A Qualitative and Quantitative Approach to the Drivers of Economic Growth in the EU

Elena-Alexandra Sinoi
Faculty of Economics and Business Administration, West University of Timisoara, Romania
elena.sinoi@e-uvt.ro

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Summary: This study assesses the effects of human capital (focusing on highly educated immigrants), knowledge creation, and global governance quality on economic output (proxied by gross domestic product [GDP] per capita) for EU member states between 2000 and 2020. First, we use a qualitative approach to emphasise the connections between GDP per capita and various determinants of economic growth by performing a social network analysis [SNA]. The results reveal that the three most important features of each network are a high GDP per capita, governance quality, and human capital endowment (low scenario, respectively). Second, we use quantitative data with which we run different econometric models, such as robust regression analysis, generalised method of moments (addressing endogeneity issues), and structural equation modelling. We find that all the regressors have a significant influence on GDP per capita, with the greatest magnitude exercised by tertiary-educated immigrants (valuable resources acquired by destination countries), followed by knowledge and governance quality indicators. These results remain robust to several changes in the empirical estimation techniques.

Keywords: human capital; knowledge; governance; growth; EU.
JEL codes: I28; O15; O33; O43; F22.

1. Introduction

Many academics and researchers have analysed and discussed economic growth and its determinants, and several broad categories of growth theories have been developed. However, opinions are divided, and countless questions remain unanswered: Why do some regions maintain ongoing growth during the years, while others stagnate? Why do some states fail to catch up with others in economic growth and development? Will developed countries remain rich and emerging countries remain poor over the decades? Owing to these uncertainties, the subject of growth and development warrants further study.

Various researchers have identified different predictors of economic prosperity and growth (Rosa Capolupo, 2009). Along with standard economic factors, such as physical capital (Robert Solow, 1956), human capital accumulation (Claude Diebolt and Ralph Hippe, 2022), and technological change (Rudra P. Pradhan et al., 2020), there are also some non-standard variables that are meaningful drivers of economic success, such as high institutional quality (Jacob A. Jordaan and Bogdan Dima, 2020; Junaid Ashraf, Liangqing Luo, and Muhammad A. Khan, 2022). Moreover, apart from internal factors that could stimulate welfare and growth, there are also external factors, such as highly skilled foreigners. Therefore, states are racing to attract the best of the best labour force, with meaningful implications for innovation and technological change (Frédéric Docquier and Joël Machado, 2016; William Kerr, 2020). Because all these factors intermingle and operate together, they cannot be perceived as context free. Countries must consider all these aspects to achieve competitive advantage, wealth, and better living standards.

This study contributes to the literature by assessing the bidirectional relationship between economic output and (i) human capital (focusing on highly educated immigrants), (ii) knowledge creation, and (iii) global governance quality using qualitative and quantitative approaches. The sample comprises the EU-27 countries and the timeframe was between 2000 and 2020.

Concerning study novelty, in the first part of the paper, we develop an explanatory framework for various determinants of economic growth, by letting the data 'speak for itself' (Jean-P. Benzécri, 1973; i.e. we do not start from a theoretical growth model). Therefore, we collected numerical data regarding the growth process and transformed them into categorical data (qualitative data), with which we performed a social network analysis [SNA]. The aim was to identify the key characteristics (features) connected within a specific community (subgroup). In this manner, we obtain an overview of the factors associated with high, medium, and low levels of economic growth (a picture in which the model tracks the data, not the other way around). Additionally, this approach enabled us to highlight the three most important characteristics of the communities detected in our sample (UE-27). In the second part of the study, we use quantitative data to run various econometric models to examine the impact and magnitude of the explanatory variables on economic growth (addressing endogeneity problems). Moreover, regarding the variables used, we employed the principal component analysis (PCA) method to create two indicators (global governance quality and knowledge) from a set of observed variables, rather than simply using variables that already exist in a database. Further, our study focuses on the effects of human capital endowment, knowledge creation, and governance quality on the evolution of growth in the long run, whereas most studies mainly evaluate the implications of one or two aspects mentioned above (they are not considered jointly). Finally, our results highlight that the present analysis is yet another piece of evidence that human capital, innovation capacity, and good governance intermingle and reinforce each other, being key stimuli for economic growth.

The rest of this paper is structured as follows: Section two presents the theoretical framework of the role played by human capital, innovation, and governance quality in intensifying economic growth. Section three comprises our research methodology. Section four discusses the results of the qualitative and quantitative approaches. In Section 5, we check the robustness of our estimations. Finally, in Section six, we emphasise our main conclusions.

2. Literature review

Economic growth remains one of the most significant and compelling sub-areas of economics and is a precondition for economic development. Over the years, nations have experienced different growth episodes; some have proliferated, while others have stagnated. This evolution has led to an increased gap between rich and poor states in terms of income per capita and living standards of citizens, differences that persist to this day (Daron Acemoglu, 2012). Moreover, global economic situations (e.g. periods of crisis) affect the economic health of the world's states differently. While most developed economies experience adverse effects to a lower extent, countries that have not yet been able to mobilise to evolve and catch up with more prosperous countries are affected to a higher degree. Consequently, inequalities between highly developed and developing countries are deepening, generating negative overall effects on societies. Therefore, there is a need for cooperation between states to promote a solid system of government, economic connections, knowledge diffusion, and collaboration, and to encourage proper investments with the aim of gaining economic growth and long-term progress.

Although different developing countries managed to grow, not all of them accomplished the alleviation of poverty, inequality, and unemployment. This is because high growth rates alone do not automatically induce positive social outcomes. Even more essential than quantity is the quality of growth, implying that to achieve sustainability and poverty reduction in a country, growth must be inclusive (Montfort Mlachila, René Tapsoba, and Sampawende J.A. Tapsoba, 2017). The three spheres of sustainability include high-quality economic, social, and environmental aspects. The conceptualisation of these pillars was first presented by Edward B. Barbier (1987), and many other researchers have referred to them as meaningful factors for countries' development (Mehrbakhs Nilashi et al., 2019; Ben Purvis, Yong Mao, and Darren Robinson, 2019). Beyond this, overall governance represents an essential component in regulating the economic sphere in relation to the other two, such that thriving economic activities are achievable (Martin O'Connor, 2006). Therefore, the fourth sphere of sustainability was introduced: the political sphere (governance activity). It is thus paramount that the topic of growth and development be analysed further so that more economies succeed in becoming prosperous and flourishing.

Considering that we live in a consistently changing globalised era, it is fundamental that governments discover and implement specific growth strategies according to the conditions and specificities of their states. It is not sufficient for them to replicate approaches that have been successful in particular countries, but rather to find the appropriate ones for each region (Timothy W. Mazzarol, 2014). A market that operates healthily intensifies its economic efficiency through investments that spur human capital endowment and technological change, which have the most valuable influence on economic output and endogenous growth theory.

Many scholars have noted that the government plays an essential role in enhancing growth and development through robust, predictable, and adequate economic policies (Bogdan Dima et al., 2017) that stimulate innovation, productivity, and entrepreneurship. As Bogdan Dima and Ștefana M. Dima (2016) emphasise, a society is built up by comprehensive interactions between its members and to promote and mediate flourishing interactions, it is essential to exist adequate institutions, mechanisms and consciously designed rules that lead to the desired range of social behaviours and achievement of specific societal goals.

Similarly, in an attempt to determine the elements that enabled Western European countries to rise to affluence, Douglass C. North and Robert P. Thomas (1973) discovered that an efficient economic system is a precondition for growth. An efficient market involves complex and effective governance structures that can formulate and enforce sound policies and implement high levels of institutional quality, which are crucial channels for growth and poverty mitigation. It is crucial to consider that any model on how policies impact economic growth cannot be regarded as isolated from existing institutional frameworks (Bogdan Dima and Ștefana M. Dima, 2018). There are cases in which a country benefits from good institutions but applies bad policies, or when good public policies are developed, they cannot be implemented *per se* because of the poor quality of institutional surroundings. Therefore, in the growth process, it is meaningful for a country to have a good institutional framework as well as sound and effective policies. Although the dividing line between these two structures (institutions and policies) is thin (Rana Hasan, Devashish Mitra, and Mehmet Ulubasoglu, 2006), it is necessary to distinguish between them to clarify their impact on economic performance in both the short and long run. Institutions are regarded as the formal and informal 'rules of the game' in society (North and Thomas, 1973), and their construction process is on longer time horizons. Instead, the policies are regarded as the instruments through which the government can change the 'rules of the game', can achieve its objectives in conformity with the country's institutional framework, being designed for shorter periods (Hasan, Mitra, and Ulubasoglu, 2006).

In an interesting research regarding the case of the EU-27 member states, Bogdan Dima, Ștefana M. Dima, and Oana-R. Lobont (2013) examined the correlation between the quality of governance and growth (represented by GNI per capita) between 2000 and 2010. The authors used an exploratory factor analysis to generate three aggregate indicators (variables of interest) to proxy for the quality of (i) policies, (ii) institutions, and (iii) overall governance. In this respect, the data used were from the World Bank's Worldwide Governance Indicators (WGI): (i) voice and accountability, (ii) political stability and the absence of violence/terrorism, (iii) government effectiveness, (iv) the rule of law, (v) regulatory quality, and (vi) control of corruption. An advantage of using WGI data in describing and evaluating governance is that 'the ideological bias may be rather small relative to the biases of other metrics, such as the Heritage Foundation's measures of economic freedom; and also, […] provide superior performance relative to other available indicators of governance' (Dima, Dima and Lobont, 2013, p. 4). For econometric estimations, we employ the GMM-system model (a dynamic panel data model that addresses endogeneity issues) for both the sample with all EU member states and the sample with old EU members. The results clearly emphasise that all constructed indicators are significant ($p < .01$) and that a standard deviation shock in these indicators leads to changes in income per capita between 0.03- and 0.05-fold. Therefore, higher quality public policies and institutions increase economic output. Interestingly, the coefficients from the old EU state group appear to be five times lower than those of the entire sample. This finding is explained by the fact that the magnitude of the impact of governance depends on a country's growth phase (the EU-27 is heterogeneous in terms of growth and other aspects).

