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**Examining the long-term education policies of the Visegrad 4 countries in
the perspective of East Asian educational growth model**

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Abstract

As one of the foundations of the modern state, education and educational development should be taken into consideration by policy makers when formulating general policy (Yan, 2019). The East Asian region is a prime example of growth, so research on the role of education can help the lagging European countries to catch up and provide accurate policy recommendations. The research is structured around three research questions. The first question is which educational component influences growth. This was necessary because the literature gives them ambiguous roles; therefore, it may be crucial to clarify this in later discussions. In order to better understand how education in East Asian and European countries differ, the second research question focuses specifically on this region. It asks what factors have contributed to East Asian success. The third study focuses on Poland, the Czech Republic, Slovakia, and Hungary, which are members of the Visegrad Group (V4). It investigates precisely which metrics in this area are falling behind and what advancements these nations can make. To collect the data, I carried out secondary data collection by country. In the analysis I used several databases (World Bank, Penn World Table, OECD, UNDP and DECS) and the country categorization system to create different dummy variables. The data was collected between 1996 and 2019 and used in 4 different sub-period to observe the time trend. Data were analyzed using panel regression with random effect specification. The result of the research is that growth in government per capita, tertiary pupil-teacher ratio, and PISA scores are positively influenced the growth. In contrast, increases in governmental budget % of GDP, secondary and tertiary enrollment rates, and secondary pupil-teacher ratio decrease GDP per capita. In East Asia the governmental budget per capita, all and secondary level budget % of the GDP, and the vocational training ratio is lower, while the pupil-teacher ratio at primary and secondary level, PISA scores are higher. The analysis shows that the V4 countries are lagging in several variables. The results suggest that Visegrad countries should focus on three variables: governmental budget per capita, pupil-teacher ratio at secondary level and PISA score.

I. Introduction

Education shapes the lives and future opportunities of citizens from the very beginning. Every student encounter educational deficiencies directly or indirectly, but it is not their responsibility to change them. Today, education is the cornerstone and pillar of the modern state (Schofer - Ramirez - Meyer, 2021)., which is why policy makers are constantly trying to improve it. However, education policies can vary widely from country to country, which can lead to different development paths.

The literature now agrees that there is a link between education and growth (King - Levine, 1993, Barro, 2001, Maneejuk - Yamaka, 2021), which makes it inevitable for the state to examine it. Often, research on theory does not provide practical advice to policy makers, which means that the results are not used, or change is slow. This research seeks to bridge this gap by translating the results of econometric models into practical advice for the Visegrad countries.

The research is structured around three central questions. The first question is a question often addressed in the literature; namely how different educational variables affect growth. The second question examines the variables on which East Asia and Europe differ. Research on the role of education can aid the developing European nations in catching up and in making informed policy recommendations because the East Asian region is a pristine example of growth. The third question examines the situation of the Visegrad countries, looking at which education-related variables they lag and how they could improve in the growing.

The research starts with a theory and literature review in Chapter II, followed by a methodological summary in Chapter III. The results are presented in Chapter IV and the discussion in Chapter V. Chapter VI is the conclusion.

II. Theory and literature review

Education and educational development are seen as one of the pillars of the modern state and should therefore be taken into account by policy makers when shaping everyday policy. Both policy research and practical application of policy have largely acknowledged the significance of basic education for economic and human development (Yan, 2019). This chapter analyzes the relationship between education and growth, East Asian education policies, European and then V4 education development.

II.1. Education and growth

When politicians and economists discuss policies that could boost growth rates, education often takes the center stage. The real facts on how growth is impacted by education is very ambiguous (Temple, 2001). Nonetheless, there is a wealth of research that shows a correlation between economic growth and education that is favorable, and that led economists to redirect their attention to the economic value of education (King - Levine, 1993, Barro, 2001, Maneejuk - Yamaka, 2021).

