rather than toward a single European steady state. These findings confirm that Europe follows a multi-speed convergence trajectory shaped by structural and institutional heterogeneity and that convergence in growth rates does not automatically translate into full income equalization.

The analysis of structural change provided nuanced evidence regarding the role of education quality. In the pooled OLS specification, PISA scores are positively and significantly associated with structural change, suggesting that countries characterized by higher cognitive skills tend to exhibit more advanced structural positions. However, this relationship does not remain statistically significant in the dynamic fixed-effects models, which focus on within-country variation over time and control for structural persistence. This indicates that education quality appears to capture long-run cross-country differences rather than short-run adjustment dynamics. In contrast, life expectancy and investment remain positively associated with structural transformation in the dynamic specifications. These results indicate that structural transformation depends not only on the scale of educational investment but also on the effectiveness of skill formation and broader human development conditions.

A central contribution of the thesis lies in distinguishing between human capital quantity and human capital quality. The panel ARDL–PMG estimations indicate that education quality, proxied by PISA scores, is positively associated with long-run GDP per capita in the baseline specification. Education expenditure does not display equally stable long-run effects once structural controls are included. However, the magnitude and statistical significance of these relationships vary across alternative specifications, suggesting that the growth effects of human capital depend on model structure and conditioning variables. Overall, the results provide partial support for the view that cognitive skills are an important component of long-run economic performance.

In the last part of the thesis, by examining the determinants of human capital through System GMM models, the thesis also highlights the endogenous nature of human capital. Human capital accumulation depends on economic conditions, public expenditure, demographic characteristics and health outcomes, revealing a dependent relationship between development and human capital formation. Therefore, human capital is both a driver and a product of economic development, emphasizing the need for integrated policy approaches.

Our findings generate relevant policy implications for advanced economies operating in an increasingly volatile environment characterized by pandemic shocks, armed conflicts, energy security risks and changing global trade relations. First, the results suggest that simply increasing education expenditure is insufficient to ensure long-run growth and convergence. Policies should prioritize improvements in education quality, focusing on cognitive skills, learning outcomes, and curriculum effectiveness rather than solely on input-based measures. Second, health outcomes, reflected in life expectancy, emerge as a complementary dimension of human capital, indicating that integrated strategies which consider both education and health may yield stronger productivity gains. Thirdly, sustainable convergence requires not only improvements in human capital quality, but also attention to broader structural conditions such as investments, health, trade and energy exposure, as these factors jointly shape growth dynamics.

Although the thesis offers a multidimensional analysis of human capital and its role in growth and convergence, further research is still needed. Future research could explore nonlinear convergence or threshold dynamics in greater detail, particularly regarding education quality. Thus, it would benefit from more detailed and granular data on the skills of the population, including information on cognitive abilities, the quality of education across different fields, and the alignment between educational qualifications and actual occupations. Such

evidence would allow for a deeper understanding of how the structure of skills within an economy influences productivity and long-term growth. An interesting direction for future research is also the oneof exploring how the rapid expansion of artificial intelligence reshapes skill demand, productivity dynamics and long-run convergence patterns. For Romania, preliminary evidence is already available through the UEFISCDI graduate employability database (UEFISCDI “Angajabilitate” database), which provides information on labour-market integration by field of study. Extending similar datasets at the EU–OECD level would substantially enhance the empirical analysis of human capital determinants and economic performance.

While our empirical results offer useful and important insights on the human capital and structural change in the context of economic growth alongside with a deep analysis of determinants of human capital, future studies should develop a theoretical model which could be tested with empirical data so as to ensure even higher applicability.

Overall, this thesis contributes to the literature by providing an updated and integrated assessment of growth and convergence in EU–OECD countries, highlighting the importance of distinguishing between human capital quantity and quality in explaining long-run development patterns.

Selected References

1. Alataş, S., & Çakir, M. (2016). The Effect of Human Capital on Economic Growth: A Panel Data Analysis. */ Journal of Administrative Sciences, 14*(27), 539-555.
2. Andersson, L. F., & Lindmark, M. (2008). Is structural change speeding up? The case of Sweden, 1850–2000. *Scandinavian Economic History Review, 56*(3), 192-208. doi:https://doi.org/10.1080/03585520802456941
3. Arellano, M., & Bover, O. (1995). Another look at the instrumental variable estimation of error-components models. *Journal of Econometrics, 68*(1), 29-51.
4. Arrelano, 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.
5. Aslam, A. (2020). The hitky debate of human capital and economic growth: why institutions may matter? *Quality and Quantity, 54*(4), 1351-1362.
6. Baldacci, E., Clements, B., Gupta, S., & Cui, Q. (2004). *Social Spending, Human Capital, and Growth in Developing Countries: Implications for Achieving the MDGs.* International Monetary Fond, Fiscal Affairs Department. Washington: IMF.
7. Barro, R. J., & Sala-i-Martin, X. (1992). Convergence. *Journal of Political Economy, 100*(2), 223-251.
8. Barro, R., & Lee, J. (2010). A new data set of educational attainment in the world, 1950-2010. *Journal of Development Economics*(104), 184-198.
9. Becker, G. S. (1964). *Human Capital: A Theoretical and Empirical Analysis with Special Reference to Education.* New York: Columbia University Press.
10. 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.
11. Blundell, R., & Bond, S. (1998). Initial conditions and moment restrictions in dynamic panel data models. *Journal of Econometrics, 87*(1), 115-143.
12. Castro-Aldrete, L., Grenfield, M., Smith, E., Eyre, H. A., Barbato, M., Pérez, L., & Santuccione, C. A. (2021). Brain capital: A new perspective on economic growth. *Nature Human Behaviour, 5*(9), 1244–1247. doi:https://doi.org/10.1038/s41562-021-01096-8
13. Cieślik, A., Wciślik, & Roza, D. (2020). Convergence among the CEE-8 economies and their catch-up towards the EU-15. *Structural Change and Economic Dynamics*(55), 39-48.