Similarly, Mahran (2023) recently evaluated the influence of governance on economic growth for 116 states worldwide in 2017 by employing spatial econometric models. He used PCA to create a single aggregate index of governance from six basic governance concepts that referred to both policy and institutional frameworks (the six variables retrieved from the WGI database). Similar to other studies, our results show that good governance is one of the main factors enhancing growth (a 1% increase in effective governance leads, on average, to a 1% rise in growth). Moreover, regional cooperation is essential for promoting good governance by reducing political conflicts between neighbouring regions, improving economic connections, facilitating knowledge diffusion and collaboration, and encouraging investments, thereby fostering economic growth and prosperity.

Given previous studies regarding the process of growth and governance, we develop the first hypothesis of this research: ***H_1*: *A high quality of governance (including both effective institution and policy frameworks) has an essential role in enhancing economic growth in the long run*.

In addition to the government's implications for a country's development, abundant theoretical and empirical research has evaluated the nexus between human capital endowment, innovation, and economic growth in the long run (Daron Acemoglu and David Autor, 2012; Aurora A.C. Teixeira and Anabela S.S. Queirós, 2016; Diebolt and Hippe, 2022). From the perspective of proponents of endogenous growth models, technological change (Paul M. Romer, 1986) and the accumulation of human capital (Robert Lucas Jr., 1988) represent the engines of economic growth and development. Human capital is an intangible asset embedded in the workforce that spurs productivity, profitability, and growth (Claudia Goldin, 2016). These intangible resources capture the knowledge and skills acquired through education, experience, creative encouragement, and proper healthcare (Latif Zeynalli, 2020). Following the Schumpeterian framework, technological change covers three developmental steps: (i) invention, (ii) innovation, and (iii) technology or process diffusion. While invention implies the creation of novel technology (new products or processes) using new knowledge or a new mixture of existing knowledge, the innovation phase implies the initial commercialisation of inventions (practical implementation of new ideas). However, innovation does not necessarily involve new inventions; it can consist of improving or redesigning existing inventions to satisfy current market requirements more efficiently. The third step of technological change is the diffusion of technology, which implies the spread of innovation. On the demand side, this occurs when consumers purchase that innovation (good or service), whereas on the supply side, it occurs when competitors start to replicate or integrate that new technology into their own processes (Jonas Grafström and Åsa Lindman, 2017). Overall, innovation is regarded as an inherent process of human development; therefore, these two factors should be studied together when analysing the factors influencing economic growth.

An interesting question is whether pre-existing human capital has persistent effects on current innovation and economic development in a country. Diebolt and Hippe (2022) assessed this issue for European regions in the 19th and 20th centuries. The results show that the paramount historical factor for the actual innovation level (proxied by the number of patent applications) and economic flourishing (proxied by gross domestic product [GDP] per capita) is a society's embedded human capital. It is essential for a nation to be aware that human capital accumulates over time, as it cannot be accumulated instantaneously. Thus, to benefit from it in the long run, society should continuously support the education and development of its people. A widely used indicator of human capital accumulation is educational attainment, which captures the years spent in school (a quantitative measure). Nevertheless, acquired cognitive skills (a qualitative measure) are much more relevant than time spent in education. Both primary and high-level skills are required to enhance economic well-being. However, to obtain the educational accomplishments of students, it is necessary not only to increase the resources dedicated to schools (money alone does not invariably contribute to higher performance) but also to set up structural reforms in schooling institutions (Eric A. Hanushek and Ludger Woessmann, 2008).

Moreover, to fully benefit from human capital, countries should ensure inclusive and equitable quality education for all people (Stage 1) and lifelong learning opportunities to improve and develop new adult skills (Stage 2). These stages are paramount because for a person to take advantage of initial investments in education and maintain and further develop skills, subsequent investments in career stages are required. Usually, the more human capital a country owns, the more incentive it has to invest in it; therefore, these two aspects are self-reinforcing and mutually determining. An increase in the workforce with high cognitive skills can strengthen a country's innovation channels by increasing the number of inventors and innovative entrepreneurs. As we live in a knowledge-based economy, tertiary-educated individuals are instrumental in acquiring aggregate productivity, boosting shared prosperity, and economic growth.

Alina C. Coman, Dan Lupu, and Marcel Nuţă (2022) assess the implications of government investment in education on economic growth for the case of 11 former communist countries that are now EU member states. Their results suggest a need to improve the effectiveness of public expenditure on the education system (in particular, in terms of student enrolment and knowledge acquisition) to ensure an adaptable and competitive workforce. Human capital is a fundamental driver of prosperity and growth because of its quality and skills. Similarly, Elena Pelinescu (2015) revealed the significant role played by human skills, knowledge, and value in acquiring smart, sustainable, and inclusive growth for 28 European countries (in accordance with the Europe 2020 strategy). The econometric estimates (pooled least-squares model) confirm the positive and significant impact of secondary-educated employees, along with the number of patents, on GDP per capita growth.

Considering former studies on the process of growth and human capital, we propose the second hypothesis of this research. ***H_2*****:** *Human capital, with a focus on immigrants with tertiary education, represents a fundamental factor in generating and maintaining the growth and well-being of a nation.*

Further, governments should create favourable environments for stimulating innovation, productivity, and entrepreneurship, as these aspects positively influence regional competitiveness and lead to economic growth and development (Jacques Poot, 2007). Collaborations between researchers, inventors, and academics from different disciplines represent other milestones in economic development (Claudio Michelacci, 2003). By integrating their knowledge and expertise, they can find better solutions to complex questions, supporting scientific communities while paving the way for innovation, and thus raising regional competitiveness (Julia Eberle et al., 2021). While an inventor can design and develop novel products or services but does not necessarily bring them to the market, an entrepreneur does take the risk of investing resources to make that product/service available to the market, with the purpose of withdrawing the initial investment and recording a profit (Joseph Schumpeter, 1947). Therefore, cooperation among different actors is needed to add economic value to an invention (with positive spillovers for economic change and improvement).

Moreover, encouraging and supporting entrepreneurial activities can boost economic output (Jia J. Tu and Shamim Akhter, 2022). This facilitates entrepreneurial investments and creates a greater possibility of breakthroughs in products and processes. In this vein, Pradhan et al. (2020) analysed the possible Granger causal relationship between entrepreneurship, innovation, and economic growth per capita between 2001 and 2016, in the case of the 19 Eurozone countries. Dynamic panel regression analyses are estimated using a vector error correction model, which is a special case of the Vector Autoregressive model. The results emphasise that for the entire sample, in the long run, there is a positive and persistent link between innovation, entrepreneurship, and growth. However, in the short term, no overall uniform Granger causality conclusion can be drawn (the results differ for some countries compared to others). Nevertheless, the authors maintain that innovation and entrepreneurship remain essential drivers of growth acquisition. Therefore, the starting point for propelling economic growth in a country is building vibrant innovation and entrepreneurial ecosystems. Entrepreneurs could contribute to economic prosperity and wealth creation through several channels, such as job creation, investments in research and development (R&D) activities, product and process innovation releases, increasing the efficiency of undertaking activities and reducing cost structures, encouraging competitiveness in the market, permanent improvement of the products and services offered (with positive effects on consumers and market demand), support networks in international trade and cooperation between economic agents, or involvement in corporate social responsibility programmes.

In addition, public financial support for R&D positively influences technological innovation, which is considered one of the preferred channels for obtaining a new form of economic growth: green economic growth. In this respect, Dongyang Zhang et al. (2021) evaluated the importance of public spending on R&D (particularly on green energy technologies) along with human resources (through high-quality education) in accelerating sustainability in Belt and Road Initiative member countries from 2008 to 2018. Their estimations revealed that there was a significant positive relationship between the evaluated aspects and growth. Moreover, the authors argue that each country should formulate and implement specific strategies to gain higher benefits according to their particularities and should not replicate a general plan for all nations.

Finally, analysing the existing research in the literature related to the process of growth and creation of knowledge, we formulate the third hypothesis. ***H_3*:** *To benefit from high growth levels, states need to continuously invest in education, R&D fields, and knowledge generation.*

3. Research methodology

3.1. Purpose of the study and research hypotheses

Economic growth could be regarded as sustainable if there is a propitious interplay among human capital endowment, technological change, and institutional and political frameworks. Bearing in mind that all these aspects are intertwined and often involve feedback effects, great attention should be paid to them to achieve economic prosperity and growth. Hence, the purpose of this study is to analyse the implications of governance quality, human capital (focusing on highly educated immigrants), and knowledge creation on economic output for the 27 EU member states over the period 2000–2020.

The reason for analysing the case of EU countries derives from the following characteristics: The EU member states are part of an economic union and are connected in different ways. For instance, they are subject to a common institutional framework at the EU level (of course, along with a particular degree of autonomy for national public authorities in each country). In addition, if a member state encounters an endogenous or exogenous shock, it is plausible that it will extend to other EU countries (the existence of spillover effects). Nevertheless, EU member states display different characteristics in various fields (e.g. Kosta Josifidis, Radmila Dragutinović-Mitrović, and Slađana Bodor, 2021; Irena R. Krištić and Jurica Šimurina, 2021). For instance, the level of development, economic growth phase, innovation capabilities, human capital endowment, and other aspects differ significantly between these states. Therefore, it is appropriate to further analyse the case of EU member states.

To achieve this goal, we followed both qualitative and quantitative approaches. First, we develop an explanatory framework for various determinant factors of economic growth by following Benzécri's (1973) idea of letting the data 'speak for itself' (in this respect, we do not start from a theoretical growth model). To accomplish this, we transformed the collected numerical data into categorical data to obtain an overall picture of the factors that are correlated with high, medium, or low levels of growth (a frame where the model follows the data, not the other way around). Second, we use quantitative data to estimate various econometric models such as robust regression, the generalised method of moments (GMM), and structural equation modelling (SEM). The aim was to estimate the effects and magnitudes of different regressors on GDP per capita (a proxy for growth).

3.2. Variables and summary statistics

Gross domestic product [GDP] is one of the most popular and effective indicators of a country's economic product. Hence, we use GDP per capita based on purchasing power parity (constant 2017 international dollars) as a proxy for economic growth (dependent variable).