The effect of education on economic growth was one of the factors contributing to the shift in attention in economics towards the economic function of education. Researchers studying economic growth in the 1950s discovered that a sizable amount of growth remained unexplained if only the traditional production elements of labor, land, and capital were taken into consideration as explanatory variables when assessing growth. Technical advancement was initially regarded as the source of the "residual unexplained value", but even later, the traditional definition of capital had to be expanded to include human capital, and hence education (Varga, 1998).

Even though it is crucial to measure how education affects productivity, it is unclear how much spending on education will be based on empirical evidence, especially given that education policy serves many purposes in addition to boosting productivity (Temple, 2001).

The overall data on education and growth for large samples of countries is still being debated. This is especially true if one uses the change in average educational attainment to explain growth at the aggregate level to support the significance of education found in estimates of earnings regressions (Temple, 2001).

Investing in human capital for economic growth should be focused primarily on basic education. It is essential to have a high quality, universally available education before

developing higher education (Jimenez - Nguyen - Patrinos, 2012). Education's role in the diffusion of knowledge and technology offsets the diminishing returns to physical capital that would otherwise occur. Output per capita thus increases indefinitely, given the right policies are in place (McMahon, 1998). Income is also significantly influenced by education. The macro growth literature, however, has shown that changes in average schooling levels across countries are not always related to growth, even though initial levels of education are linked to a country's subsequent GDP growth rate (Krueger & Lindahl, 1999).

Government leadership is vital in addressing the information, incentive and capacity challenges facing education, and in making education accountability reforms more coherent, thoughtful and practical. Accountability is increasingly emphasized to improve the quality of primary education (Yan, 2019).

For decision-makers, investing in the educational components of the system that have the greatest social returns is the obvious way to increase growth. However, depending on each country's level of development, income distribution, and educational system structure, the advantages of investing in different educational levels are anticipated to vary (Krueger & Lindahl, 1999). Economic growth goes hand in hand with demand for highly skilled labor, so countries devote an increasing share of their budgets to higher education over time (World Bank, 2018). In parallel with spending on higher education, well-performing economies have continued to increase spending on primary and secondary education, which has a positive long-term impact on the quality of education (Hsieh - Klenow, 2010; World Bank, 2018).

The development of human capital is key to endogenous growth in all countries. First, an alternative way of measuring investment in human capital is to use enrollment rates (McMahon, 1998). There is a correlation between higher initial secondary school enrollment rates and faster growth afterwards (King - Levine, 1993). Higher education enrollment is linked to key dimensions of rationalization, globalization, social mobilization, and the expansion of the service economy. In fact, the central features of modern society depend on the institutionalized, distinctive form of higher education worldwide (Schofer - Ramirez - Meyer, 2021).

Second, the amount of schooling is also measured by years of schooling, where growth in years has a positive effect on economic growth (Barro, 2001, Maneejuk - Yamaka, 2021). However, the number of unemployed graduates has a negative effect on economic growth in all countries (Maneejuk - Yamaka, 2021).

Third, A comparable measurement of the quality of school education is the performance of students in science-related mathematics and reading examinations. Economic growth is strongly positively associated with high scores on science tests (Barro, 2001).

It is necessary to examine the education system and the economic system at the same time, but research may produce biased results. This is because countries that are improving their education systems are also trying other growth-enhancing policies (Krueger - Lindahl, 2001). To try to counteract these effects, it is crucial to incorporate various control variables and econometric techniques.

II.2. Literature review

II.2.1. East Asia

East Asia is a region of Asia that can be defined both geographically and culturally. Traditionally, the following 8 countries have been classified as part of the East Asian region: Japan, Republic of Korea, North Korea, China and its autonomous city-states of Macao and Hong Kong, Taiwan, and Mongolia (Berglee, 2012).

Primary education has been common in East Asian countries for a long time, but improvements in the quality of secondary education also have played a prominent role in achieving high government investment rates and per capita growth. If investment in primary education becomes universal, spending on secondary and tertiary education will be more significant from there (McMahon, 1998). Rao et al. (2019) have highlighted that not only is primary education important, but that special efforts should be made by governments to ensure that all children have access to quality early childhood education. A positive relationship between close proximity and the development of cognitive and non-cognitive skills has been demonstrated in countries of all income levels (Rao et al, 2019). When analyzed across the region, countries where early childhood education and development services were available to the population reached higher PISA scores than those without (OECD, 2013-14).