14. Cuevas, A. V., & 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.

15. Development, U. N. (2025, October 31). *Productive Capacities Index*. Retrieved from UNCTADstat: https://unctadstat.unctad.org/datacentre/dataviewer/US.PCI

16. Dumitrecsu, E.-I., & Hurlin, C. (2012). Testing for Granger non-causality in heterogeneous panels. *Economic Modelling, 29*(4), 1450-1460.

17. 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.

18. Genna, K., Ghiglino, C., Nishimura, K., & Venditti, A. (2024). Knowledge-based structural change. *Economic Theory*(78), 1333–1388. doi:https://doi.org/10.1007/s00199-024-01587-4

19. Hansen, L. P. (1982). Large Sample Properties of Generalized Method of Moments Estimators. *Econometrica, 50*(4), 1029–1054.

20. Hanushek, E. A., & Woessmann, L. (2008). The Role of Cognitive Skills in Economic Development. *Journal of Economic Literature, 46*(3), 607-668.

21. Hanushek, E. A., & Woessmann, L. (2008). The Role of Cognitive Skills in Economic Development. *Journal of Economic Literature, 46*(3), 607-668. doi:https://www.jstor.org/stable/27647039

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

23. Holobiuc, A.-M. (2020). Real Convergence In The European Union: “New” Versus “Old” Member States. *SocioEconomic Challenges,, 4*(4), 5-17.

24. Koschatzky, K., & Hansmeier, H. (2026). Structural and transformative change as central challenges for regional development. *Review of Regional Research, 46*(1), 1-25. doi:https://doi.org/10.1007/s10037-026-00273-3

25. Lucas, R. E. (1988). On the mechanics of economic development. *Journal of Monetary Economics, 22*(1), 3-42.

26. Maitra, B., & Chakraborty, M. (2021). International trade, human capital and economic growth in Sri Lanka. *International Journal of Economic Policy Studies, 15*, 405-426. doi:https://doi.org/10.1007/s42495-021-00065-2

27. Mankiw, N., Romer, D., & Weil, D. N. (1992). A contribution to the empirics of economic growth. *Quarterly Journal of Economics, 107*(2), 407-437.

28. Matkowski, Z., & Próchniak, M. (2007). Economic convergence between the CEE-8 and the European Union. *Eastern European Economics, 45*(1), 59–76.

29. Monfort, P. (2020). *Convergence of EU Regions REDUX: Recent Trends in Regional Disparities.* Luxembourg: Europe Comission .

30. Nouira, R., & Saafi, S. (2020). 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.

31. Peng, X. (2005). Population ageing, human capital accumulation and economic growth in China: An applied general equilibrium analysis. *Asian Population Studies, 1*(2), 169-188. doi:https://doi.org/10.1080/17441730500317246

32. Phillips, P., & Sul, D. (2007). Transition modeling and econometric convergence tests. *Econometrica, 75*(6), 1771–1855.

33. Pina, A., & Sicari, P. (2021). *Enhancing regional convergence in the European Union.* OECD Publishing.

34. Quah, D. T. (1995). Empirics for Economic Growth and Convergence. *European Economic Review, 40*(6), 1353-1375.

35. Raheem, I. D., Isah, K. O., & Adedeji, A. A. (2018). Inclusive growth, human capital development. *Economic Change and Restructuring*(51), 29-48. doi: https://doi-org.web.bcucluj.ro:2443/10.1007/s10644-016-9193-y

36. Sghaier, I. M. (2022). Foreign Capital Inflows and Economic Growth in North African Countries: the role of Human Capital . *Journal of the Knowledge Economy*, 2804-2821.

37. Solow, R. M. (1956). A Contribution to the Theory of Economic Growth. *The Quarterly Journal of Economics, 70*(1), 65-94.

38. Strulik, H. (2009). On demographic transition, structural change, and economic growth and stagnation. *Mathematical Population Studies, 8*(4), 333–356. doi:https://doi.org/10.1080/08898480009525490

39. 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*(4).

40. Swan, T. W. (1956). Economic Growth and Capital Accumulation. *Economica, 32*(2), 334-361.

41. Thasni, T., Gangopadhyay, K., & Mondal, D. (2025). Analyzing the impact of structural change on aggregate productivity in Indian states: A three-sector study. *Journal of Quantitative Economics, 23*(4), 899–923. doi:https://doi.org/10.1007/s40953-025-00452-y

42. Valente, A. C., Salavisa, I., & Lagoa, S. (2015). Work-based cognitive skills and economic performance in Europe. *Economic performance in Europe, 19*(3), 383-405.

43. World Economic Forum. (2017). *The global human capital report 2017: Preparing people for the future of work.* Geneva: World Economic Forum.

44. Xin, G., Aiko, K., & Jong, W. K. (2021). *Evaluating the impact of remittances on human capital investment in the Kyrgyz Republic.* ADB Economics Working Paper Series.