For the *qualitative approach*, the following determinants of growth were considered:

- Foreign Doctor of Philosophy [PhD] students (as a % of all doctoral students)
- The human capital index, which calculates the contributions of health and education to worker productivity and is expressed as a score ranging from 0 to 1, where higher values indicate better results
- Global social mobility (which captures the extent that all people in a society have fair opportunities to accomplish their potential and is expressed as scores ranging from 0 to 100, where higher values reveal better results)
- Research and development [R&D] expenditures in all sectors (expressed as a percentage of GDP)
- The global governance quality indicator, which was constructed using principal component analysis [PCA] from six variables that emphasise the quality of public institutions and policies: (i) voice and accountability, (ii) political stability and absence of violence/terrorism, (iii) government effectiveness, (iv) regulatory quality, (v) rule of law, and (vi) control of corruption. The first two variables refer to the institutional framework (i + ii); the following three variables explain the political framework (iii + iv + v); and the last variable could be regarded as part of both institutions and policies (vi). These six variables are expressed in rescaled values, running approximately from -2.5 to +2.5, where higher values express better governance. They are widely used as a proxy for the computation of an aggregate governance indicator (e.g. Cristiano Perugini and İpek Tekin, 2022)
- Income distribution inequality (S80/S20 income quintile share ratio–EU-SILC and ECHP surveys)

For the *quantitative approach*, we employed the following independent variables:

• Immigrants with tertiary education ranging from 25 to 69 years (expressed as a %)

• Knowledge indicator constructed with PCA method from five variables: (i) school life expectancy: the total number of schooling years from primary to tertiary education which a pupil can expect to get, supposing that the probability of his/her being enrolled in school at any particular future age is equal to the current enrolment ratio at that age (expressed in years); (ii) expenditure on higher education sector (expressed in % of GDP); (iii) R&D expenditure in all sectors (expressed in % of GDP); (iv) researchers in R&D (per million people); (v) participation rate in education and training (lifelong learning) from 18 to 69 years

• Global governance quality indicator constructed with PCA method (as mentioned above)

• Dummy variable for post-Communist countries (1 = former Communist countries, 0 = otherwise)

Data were obtained from the World Bank, Eurostat, and World Economic Forum databases. For the quantitative approach, for each year, we did not take the value of a variable *per se*, but calculated the last five-year average (representing the business cycle period). This approach is designed to absorb the transitional short-run shocks that occur over a 13-year period. Moreover, to ensure data comparability, we rescaled the data using the following formula:

$$X_{i,t}^{rescaled} = \frac{X_{i,t} - \underset{i=1,2,\dots N}{average} \, (X_{i,t})}{\underset{i=1,2,\dots N}{standard\ deviation} \, (X_{i,t})} \quad (1)$$

The *average* $(X_{i,t})$ and *standard deviation* $(X_{i,t})$ are calculated across countries *i* and years *t* for the considered variable *X*. Rescaling the data is required when applying the PCA technique (in *section 3.3*) to ensure that the results are unbiased. The only variables that were not rescaled were those referring to the quality of public institutions and policies, as they were already rescaled using the methodology of Daniel Kaufmann, Aart Kraay, and Massimo Mastruzzi (2010), as reported by the World Bank's Worldwide Governance Indicators [WGI].

Table 1 presents summary statistics of the rescaled data used in the quantitative approach. By evaluating the normality of the data distribution through the skewness parameter (measurement of asymmetry, with a value of 0 for normality) and kurtosis parameter (measurement of peak sharpness, with a value of 3 for normality), we can conclude that some variables are closer to a normal distribution, whereas others are farther away. However, overall, the data showed heterogeneity with a non-normal distribution. The standard deviation emphasises, on average, how far the variables' values are from their mean (the lowest value is equal to 0.29, whereas the highest value is equal to 1). All the rescaled variables have a zero mean and unit standard deviation.

Table 1. Summary statistics (rescaled data)

Variables	Mean	Std. Dev.	Kurtosis	Skewness	Min	Max	Obs.
GDP pc	0	1	10.20	2.42	-1.17	4.04	325
Tertiary immigrants	0	1	2.57	0.31	-1.80	2.43	324
School expectancy	0	1	2.75	0.41	-2.00	2.37	325
Higher education expenditure	0	1	3.02	0.82	-1.81	2.90	325
R&D expenditure	0	1	2.22	0.61	-1.41	2.29	325
Researchers R&D	0	1	3.07	0.78	-1.54	2.70	325
Lifelong learning	0	1	3.98	1.32	-1.17	3.03	325
Voice and accountability	1.15	0.29	2.41	-0.23	0.43	1.63	325
Political stability	0.79	0.36	3.59	-0.68	-0.32	1.53	325
Government effectiveness	1.19	0.50	2.02	0.14	0.24	2.25	325
Regulatory quality	1.23	0.40	2.09	-0.08	0.31	1.94	325
Rule of law	1.20	0.54	1.87	-0.09	0.08	2.08	325
Corruption control	1.09	0.74	1.75	0.20	-0.11	2.42	325
Post-communist country	0.28	0.45	1.96	0.98	0	1	325

Source: computation in STATA

GDP pc = gross domestic product per capita, R&D = research and development, Std. Dev. = standard deviation, Obs. = observations

3.3. Indicators constructed with PCA

To reduce the number of variables in the dataset while ensuring that most of the information was preserved, we implemented principal component analysis [PCA]. This statistical procedure is a dimensionality transformation and reduction technique that allows us to extract and summarise essential information from the data and express it as a set of summary indices called principal components. Therefore, these components are new variables constructed as linear combinations of the initial variables that are uncorrelated and contain the maximum possible information. Each principal component contained different amounts of information regarding each attribute. An essential feature of this method is that it can be applied to heterogeneous data (Hillol Kargupta et al., 2000), as was the case in this study.

In Table 2, we employ a PCA (based on the correlation matrix of variables) to build an aggregate estimator of governance quality. This indicator was created from the six broad dimensions of governance, which emphasise the quality of public institutions and policies, as presented in *section 3.2*. Figure 1 illustrates the scree plot of the eigenvalues after running PCA.

Table 2. Global Governance Quality indicator constructed with PCA

Component	**Eigenvalue**	**Proportion**	**Std. error of proportion**	**Bias**
Component 1	5.05	0.84	0.01	0.00
Observed variables (attributes)		**Eigenvectors for Component 1**	**Unexplained**	**KMO**
Voice and accountability		0.43	0.08	0.91
Political stability		0.41	0.14	0.94
Government effectiveness		0.43	0.07	0.87
Regulatory quality		0.42	0.11	0.95
Rule of law		0.44	0.04	0.90
Corruption control		0.43	0.06	0.87
Likelihood ratio tests for independence	$\chi^2 = 3121.82$ ($p < .01$)			
Likelihood ratio tests for sphericity	$\chi^2 = 3127.75$ ($p < .01$)			
KMO overall	0.90			
Cronbach's alpha	0.94			

Source: computation in STATA
PCA = principal component analysis, KMO = Kaiser–Meyer–Olkin

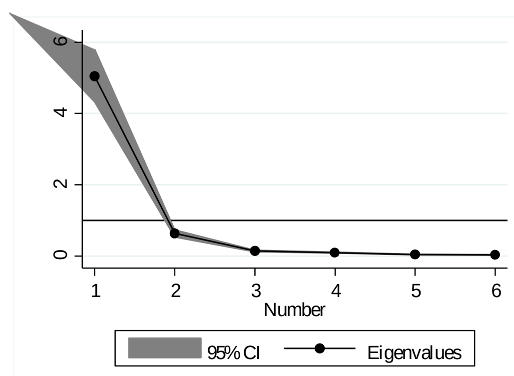

Figure 1. Scree plot of eigenvalues after PCA
Source: computation in STATA

Six components were generated by applying the PCA technique during the first phase. However, in the above table, we report only those that are retained (in conformity with Kaiser's criteria, only components with an eigenvalue greater than one are extracted, as these are 'stable'). Thus, Component 1 was retained, with an eigenvalue equal to 5.05, which extracts the largest amount of variance, explaining approximately 84% of the total variance in the data. The overall Kaiser–Meyer–Olkin [KMO] test for sample adequacy registers a value of 0.90, which is perceived as a 'marvellous result' (Henry F. Kaiser and John Rice, 1974). In addition, likelihood ratio [LR] tests of independence and sphericity have significant p-values, highlighting that the six variables are highly intercorrelated and, therefore, appropriate for a data reduction technique. By applying Cronbach's alpha test, we check the items' internal consistency in the scale, the value of 0.94 revealed excellent internal consistency (Joseph A. Gliem and Rosemary R. Gliem, 2003). We did not opt for any type of rotation, as it is not necessary since only one component is retained. To clarify the adequacy of all six observed variables in constructing the global governance quality indicator, the KMO test was reported individually for each variable. Therefore, the high values (all above 0.87) emphasise ‘meritorious results’ and imply that the variables have enough in common to warrant a PCA. Unexplained values represent the proportion of the variance of the observed variable unexplained by the first component retained. Lower values are preferred, as in our case. Overall, Component 1 reproduced the variance of the original explanatory variables well. In this case, we use the first component to construct a synthetic index labelled global governance quality.

In Table 3, we employ a PCA (based on the correlation matrix of variables) to build an aggregate estimator of knowledge endowment. This indicator was created from the five observed variables mentioned in *Section 3.2*. Figure 2 illustrates the scree plot of the eigenvalues after running PCA.