In East Asia, support for secondary education has helped to create a successful export-led growth strategy. This is particularly noticeable in developing countries in the 1990s but there was a similar pattern observed beforehand in East Asia, as these countries sought to attract capital from Japan and world capital markets, and human capital became a key factor in this effort (McMahon, 1998).

The increased impact of globalization and marketisation has created new forms of internationalization of higher education in many East-Asian countries. The effects can be seen in the influx of imported foreign higher education services and the export of education programs abroad from the countries' point of view (Huang, 2007). Furthermore, the policies offered citizens a vision of the future in which parents saw their children gaining secure employment as they obtained higher education through school. The initial success in employing graduates in newly established industries reinforced both the demand for schooling and the value that parents placed on their children's performance (World Bank, 2018).

Creating entrepreneurship is an important factor in East Asia, which is closely linked to education. In the long run, enterprises contribute to industrialization, economic growth and improve living standards, and the tax revenues from their enterprises contribute to the financial growth of the nation. It is in the interest of the state to support citizens with substantial financial incentives to create entrepreneurs through supporting education (Dana, 2001).

There are several transnational or national surveys available to measure educational performance in the region. Transnational may be the PISA survey (World Bank, 2018), while national can be the Chinese CEPS, which collects detailed data on household expenditure on education, public financial support to students such as free school meals and free textbooks, and a wide range of personal, family, class and school characteristics (Wang - Cheng, 2022).

II.2.1.1. PISA scores

East Asia has a total of 304,4 million school-age children. According to the Word Bank (2018), only 3 percent of school aged children are out of school in East Asia and the Pacific, which is 13 per cent of the world's out-of-school children. China has over 10 million students in the national education system. In its research, Word Bank (2018) divides East Asian countries into 4 groups: emerging countries, countries performing above or below the OECD average, and areas with best performing education systems.

Group	Group countries	Average all PISA scores*	Number of students (million students)**
Emerging countries	Mongolia, North Korea (n.a)	-	0,7
Countries performing below OECD average	-	406	-
Above OECD average performing countries	China	512	266
Best performing countries	Hong Kong SAR, Japan, Republic of Korea, Macau SAR, Taiwan	556	37,7

Table 1: Grouping of East Asian countries by educational development - Source: World Bank, 2018 – Own edit

** Composite constructed average of PISA performance over all available iterations of all countries in East Asia and the Pacific, World Bank calculation*

*** The Pre-primary (before primary, example kindergarten etc., Primary, Secondary and Higher education*

The first group is the emerging countries, which do not participate in global comparisons, so PISA results cannot be attributed to them, and Mongolia and North Korea could be included. Emerging countries should focus on ensuring that all young people have the fundamental right to learn. Spending tracking is a priority for the primary education. Continuous benchmarking and test scoring of grades is a relevant to improve basic reading and mathematics education. A secondary goal should be the appropriate allocation of resources and the use of policy to support teachers. It is then important to review teacher training and the extent to which it focuses on improving the quality of education (Word Bank, 2018).

The second group consists of countries with a persistent position below the OECD average. Countries with below-average performance should review the number of teachers and their policies, as this could help to improve the institutional context. In the long term, this could lead to comprehensive reforms aimed at improving the quality of education. The introduction of monitoring, collaboration and feedback, and the creation of appropriate incentives for teachers, will pay significant dividends. Classroom evaluation programs should be complemented by national evaluation systems, which should be adapted to internationally comparable data. Making teachers' work easier should be a priority. At the same time, holding teachers accountable and increasing the attractiveness of the teaching profession will increase good classroom performance (Word Bank, 2018). Shaturaev's (2021) research found that low-quality physical infrastructure is a fundamental aspect for education in countries performing below OECD average. The quality and low welfare of teachers emerge as factors requiring change. In addition, it is important to mention that education is very costly but if it remains underfunded, it will limit educational opportunities (Shaturaev, 2021).