Table 3. Knowledge indicator constructed with PCA

Component	Eigenvalue	Proportion	Std. error of proportion	Bias
Component 1	3.76	0.75	0.02	0.00
Observed variables (attributes)		**Eigenvectors for Component 1**	**Unexplained**	**KMO**
R&D expenditure		0.47	0.16	0.77
Higher education expenditure		0.47	0.18	0.80
School life expectancy		0.45	0.25	0.80
Lifelong learning		0.45	0.23	0.77
Researchers		0.48	0.12	0.73
Likelihood ratio tests for independence	$\chi^2 = 1399.77$ ($p < .01$)			
Likelihood ratio tests for sphericity	$\chi^2 = 1402.37$ ($p < .01$)			
KMO overall	0.77			
Cronbach’s alpha	0.91			

Source: computation in STATA

PCA = principal component analysis, R&D = research and development, KMO = Kaiser–Meyer–Olkin

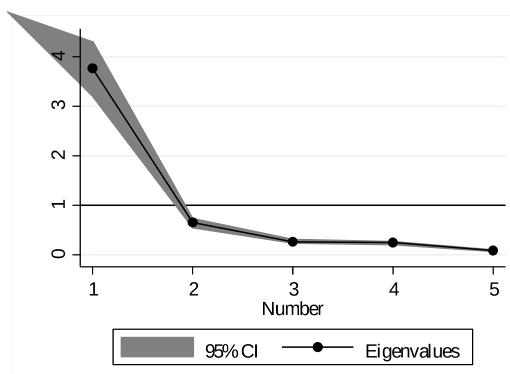

Figure 2. Scree plot of eigenvalues after PCA
Source: computation in STATA

In the second PCA, five components were generated, but only the first component was retained with an eigenvalue greater than 1 (3.76), which explained the largest amount of the total variance in the data (75%). The value of the overall KMO test (0.77) for sample adequacy revealed good results, as did the individual KMO test for each variable (above 0.73). In the same manner, a Cronbach’s alpha test of 0.91 revealed excellent internal consistency, and LR tests of independence and sphericity register significant p-values, implying that the observed variables are intercorrelated enough to run a PCA. We did not opt for any rotation type because it was unnecessary because only one component was retained. All variables registered low proportions of unexplained variance, which is desirable. Therefore, the first component is used to construct a synthetic index that groups the explanatory variables considered, which we label as knowledge.

4. Results and comments

4.1. Qualitative approach

In this section, we build an explanatory framework for economic growth and six of its determinants (as mentioned in *Section 3.2*). The aim of this approach is to allow the data to 'speak for itself' and reveal the connections between all considered indicators. Therefore, we collected numerical data on the growth process and transformed it into categorical data. Consequently, the numbers in the dataset (depending on their value and the indicator to which they refer) were replaced with different labels (features).

For each country, we calculated the average value of each indicator between 2000 and 2020 (in this way, we could include both normal and crisis periods and compensate for the distortions induced by critical periods). Further on, we grouped the values of each indicator into one of the following three categories: high, medium, or low. To determine this repartition as appropriately as possible, we adopt a quantile approach. This approach is preferred over other techniques for dividing a series of data (for example, the arithmetic mean) because the results are not distorted by outliers, and the values are more equitably distributed between high, medium, and low intervals. However, when necessary, we adjusted the thresholds for the three intervals to make the split more realistic. For instance, for the GDP per capita variable, each country falls into one of three intervals–high GDP/medium GDP/low GDP–according to the value of its GDP. This fundament was repeated for all the other variables. The Appendix provides Table A1 with all the indicators and countries framed in a specific interval.

The next step was to associate two different features (for instance, High GDP with High Governance; High GDP with Medium Governance; High GDP with Low Governance) until no possible combination could be found (this was done for each country-indicator pair). Subsequently, we determined the frequency of occurrence of each pair of features and attributed each pair to a weight based on that frequency. For all frequencies equal to or greater than eight, we set a weight of two, otherwise 1. Therefore, based on the aforementioned pairs of features and their weights, we developed a network in which the nodes were represented by these features (characteristics).

The nodes were grouped according to their characteristics (attributes), measured through betweenness centrality [BC], which is a measure of centrality in a graph based on the shortest paths that pass through that vertex to the others. The network was represented by an undirected graph with weighted edges. Therefore, the strength of a node is determined by the sum of the weights of its adjacent edges, adding another dimension of heterogeneity to the network. Table 4 presents the BC results for each feature type. The values range from 0.16 to 13.48. The modes with the highest BC are medium inequality (13.48), medium PhD foreigners (9.76), low inequality (8.31), medium human capital (7.64), and medium R&D expenses (7.45). Hence, more information is passed through these vertices compared to the others.

Table 4. Betweenness centrality of the nodes

High level	Medium level	Low level
High GDP pc 3.12	Medium GDP pc 2.48	Low GDP pc 0.99
High governance 1.01	Medium governance 2.48	Low governance 1.87
High human capital 1.69	Medium human capital 7.64	Low human capital 2.51
High PhD foreigners 0.90	Medium PhD foreigners 9.76	Low PhD foreigners 0.18
High inequality 1.22	Medium inequality 13.48	Low inequality 8.31
High social mobility 1.81	Medium social mobility 2.50	Low social mobility 2.87
High R&D expenditures 0.16	Medium R&D expenditures 7.45	Low R&D expenditures 2.57

Source: computation in R

GDP pc = gross domestic product per capita, R&D = research and development, PhD = Doctor of Philosophy

Our aim was to identify the subgroups (communities) of features that interacted the most in the entire network. A community is a group of nodes that are more densely connected among themselves than with other nodes from outside the group. Therefore, we used community detection methods (mathematical methods) to cluster the tightly linked features. In this regard, we employed five different algorithms to detect existing communities: Louvain, Walktrap, Spinglass, Leading

Eigenvalue, and Edge Betweenness. The advantage of running various community detection methods is that we can gain insight into whether the results remain robust. Further, for each method, we reported the graph modularity score (ranging from -1 to +1), which measures the density of the connections between the nodes within each group versus the connections outside that group (are the vertices tightly linked inside a community and loosely connected outside that community, or *vice versa*?). To implement this framework, we used the following R packages *igraph*, *readr*, *knitr* and *dplyr*.

The Louvain, Walktrap, Spinglass, and Leading Eigenvalue algorithms identified two communities (Figures 3–6), whereas the Edge Betweenness algorithm detected one major community and nine isolated nodes (Figure 7). Table 5 lists the modularity scores for all the algorithms. The conclusion regarding which algorithm is more appropriate is drawn based on the node association in the extracted communities and the modularity score.

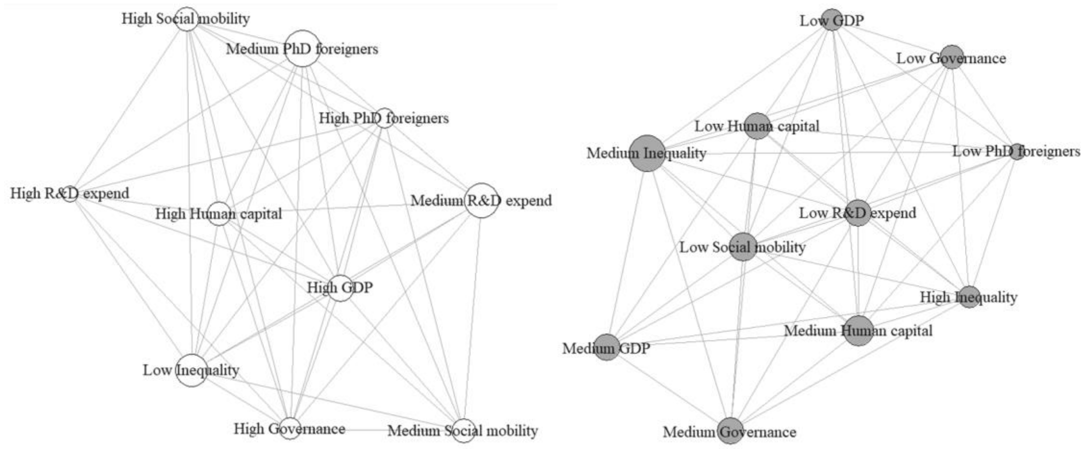

Figure 3. Identify communities - Louvain method
Source: computation in R

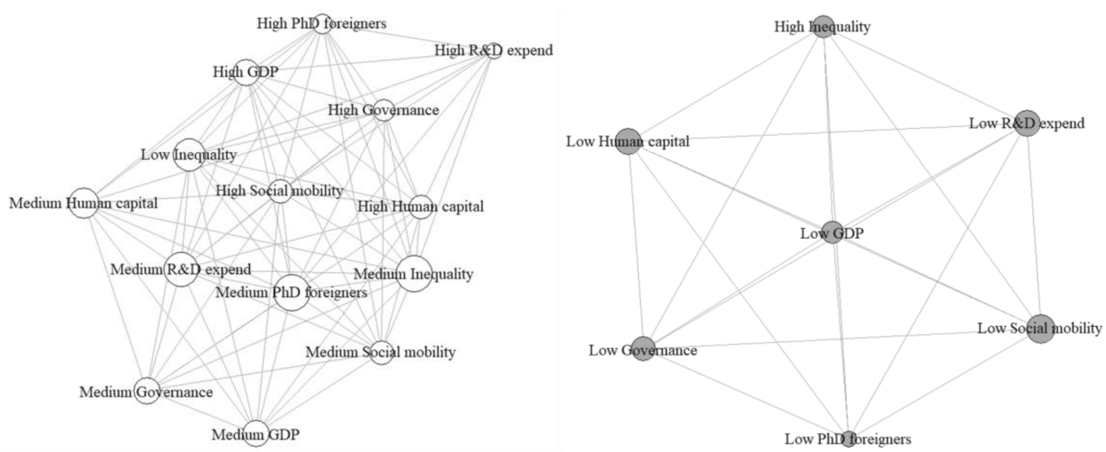

Figure 4. Identify communities - Walktrap method
Source: computation in R

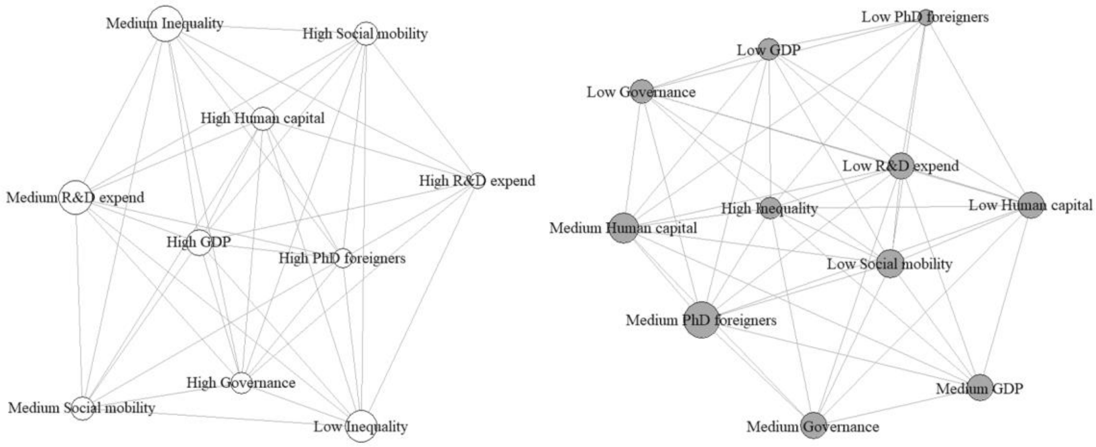

Figure 5. Identify communities - Spinglass method
Source: computation in R

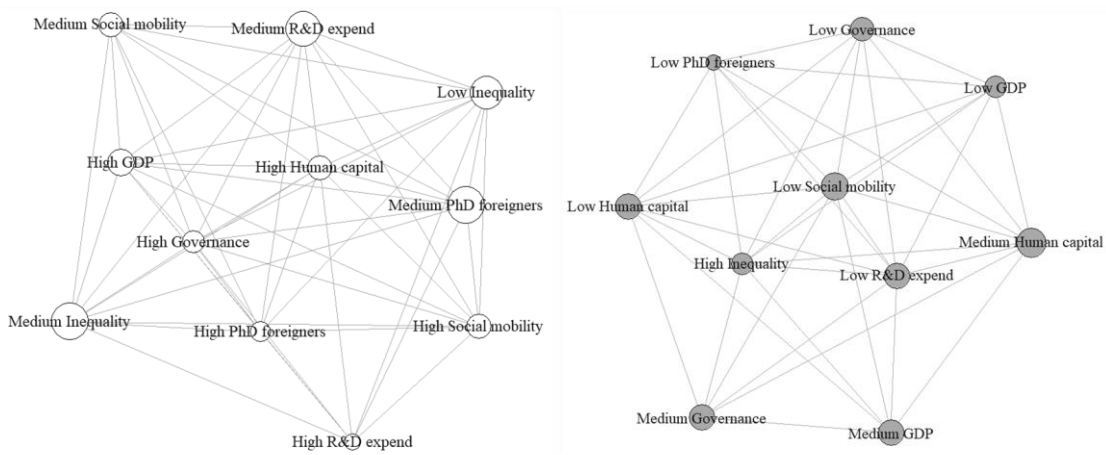

Figure 6. Identify communities - Leading Eigen method
Source: computation in R

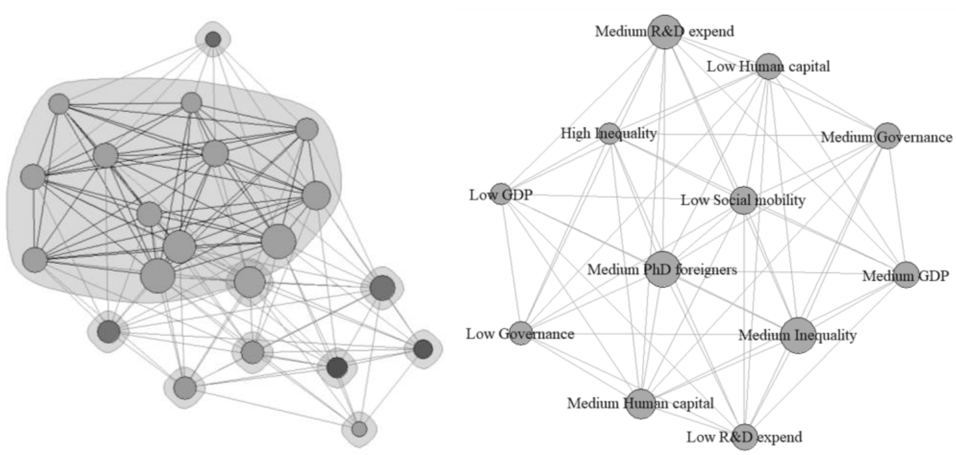

Figure 7. Identify communities – Edge Betweenness method
Source: computation in R

Table 5. Modularity scores for different community detection algorithms

Algorithm	Modularity score
Louvain	0.15
Walktrap	0.13
Spinglass	0.15
Leading Eigen	0.15
Edge Betweenness	0.03

Source: computation in R

We refer to 'high cases' as the best results for each indicator, and therefore these imply high GDP, high governance, high human capital, high PhD foreigners, high social mobility, high R&D expenditures, and low-income inequality. In contrast, 'low cases' stand for the worst situation and thus imply low GDP, low governance, low human capital, low PhD foreigners, low social mobility, low R&D expenditures, and high-income inequality.

By analysing the first four computed algorithms (Louvain, Walktrap, Spinglass, and Leading Eigen), we observed similarities in terms of feature associations between the generated communities. Therefore, in all four methods, the first community depicts 'high cases' associated with 'high cases' (as expected) but also with some 'medium cases'. Regarding the second community, apart from the Walktrap method, which comprises only 'low cases', the other methods connect 'low cases' with both 'low and medium cases'. Edge Betweenness algorithm is the only one that identifies only one significant community of 'low and medium cases', all the other nodes being isolated. Overall, the communities detected give us clear frameworks where 'high cases' and 'low cases' are not part of the same subgroup, no matter what algorithm we use. Considering the above, the results appear robust, regardless of the method applied.

A reasoning that underlies these results (features labelled as 'high' connected with 'medium' or features labelled as 'low' connected with 'medium') might be the fact that some countries are on their way to improve various aspects, and so, they are in transition from a medium class to a high class, or from a low class to a medium class. For instance, in the Czech Republic, we encounter medium levels of GDP, governance, foreigners with PhDs, social mobility, and R&D expenditures, but a high level of human capital and a low level of income inequality. As observed, some aspects, such as human capital and inequality, have already improved, whereas others are expected to improve in the long run. Another example is Poland, which has low levels of GDP, governance, PhD foreigners, social mobility, and R&D expenditures but medium levels of human capital and inequality. In this case, human capital and income inequality evolved in a better direction.

Regarding the modularity scores, for the Louvain, Walktrap, Spinglass and Leading Eigen algorithms the scores are very close (0.13–0.15), emphasising that the vertices are denser connected inside each community than outside of it. However, these values were not high and showed heterogeneity in the data. The modularity score of the Edge Betweenness algorithm was the lowest (0.03), emphasising even greater data heterogeneity compared to the other methods used. However, these results are not surprising because the EU member states display different characteristics in various fields (see *Section 3.1*).

Overall, the results obtained using the Walktrap algorithm were the most justified for our dataset. This choice is mainly based on the 'textbook' results from the second community, which displays associations only between 'low cases'. Therefore, countries with a low level of GDP per capita are the same as countries that invest few resources in R&D, have low endowments of human capital/PhD foreigners, provide low opportunities for people to accomplish their potential (low social mobility), have poor governance quality, and experience high levels of income inequality. These outcomes suggest a bidirectional relationship between economic output and other variables of interest. In contrast, in the first community, we find only 'high and medium cases' connected. Therefore, a country could have some aspects framed as 'high' and others as 'medium' because some things are already good enough, while others still must be improved (i.e. Portugal, Slovenia, etc.). Not all states reached the best overall situation with only 'high cases', like Sweden, Denmark, Belgium, or the Netherlands, which are very strong economies (Table A1).

Table 6 emphasises the three most important features in each community, based on the number of connections each feature has (degrees in the network). This performance measure excludes small communities. The most significant features of both communities are GDP per capita, governance quality, and human capital endowment (or PhD students, which are part of human capital). Therefore, the results obtained coincide with the literature that identifies the main predictors of economic prosperity: (i) human capital accumulation, (ii) technological change, and (iii) economic institutions (Capolupo, 2009). Although we do not have the technological change feature at the top, bearing in mind that it is inherent to capital accumulation, we can affirm that it is a logical outcome of the existence of highly skilled and educated people. Hence, human capital enables an economy to grow in the long run (and, of course, the institutional and policy frameworks are also paramount in enhancing economic growth and development). Moreover, regardless of which cases we are referring to ('high' or 'low'), there is a tight connection between GDP per capita, human capital, and the quality of governance (therefore, we can affirm that the results are robust). In summary, starting from qualitative data, our results are in accordance with the existing theoretical frameworks of economic growth.

Table 6. Top three features in each community

Community	1st	2nd	3rd
1	High GDP pc	High governance	High human capital
2	Low governance	Low GDP pc	Low PhD foreigners

Source: computation in R

GDP pc = gross domestic product per capita, PhD = Doctor of Philosophy

4.2. Quantitative approach

In this section, we run various models to estimate the impact and magnitude of different regressors on economic output. Therefore, we first generated a preliminary robust regression analysis to emphasise the relationship between several explanatory variables (immigrants, knowledge, governance quality, and status as a former communist country) and GDP per capita (Table 7). Compared with other methods (e.g. ordinary least squares [OLS]), which provide misleading results if their underlying assumptions are violated, robust regression analysis has the advantage of not being overly affected in these circumstances.

Evaluating the results, immigrants with tertiary education, overall governance quality, and knowledge endowment are significant ($p < .01$), positively influencing GDP per capita. In contrast, being a member of an ex-Communist group has a negative effect on economic growth, exercising the greatest impact (with a coefficient of 0.505; $p < .01$). The F-statistic provides overall evidence that all the independent variables significantly influence the evolution of GDP per capita ($p < .01$). Therefore, this baseline estimation provides empirical evidence of the variables' relevance to economic growth.