The group of above-average performers is defined as scoring above the OECD average on the PISA test. In the region, this category includes China, which had an average PISA score of 512. China had 266 million students in 2018. It is important to highlight that continuous improvement is also important for above-average performers. Increasing and monitoring the knowledge of the teaching profession is an important long-term concern. The continuous improvement of the education system and its adaption to new needs should be an objective, including the teaching and measurement technological and problem-solving skills. In addition, it is essential to promote the widespread uptake of early childhood education and development programs (Word Bank, 2018).

The best performing countries perform better than the OECD average education year by 1.6 years. Countries in this group are Hong Kong, Japan, Republic of Korea, Macao, and Taiwan. The countries in that group have an average PISA score of 556, but only 37.7 million school-aged people belong to this group. The education systems in these countries are characterized by continuous and creative improvement, which stimulates teacher motivation and competence development. Their ongoing efforts show that maintaining and expanding existing capacity and expertise is a prerequisite for performing continuously above average. This kind of thinking is essential for systems with outstanding results, as it will sustain continuous improvement (Word Bank, 2018).

II.2.1.2. China

The traditionally very controlled Chinese educational system is recently progressively shifting to a more decentralized one, where local governments are given more control over finance, policy execution, and curriculum development. China aims to educate over 266 million children in 2018 from pre-primary through tertiary levels and to ensure that its 15 million instructors uphold the high standards required to position the nation for future economic development in its more than 500,000 schools. Nine years of education are required in China. Pre-primary schooling, which is currently primarily offered through private institutions, is now universally available. Students who have completed their ninth year of school take the zhongkao exam, which determines whether they will be admitted to upper-secondary education. The gaokao, which determines university admissions, is open to students who have completed upper-secondary education. Teachers must also meet state requirements for teaching. Before submitting an application for a teaching position, teachers must be certified. A new system of certification is based on the results of a nationwide exam is implemented in China (Word Bank, 2018).

The Ministry of Education, a body of the government that reports to the State Council, develops legislation and sets policy for the nation's educational system. The delivery of education remains the responsibility of county-level education offices, who also handle most of the financial management, local policy development based on ministry directives, organizing standardized testing, and other administrative duties. National standards for curricula, including lesson length and other requirements, are established. Based on national instructions, provincial authorities create implementation plans; these plans must be reviewed before being put into action (Word Bank, 2018).

II.2.1.3. Hong Kong, SAR

Under British administration, the educational system was mainly “imported”. The system employs over 55,000 instructors and educates about 1.2 million children from pre-primary through university levels. From elementary to secondary school, all students must attend mandatory classes. There are six years in primary school. Students are taking the Hong Kong Diploma of Secondary Education Examination after upper-secondary school. Usually there are more competent students than available slots in tertiary education. As a result, many of students go to college abroad. Education is managed by the Education Bureau. Curricula are created by the Curriculum Development Council, an autonomous advisory board of subject matter experts (Word Bank, 2018).

II.2.1.4. Japan

Japan's educational system is largely centralized. The Ministry of Education, Culture, Sports, Science, and Technology (MEXT) established strict requirements for educators, institutions of higher learning, curricula, and many other areas of education. The 21 million pupils in Japan routinely score in the top third on international exams. About 1.3 million teachers are employed in Japan's pre-primary through postsecondary schools. Although upper-secondary education is almost always continued after the nine years of compulsory school (Word Bank, 2018).

The Central Council for Education and specialists from universities across Japan provide input as MEXT creates the country's curriculum. The curriculum is changed every ten years, to guarantee that its content meets the demands of Japan's students and workforce. Most of the time is devoted to a small number of core courses in Japan's curriculum, which is quite specialized. Japanese teachers receive extensive training. MEXT mandates that all prospective instructors complete a recognized university program (Word Bank, 2018).