Table 7. Determinants of GDP per capita (baseline estimation robust regression analysis)

Variables	Coefficients
Tertiary immigrants	0.055***
	(0.02)
Post-communist country	-0.505***
	(0.04)
Governance quality	0.138***
	(0.01)
Knowledge	0.034***
	(0.01)
Constant	-0.019
	(0.02)
F(4, 319)	273.24
	(p < .01)
No. of observations	324

Source: computation in STATA

***p < .01. Standard errors are shown in parentheses. GDP per capita = gross domestic product per capita

An essential starting point for achieving our goal is to anticipate several potential problems that could arise and correct them using appropriate methods to obtain unbiased results. For instance, endogeneity is an often-encountered issue in empirical growth models (Stephen R. Bond, Anke Hoeffler, and Jonathan R.W. Temple, 2001). First, reverse causality could exist between dependent and independent variables, implying that they are likely to be jointly determined. Many researchers reveal cointegration and bidirectional relationships between economic growth and (i) human capital (Derviş Boztosun, Semra Aksoylu, and Zübeyde Ş. Ulucak, 2016), (ii) knowledge and innovation process (Maradana et al., 2017) and (iii) the quality of institutions and policies (Dima, Dima, and Lobont, 2013). Second, the variables unintentionally omitted from our model (incorporated into the disturbance term) could also be correlated with the right-hand (RHS) variables. In this case, the error term is correlated with the RHS variables. Third, explanatory (RHS) variables could be correlated, indicating that they are not strictly exogenous. In this case, systems with simultaneous equations. Another aspect to consider is that past realisations could have influenced the current realisation of the dependent variable. Therefore, the dynamic panels performed better than the static panels in terms of validity and consistency. Another violation of the assumption for linear regression analysis modelling may be the existence of heteroscedasticity (the variance of the standard errors is not constant across observations).

Bearing these issues in mind, we opt for the instrumental variable approach as it can generate more efficient and unbiased estimations than other methods. Thus, we employ a dynamic panel estimation developed by Manuel Arellano and Stephen Bond (1991) and later improved by Manuel Arellano and Olympia Bover (1995) and Richard Blundell and Stephen Bond (1998): the generalised method of moments system (GMM-system). This type of GMM comprises a system of two equations: the 'original equation and the transformed one' (David Roodman, 2009). Therefore, one equation is in difference (instrumented by lagged levels) and one equation is in levels (instrumented by lagged differences). In this case, the instruments are transformed; therefore, they are not correlated with the fixed effects. Moreover, GMM estimator is designed for datasets with 'small *T* and large *N*' (which is our case, as we deal with 13 years and 25 countries) and has the advantage of correcting as much as possible for the endogeneity problems, heteroskedasticity and autocorrelation within individuals (Roodman, 2009). Following Roodman (2009), we performed a two-step GMM-system by applying the *xtabond2* procedure in STATA. This command provides considerable flexibility in the model specifications, eliminating different sources of bias. For instance, we could use the command 'collapse' for instruments; thus, we restrict the instruments' proliferation and, therefore, avoid a too high number of instruments which leads to weak model adequacy. In addition, four diagnostic tests were automatically displayed regarding the overall validity of the instruments (Sargan and Hansen tests) and the presence of autocorrelation in residuals (for the first- and second-order). Consequently, we applied the GMM estimation to counteract all possible issues that could bias our results (Table 9).

Writing the stochastic equation of the multifactorial regression analysis, we obtain the following form:

$$Y_{i,t} = \beta_0 Y_{i,t-1} + \beta_1 X_{i,t} + \beta_2 Z_{i,t} + \delta_i + \delta_t + \varepsilon_{i,t} \quad (2)$$

where $Y_{i,t}$ is the dependent variable; $X_{i,t}$ is a vector of interest variables (taken as predetermined variables); $Z_{i,t}$ is a vector of control variables (taken as strictly exogenous variables); δ_i represents the unobserved time-invariant specific effects, δ_t represents the unobserved country-invariant specific effects and $\varepsilon_{i,t}$ represents the random disturbance, assumed to have zero mean ($E(\varepsilon_{i,t}) = 0$) and finite variance ($\sigma^2(\varepsilon_{i,t}) = a$, $a \in \mathbb{R}$).

Before running the GMM estimations, we apply the variance inflation factor [VIF] test to evaluate the degree of interdependency among the explanatory variables (Table 8). As observed, the values are low enough to state that there is no concern of severe multicollinearity between the regressors (values below the threshold of five); therefore, no corrective measures are required. We also test for serial correlation in idiosyncratic errors by applying the Breusch-Godfrey/Wooldridge test in R. Therefore, we obtain a $\chi^2 = 216.46$ ($p < .01$), which emphasises the presence of autocorrelation in the disturbance term. Finally, we examined whether the homoscedasticity assumption was valid by applying the Breusch-Pagan test in R. The results revealed a high test statistic of BP=117.4 ($p < .01$), which means that we deal with the presence of heteroscedasticity. Thus, the GMM estimation is helpful for correcting these problems.

Table 8. Variance inflating factor test for explanatory variables

Explanatory variables	**VIF**	**1/VIF**
Tertiary immigrants	1.34	0.75
Knowledge	2.42	0.41
Governance quality	2.99	0.33
Post-communist country	1.41	0.71
Mean VIF	2.04	

Source: computation in STATA
VIF = variance inflation factor

Table 9. Determinants of GDP per capita (two-step GMM-system estimations)

Variables	**Model 1**	**Model 2**	**Model 3**
Lag GDP pc	0.942***	0.897***	0.929***
	(0.01)	(0.01)	(0.01)
Tertiary immigrants	0.090***	0.076***	0.082***
	(0.00)	(0.01)	(0.00)
Post-communist country	-0.021**	-0.088***	-0.019**
	(0.01)	(0.01)	(0.01)
Knowledge	0.022***		0.013***
	(0.00)		(0.00)
Governance quality		0.018***	0.010***
		(0.00)	(0.00)
Second order autocorrelation	-0.40	-0.30	-0.56
H_0: no autocorrelation in residuals	(p = .69)	(p = .77)	(p = .57)
Hansen's *J* test	23.88	21.64	23.19
H_0: instr. overall validity	(p = .92)	(p = .95)	(p = .99)
No. of instruments	39	39	52
No. of groups	25	25	25
No. of observations	300	300	300

Source: computation in STATA

**p < .05, ***p < .01. Standard errors are shown in parentheses. Tertiary immigrants, knowledge, and governance quality are predetermined variables (with one lag), and the post-communist country is a dummy variable that is strictly exogenous (without lag). GDP pc = gross domestic product per capita; GMM = generalized method of moments

Tertiary immigrants, knowledge, and governance quality variables are predetermined, meaning that they are not correlated with past or current error terms but could be correlated with future error terms. The post-communist country variable is a dummy that is strictly exogenous (uncorrelated with the past and future error terms). In Models 1 and 2, we did not combine standard and non-standard growth drivers; thus, we used the PCA-created indicators separately. Instead, in Model 3, we assessed the impact of the explanatory variables together to ensure that the results were as close to reality as possible, and that our approach did not overestimate the impact of any indicator. Therefore, in all the models, the variables have significant coefficients (p < .05) and maintain the expected sign. Overall, in Model 3, the magnitude of the variables was lower than in the other models, but with no significant discrepancy.

The greatest impact is exercised by lagged GDP per capita (with an average coefficient of 0.9), highlighting that economic growth from one period is significantly and directly influenced by past levels. Therefore, a one-unit increase in one-year lagged rescaled GDP per capita causes an increase of approximately 0.9 units in the current rescaled GDP per capita. This remark is also emphasised by the evolution of different economies over the years; the more developed a country, the greater its chances of growing and developing further. The underlying rationale behind these results is that a wealthy nation has more incentives and possibilities to continuously invest in education, healthy lifestyles, stimulation of technological change, and development of efficient policies and institutions to achieve specific societal goals (Dima and Dima, 2016). As Daron Acemoglu (2008, p. 131) purports, 'countries that are more productive will also invest more in physical and human capital', and, consecutively, it is natural to enjoy technological advances. This cycle repeats as countries with high levels of technological advances continue to make further well-thought-out investments to have a society as prosperous as possible. Moreover, high levels of past economic growth and development induce a market's ability to accelerate the current increase in governance quality, innovation capacity, or human capital. In contrast, in less-developed economies, where the aspects mentioned above are in the infant stage, it is expected that their implications are not yet very profound and have a minor impact on economic growth (Pradhan et al., 2020). More significant effects are expected over a much broader timeframe. Thus, the bidirectional relationship between economic output and the independent variables considered in the models was highlighted.

The second-greatest magnitude is exercised by tertiary-educated immigrants, with coefficients between 0.07–0.09, which are significant (p < .01). Overall, an increase of one unit in the rescaled tertiary immigrant variable induces an average increase of 0.08 units in the current rescaled GDP per capita. As endogenous growth theory states, educated and skilled people positively influence technological change, which is the engine of economic growth. Similarly, Carlo M. Cipolla (1972, p. 48) highlights the importance of migrants by arguing that 'through the ages, the main channel for the diffusion of innovations has been the migration of people'. Over the years, it has been confirmed that skilled migrants have tremendous implications in destination countries, such as spurring knowledge formation through their abilities and acquaintances

(Claudio Fassio, Fabio Montobbio, and Alessandra Venturini, 2019); encouraging unique and creative thinking in the workplace (Stephen Gelb and Aarti Krishnan, 2018); their diversity improves the team's creativity and performance (Edoardo Ferrucci and Francesco Lissoni, 2019), while providing complementary skills and knowledge to native workers (Jennifer Hunt and Marjolaine Gauthier-Loiselle, 2010). Therefore, destination countries perceive these types of migrants as a 'brain gain' (a valuable resource acquired) whose implications can reduce poverty and foster inclusive and sustainable development (Marta Foresti, Jessica Hagen-Zanker, and Helen Dempster, 2018). Moreover, the educational training of immigrants is usually provided and financed by the country of origin. However, destination countries benefit the most from these investments because foreign human capital significantly influences economic growth and development (Paula E. Stephan and Sharon G. Levin, 2001). Under these circumstances, countries are racing to attract highly skilled migrants to benefit as much as possible (Docquier and Machado, 2016). Moreover, governments need to continuously prepare human capital (both indigenous people and foreigners) for future opportunities and unexpected challenges that might arise, bearing in mind that we live in a globalised era governed by rapid technological change (as well as World Bank, 2018 emphasise). In this respect, public spending on human resources is essential for the acceleration of growth. Hence, $\boldsymbol{H_2}$ is fulfilled: *Human capital, with a focus on immigrants with tertiary education, represents a fundamental factor in generating and maintaining the growth and well-being of a nation*.

Knowledge indicators comprise aspects that spur acquaintance generation and encourage further knowledge and human capital accumulation through investments in education, R&D, and research personnel. These aspects stimulate innovation, productivity, and entrepreneurship, which are significant predictors of regional competitiveness, economic growth, and development (Poot, 2007). The technological change process is considered inherent to human development; thus, there is a tight tie between these two growth motors (Miguel-Á. Galindo and María T. Méndez, 2014). Human capital investment triggers knowledge spillovers and technological substitution, which are critical catalysts of economic progress. In practice, there is not only a one-way relationship between these broad aspects–human capital stock, innovation propensity, and growth but also multidirectional relationships (the so-called feedback relationships). Therefore, changes in one process affect the evolution of others and *vice versa*. In all the models, the knowledge indicator maintained a 1% significance level with positive coefficients of 0.022 (Model 1) and 0.013 (Model 3). An increase of a one-unit in the knowledge indicator generates, on average, an increase of 0.017 units in the current rescaled GDP per capita. These results are in concordance with the European Commission's (2010) specification that smart growth implies intensifying knowledge and innovation as motors of future growth. Therefore, economic growth is the preliminary result of technological change, as Romer (1990) states in his endogenous growth theory. Countries that are very active in the technological change field (for example, old EU members) have the same characteristic of investing large amounts of resources in R&D (above the world investment average, according to the Eurostat database). Moreover, they have strong Intellectual Property Rights that play a crucial role in stimulating technological change and innovation (Rohini Acharya, 1996), and thus, making them more competitive with the rest of the world. Only sufficiently wealthy and stable states can afford to enforce secure property rights with the support of economic institutions (Acemoglu, 2008). This idea has also been noted by other scholars who acknowledge that the development of strong property rights and control of corruption under the rule of law (a cornerstone of the governance frame) fosters economic growth (Mahran, 2023). Therefore, it is demonstrated the third hypothesis $\boldsymbol{H_3}$: *To benefit from high growth levels, states need to continuously invest in education, R&D fields, and knowledge generation*.

In line with Bhanu P. Singh (2022), who argues that development and governance are complementary, our estimations show that the global governance quality indicator positively influences GDP per capita, with coefficients of 0.018 (Model 2) and 0.010 (Model 3) and statistical significance ($p < .01$). Thus, an increase of a one-unit in the aggregate governance indicator leads, on average, to an increase of 0.014 units in the current rescaled GDP per capita. As such, the government plays a crucial role in enriching growth and development through effective and predictable economic policies (Dima et al., 2017), together with a sound institutional framework. It is beneficial to make an overall evaluation of governance quality because to achieve economic prosperity, there is a need for both good policies and institutions, as they are correlated (just one of these is not enough for a buoyant economy). Therefore, through sound policies and institutions, governments can facilitate physical and human capital investment by allocating resources efficiently, with positive effects on economic growth (Teixeira and Queirós, 2016). Overall, quality policies and institutions influence the economic climate by fostering R&D, infrastructure development, entrepreneurial activities, and labour force mobility (Bogdan Dima, Oana-R. Lobont, and Nicoleta-C. Moldovan, 2016). Another important aspect to consider is that the impact of institutions and policies depends on the economic growth phase of a country, along with other things such as changes in market mechanisms (Dima, Dima, and Lobont, 2013). Therefore, the extent of the impact of governance is not the same across the EU states (for some countries, the magnitude is higher; for others, it is lower). The laws, policies, and regulations that govern a country represent the collective choice of society members, meaning that if they resolve to change them, they can do so (Acemoglu, 2008). Hence, since institutions are paramount in generating economic performance, societies need to focus on reforming them in such a way as to improve them and thus accomplish better economic outcomes. However, owing to cross-country differences in terms of economic progress, culture, or past political regimes, countries need to discover reforms that work better for their specificities, although it is a complex task. Therefore, governments should refrain from relying on a general solution and instead formulate country-specific strategic plans for higher benefits. Moreover, overall political stability induces people's mental motivation to save money because it will not become worthless in time. Consequently, more investments can be made with these savings (e.g. in education, health, business establishment, and company development). In line with Shimelis K. Hundie (2014), savings and investments are significant features of sustainable growth. In summary, hypothesis $\boldsymbol{H_1}$ is supported: *A high quality of governance (including both effective institution and policy frameworks) has an essential role in enhancing economic growth in the long run*.

Finally, our results reveal that with the transition from the status of a capitalist nation to a former communist one, there is a negatively and significant influence on economic output ($p < .05$), leading to a decrease of approximately 0.04 units in the current rescaled GDP per capita. Therefore, even after 30 years of political and economic transition from a planned economy to a market economy, the impact of the communist system on the economy remains evident. However, the magnitude of the impact differs from country to country because former communist nations have progressed differently (i.e. in terms of political and economic situations) since the momentous events of 1989–1991 when the Berlin Wall fell and the Soviet Union dissolved. These countries have experienced a discontinuous socioeconomic development process, with various periods of economic and political instability (for instance, during periods of global crises that emerged over the years) and are more affected than non-former communist countries.

Further, we evaluated two meaningful diagnostic tests for the estimation reliability. The first is the Arellano–Bond autocorrelation test for the first-differenced error terms in the second order. We focus on AR(2) because, as Teixeira and Queirós (2016) state, rejecting the null hypothesis of no serial correlation in the first order does not involve issues within the model; however, rejecting it at higher orders reveals a model misspecification. Therefore, in all models, the p-values of AR(2) are greater than .05, indicating no rejection of H_0. The second test was Hansen's *J* test for over-identifying restrictions in the statistical model. Hence, the moment conditions are accurately specified as the p-values from each model support the quality of the chosen instruments. These tests emphasise the quality of the models estimated using the GMM-system procedure. In summary, the outcomes were in line with our expectations, and all three research hypotheses were fulfilled.

5. Robustness checks

A crucial question regarding the validity of our estimations was whether the results were robust concerning the methodology used. Consequently, we check the robustness of our results concerning the estimation technique and how the explanatory variables are computed. Therefore, we employed structural equation modelling [SEM] estimation using the maximum likelihood method with missing values and expected information matrix standard errors (Table 10). SEM is a statistical technique used to examine the relationships between multivariate data (independent and dependent variables), which can be factors or measured variables. SEM is also called 'causal modelling, causal analysis, simultaneous equation modelling, covariance structure analysis, path analysis, or confirmatory factor analysis' (Jodie B. Ullman and Peter M. Bentler, 2012, p. 661).

In this case, we used six observed variables regarding the quality of policies and institutions and five observed variables regarding knowledge production (those also used in PCA methods), through which we created two latent variables: Governance quality and knowledge. Latent variables are indirectly observed/measured constructs inferred from directly observed variables. Therefore, we check the impact of two latent constructs (governance quality and knowledge) and two observed variables (tertiary immigrants and post-communist countries) on GDP per capita. Figure 8 shows a visual representation of the SEM estimation.

In comparison with the GMM-system estimations, in SEM, the magnitude of the coefficients of each item is considerably increased. However, all explanatory variables preserved their signs and remained significant at the 1% or 5% level. The post-communist country variable registers the greatest coefficient value in the module (-0.491), as we also encountered in the baseline estimation of the robust regression analysis, followed by tertiary immigrants (0.389), governance quality (0.384), and knowledge (0.091). To conclude, this research has robust results concerning changes in the methodology used as well as to the use of a different measurement of the variables (i.e. governance quality and knowledge). Appendix (Table A2) provides the Cronbach's alpha for each variable (as well as the overall value), which assesses the internal consistency of the set of items. Therefore, all variables revealed values above 0.9, which are very good results, indicating that the items are closely related as a group (high-scale reliability).

Table 10. Determinants of GDP per capita (SEM estimation)

Variables	Coefficients
Tertiary immigrants (observed variable)	0.389***
	(0.04)
Post-communist country (observed variable)	-0.491***
	(0.03)
Knowledge (latent variable)	0.091**
	(0.04)
Governance quality (latent variable)	0.384***
	(0.04)
No. of observations	325

Source: computation in STATA

**p < .05, ***p < .01. Expected information matrix standard errors shown in parentheses. GDP per capita = gross domestic product per capita; SEM = structural equation modelling

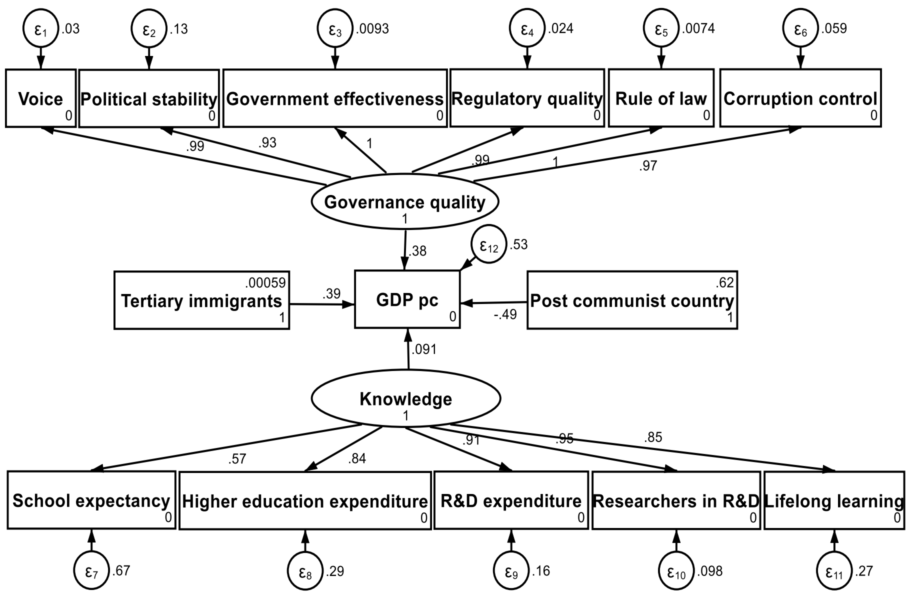

Figure 8. SEM estimation for the determinants of GDP per capita

Source: computation in STATA

GDP pc = gross domestic product per capita, R&D = research and development; SEM = structural equation modelling

6. Conclusions and policy implications

This study evaluated the impact and magnitude of human capital (focusing on an educated foreign workforce), knowledge acquisition, and global governance quality on economic output (proxied by GDP per capita). We used both qualitative and quantitative approaches. The sample consisted of EU member states between 2000 and 2020 (for the qualitative approach) and between 2008 and 2020 (for the quantitative approach). We started by employing PCA method with the purpose of generating two indicators from different variables of interest, which we labelled knowledge and global governance quality. In this way, we could reduce the number of variables in the dataset but still ensure that most of the information is preserved.