II.2.1.5. Republic of Korea

Korea employs roughly 550,000 instructors in pre-primary through postsecondary schools and educates about 11 million pupils from pre-primary through tertiary levels of education. In the Republic of Korea, there is a fair amount of decentralization in the education system, and each school has a great deal of autonomy over its curriculum and employment practices. At the county, municipal, and provincial levels, offices of education are responsible for supervising the administration of educational policies. Although upper secondary and university education are typically pursued after the nine years of required schooling in Korea. At the conclusion of high school, students take the College Scholastic Ability Tests in order to be admitted to universities (Word Bank, 2018).

II.2.1.6. Macao, SAR

One of the most dispersed systems in the region is found in Macao SAR, China. The majority of schools are privately and freely operated by various social and religious organizations. Most primary and secondary institutions offer free or discounted tuition. Roughly 100,000 students in prekindergarten through postsecondary education are educated in Macao SAR, China, which also employs about 5,000 teachers in these institutions. The school system is overseen by the Bureau of Education and Youth Affairs. Teachers must hold a postgraduate education from a teacher's college or an equivalent program in order to work in both private and public schools. The Education and Youth Affairs Bureau is in charge of examining the credentials of teachers (Word Bank, 2018).

II.2.1.7. Mongolia

About 35,000 teachers work in pre-primary through high schools in Mongolia, which has about 700,000 pupils in primary through higher education. A four-year degree from a teaching college is required for teachers. In addition to drafting, authorizing, and publishing materials and the national curriculum, the Ministry of Education, Culture, and Science is in charge of all educational monitoring. Each province's education and culture departments oversee finances, operations, quality control, and staffing for school administration.

In Mongolia, attendance at primary and lower secondary schools is required. Due to its failure to comply with sampling requirements, Mongolia did not take part in any international comparisons for the TIMSS round conducted in 2007. It did not take part in the following rounds, and it has not taken the PISA (Word Bank, 2018).

II.2.1.8. Taiwan

Taiwan is in the process of overhauling its educational system, moving away from a highly centralized system that prioritized rote memorization in favor of a system that is more student-centered and adheres to the demands of a changing economic landscape. It employs over 300,000 instructors in pre-primary through postsecondary institutions and educates roughly 4.4 million children from pre-primary through tertiary education. Taiwan recently increased its required schooling period from nine to twelve years. The action was a component of a larger reform initiative to modernize the educational system, which also included decentralizing and updating curriculum design and lowering the testing requirements for upper-secondary admission. At the federal, provincial, and local levels, the administration and regulation of the educational system are under the direction of the Ministry of Education. It is in charge of

establishing rules and guidelines for the creation and management of private educational institutions (Word Bank, 2018).

II.2.2. European Union

The European Union has traditionally tackled educational concerns with caution. The EU initially utilized soft regulation methods, then more layers of activity were gradually acknowledged and put into place (Nóvoa, 2013). While the European Union proposed various educational and training programs, the EU Treaties also reaffirmed that national governments should continue to formulate educational policies (Nóvoa - Dejong-Lambert, 2003). Aspects of the school curriculum and depictions of classroom life are inevitably going to differ substantially between countries due to the educational sovereignty of member states (Brock – Tulasiewicz, 2000). However, it has been evident that there has been a persistent effort to include a more European dimension into national educational programs (Dakowska, 2015; Nóvoa - Dejong-Lambert, 2003).

In addition to from economic, social, and political goals, joining the Single Europe has educational and technological expectations as well (Brock – Tulasiewicz, 2000). The economic challenge facing the European Union's member states highlights the need for pupils and professionals to be prepared for skilled work through widespread accessibility to technological innovation, the development of sociopolitical competencies, and the creation of opportunities for lifelong learning (Brock – Tulasiewicz, 2000).

II.2.2.1 Maastricht (1992) and Bologna (1999)

European educational cooperation went through a very cautious and constrained initial phase. Several "programs," based on voluntary or transient agreements, were used to achieve it. A policy created by the Maastricht Treaty to support European activities in this area is generally stated at the outset of publications published after 1992 (Nóvoa - Dejong-Lambert, 2003).