Further, in the first part of the study, we collected numerical data on growth and various possible factors of influence (resources invested in R&D, endowments with human capital/PhD foreigners, social mobility, governance quality, and income inequalities), which we transformed into categorical data (each indicator has values ranging from three levels: high, medium, and low). Subsequently, we performed SNA by applying five community detection methods: Louvain, Walktrap, Spinglass, Leading Eigen, and edge betweenness. We followed this approach to obtain a clear framework for the interactions between high, medium, and low levels of GDP per capita and the high/medium/low levels of the other variables analysed. In this manner, we could identify subgroups of features that are tightly linked.

Regardless of the method used, we always obtained connections between high and medium levels of the aspects analysed (low and medium levels, respectively). The outcomes are robust, as we never encounter low or high levels being part of the same group (e.g. low GDP connected with high quality of governance). The most appropriate algorithm for our dataset is Walktrap, which extracts a 'textbook' community with associations between 'low levels' of all indicators. Therefore, the interpretation is that states with low GDP per capita also have low R&D expenditures, scarce local populations with tertiary education, do not manage to attract many skilled and educated foreigners, have low social mobility, poor quality of governance, and struggle with high-income inequalities. Hence, among the analysed indicators, there are comprehensive relationships (strong endogenous links). Regarding the second extracted community, there are connections between 'high and medium levels' of the employed indicators. Therefore, a country could have some aspects framed as 'high' and others as 'medium' because some things are already good enough, while others still must be improved. In addition, as expected, the results highlight a specific heterogeneity among EU member states (i.e. the level of development, the phase of economic growth, innovation capabilities, and human capital endowment). Thus, there is no perfect means of gaining overall welfare; instead, countries should evaluate local conditions and find the best solutions according to the specificities of that region. Finally, the results are consistent with growth theories, as the three most important characteristics of each network are high GDP, high governance quality, and high human capital endowment (low scenario). Therefore, the importance of human capital and governance quality in achieving economic well-being has been emphasised.

In the second part of the study, we utilised quantitative data to run various econometric estimations such as robust regression, the GMM, and SEM. The results meet our expectation that for a country to achieve economic prosperity, a meaningful precondition is its past levels of GDP per capita (with the highest impact), followed by human capital endowment (emphasised by tertiary-educated foreigners), knowledge acquisition, and governance quality (perceived through both good policies and institutions). These findings are significant and remain robust to changes in empirical estimation techniques. These conclusions are consistent with earlier research on the same topic, which revealed the existence of cyclical relationships between investments in physical and human capital, technological advances, and prosperity (Acemoglu, 2008). Good governance is at the heart of well-thought out societal investment and, therefore, is based on economic growth (outcomes in line with the findings of Bogdan Dima, Flavia Barna, and Miruna-L. Nachescu, 218). Further, as in endogenous growth theory, technological change combined with human capital accumulation has the most beneficial influence on economic output. Therefore, improving the workforce's skills and knowledge leads to a higher stock of human capital, which further leads to improved productivity and knowledge creation and thus to better living standards and economies with high value-added.

We live in a globalised era, where countries sometimes cooperate and sometimes compete at the international level depending on their interests and goals. To gain technological progress, highly educated labour (both local and foreign), and subsequent economic growth, government policies and institutional frameworks should support and achieve product and process innovation, investments in R&D, and humans (i.e. in education, health, and well-being). Therefore, complex interactions exist between these aspects, and further research is required to discover the optimal path for each country to achieve economic growth and development.

Based on the conclusions drawn from the current research, we make the following recommendations for policymakers.

- As this study shows, human capital (both indigenous and foreign) is paramount in generating growth. Therefore, government spending should focus more on the education system so that all people have access to inclusive and equitable quality education and lifelong learning opportunities. Formal schooling must receive government support to create a qualified workforce with high cognitive skills. As is known from global experience, states that have experienced accelerated development and prosperity share the common characteristic of taking education seriously and investing appropriately in it (World Bank, 2018). Moreover, as the World Bank (2018) points out, because we live in a globalised era governed by rapid technological change, governments must continuously prepare human capital for future opportunities and unexpected challenges that could arise.
- Migration policies play an important role in attracting highly qualified inventors. Therefore, they need to be carefully developed in a manner that offers the opportunity for migrants to improve the quality of their lives (for example, offering different financial stimulations, granting tax facilities, social benefits, access to various educational programmes, simplifying entry/residence/integration procedures in the labour market, or recognition of professional qualifications). However, concurrently, countries should ensure that migrants contribute to the development of their economies of origin and destination (for instance, through knowledge transfers from destination countries back to origin countries, and *vice versa*).
- Over the years, different changes have emerged at the socioeconomic level (i.e. global competition for an educated and skilled workforce, skill-biased technical change, and population ageing) that have led to the creation of a labour market where it is often challenging to find suitable people for certain jobs. These situations increase the phenomenon of occupational mismatch, which leads to labour market inefficiency (Sara Flisi et al., 2017). Therefore, to take full advantage of human capital endowments (both local and foreign), countries need to ensure that workers fill jobs in accordance with

their education and qualifications. When workers' acquaintances, competencies, and job requirements are met, positive effects are generated not only for that person but also for the whole community. For instance, good job matching increases individual satisfaction and welfare, labour productivity, regional/country competitiveness, and ultimately the growth of the entire economy.

• Similarly, governments should allocate sufficient resources to R&D sectors to promote technology innovation, knowledge diffusion, and collaboration between scholars, enterprises, universities, and university-industry partnerships (within a state, as well as across states). A country's spending structure is crucial to its economic success.

• Although states could reach a short-term economic equilibrium, this does not necessarily imply long-run equilibrium. Therefore, there is an ongoing need for cooperation between states to promote a solid system of government, economic connections, and long-term progress for all countries, even those that need to catch up with the wealthiest ones (considering that states have different paces of progress).

• Finally, the evolution of governance mechanisms, technological changes, human capital accumulation, and growth are intertwined and often mutually determine each other. Therefore, there is not only a one-way causality relationship running from these aspects to growth but also a feedback relationship. In this respect, economic growth strategies should be carefully developed by each state based on the characteristics of that state, bearing in mind that the aforementioned aspects cannot be perceived in isolation but are interlinked.

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Appendix

Table A1. Qualitative approach for the determinants of economic growth, UE-27

Country	GDP per capita	Governance quality	Human capital index	Foreign doctorate students	Income distribution inequality	Social mobility index	R&D expenditures
Austria	High	High	High	High	Low	High	High
Belgium	High	High	High	High	Low	High	High
Bulgaria	Low	Low	Low	Low	High	Low	Low
Croatia	Low	Low	Low	Low	Medium	Low	Low
Cyprus	Medium	Medium	Medium	Medium	Medium	Low	Low
Czech Republic	Medium	Medium	High	Medium	Low	Medium	Medium
Denmark	High	High	High	High	Low	High	High
Estonia	Medium	Medium	High	Medium	Medium	Medium	Medium
Finland	High	High	High	Medium	Low	High	High
France	High	High	High	High	Low	High	High
Germany	High	High	High	Medium	Medium	High	High
Greece	Low	Low	Low	Low	High	Low	Low
Hungary	Low	Low	Low	Medium	Low	Low	Medium
Ireland	High	High	High	High	Medium	Medium	Medium
Italy	High	Low	Medium	Medium	Medium	Low	Medium
Latvia	Low	Low	Low	Low	High	Low	Low
Lithuania	Low	Low	Low	Low	High	Low	Low
Luxembourg	High	High	Medium	High	Medium	High	Medium
Malta	Medium	Medium	Low	Medium	Low	Medium	Low
Netherlands	High	High	High	High	Low	High	High

Poland	Low	Low	Medium	Low	Medium	Low	Low
Portugal	Medium	Medium	High	Medium	Medium	Medium	Medium
Romania	Low	Low	Low	Low	High	Low	Low
Slovak Republic	Low	Low	Low	Medium	Low	Low	Low
Slovenia	Medium	Medium	High	Medium	Low	High	Medium
Spain	Medium	Medium	Medium	Medium	High	Low	Medium
Sweden	High	High	High	High	Low	High	High

Source: Excel computation of each indicator's value at high, medium, and low intervals based on quantile repartition. GDP per capita = gross domestic product per capita, R&D = research and development

Table A2. Cronbach's alpha for structural equation modelling

Item	Obs.	Sign	Item-test correlation	Item-rest correlation	Average interitem correlation	Alpha
GDP per capita	325	+	0.6253	0.5332	0.2584	0.9098
Tertiary immigrants	324	+	0.3079	0.1803	0.2890	0.9255
School expectancy	325	+	0.5295	0.4231	0.2677	0.9149
Higher education expenditures	325	+	0.7829	0.7222	0.2432	0.9008
R&D expenditure	325	+	0.8431	0.7970	0.2374	0.8971
Researchers in R&D	325	+	0.9221	0.8977	0.2298	0.8920
Lifelong learning	325	+	0.8515	0.8077	0.2366	0.8966
Voice and accountability	325	+	0.9003	0.8924	0.2815	0.9058
Political stability	325	+	0.5358	0.5001	0.2889	0.9104
Government effectiveness	325	+	0.9074	0.8945	0.2654	0.8999
Regulatory quality	325	+	0.8442	0.8276	0.2751	0.9037
Rule of law	325	+	0.9124	0.8990	0.2622	0.8987
Corruption control	325	+	0.9377	0.9239	0.2461	0.8937
Post-communist country	325	-	0.4456	0.3957	0.2892	0.9117
Test scale					**0.2622**	**0.9110**

Source: computation in STATA

GDP per capita = gross domestic product per capita, R&D = research and development; Obs. = observations

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