The Bologna Process aims to increase coherence among European higher education systems. It created the European Higher Education Area, in order to improve student and faculty mobility, provide access to higher education for all people, and increase the attractiveness and competitiveness of higher education in Europe on the global stage. All participating nations agreed to implement a three-cycle higher education system with bachelor's, master's, and doctoral studies, ensure the mutual recognition of credentials and learning experiences abroad completed at other universities, set up a process of quality assurance, and increase the standard

and relevance of learning and teaching as part of the European Higher Education Area (European Commission, n.d.2).

Bologna Process has shown little interest in a number of issues, the emergence of the private and for-profit universities and colleges, the influence of market forces, the decline of public funding for higher education and public research, the differences between the challenges faced by the old EU-15 and the new member countries (Kwiek, 2004). Bologna Process is not striving to provide a concept to support Central and Eastern European higher education systems in their convergence with western European systems (Kwiek, 2004).

The European Credit Transfer Scheme (ECTS) and other programs have been used to jointly organize parallel European courses in various European institutions due to the similarity of educational structures and practices across member states of the European Union as a part of the application of clear and specific EU directives, cooperation, and exchanges (Brock – Tulasiewicz, 2000). The flexibility of study plans for students is improved by ECTS. Additionally, it aids in the design, implementation, and assessment of higher education programs. It is a key element in the Bologna Process, which strives to increase the comparability of national educational systems on a global scale. Additionally, ECTS aids in the improvement of other documents' clarity and use internationally, such as the Diploma Supplement (European Commission, n.d.1).

II.2.2.2 Lisbon (2000) and The Education & Training 2010 Work Program

Two crucial decisions were made in Lisbon: the first was to shift toward a knowledge-based economy as a means of unionization; the second was the implementation of an open-method of coordination, constructing tools that will enable tracking and evaluation of progress made, along with a stronger coordinating and guiding role for the European Council to guarantee more clear strategic direction and efficient monitoring of progress (Nóvoa - Dejong-Lambert, 2003). By putting education at the center of European endeavors, the means to achieving a knowledge society were articulated in terms of "investment in people" (Nóvoa, 2013).

The European Council in Barcelona, in March 2002, adopted a program that would concentrate on systems of education and training and be completed by 2010. Mostly the EU texts consistently reiterate the same objective: elevating the European Union among the top performers of knowledge-based economies worldwide. In order to accomplish this goal, education and training must play a vital role as sources of innovation, growth, sustainable employment, and social harmony. The three main goals of the Education & Training 2010 Work Program were to increase quality and effectiveness, make education and training more

accessible to everyone, and open up educational and training systems to the rest of the world. The first goal was centered around the "key skills." of the "knowledge society". The evaluation of development and accomplishment using similar standards and indicators results from the goal to guarantee and monitor high-quality education. The second goal exemplifies the traditional discourse about lifelong learning in European institutions by reinterpreting "employment" as a learning challenge that each individual should address and asserting that the "crisis of education" will be resolved if people continue to pursue training and education throughout their working lifetime. The third goal was to create an open "European space for education" and advance the "European dimension of teaching and training". The notion of "experiencing Europe" coexisted with mobility initiatives and the mission to strengthen European citizenship (Nóvoa, 2013).

II.2.2.3 The Europe 2020 Strategy and The New ET 2020 Program

The severe crisis that hit Europe between 2010 and 2012 raised issues that cut to the core of the unionization process. On the one hand, there is a resurgence of national differences and fractures. The Europe 2020 strategy and its education-related consequence are defined by this context of crises and a degree of disorientation (Nóvoa, 2013). The ET 2020 program is centered around economy, on-the-job training, employment, flexible and creative training possibilities, sustainable investment, and a number of youth unemployment initiatives. There is a propensity to simplify educational issues by focusing on the demands of the economy and the training of professionals who can enter the job market (EUR-Lex, 2015; Nóvoa, 2013).

II.2.2.4 European Education Area

The Communication lays out the strategies and benchmarks needed to realize the European Education Area by 2025, with help from the Erasmus+ Program and Europe's Recovery Plan. Additionally, it suggests a framework for interaction with education stakeholders and collaboration with Member States, as well as a reporting structure with agreed-upon education targets to support and monitor reforms. The two long-term strategic targets of the Action Plan are first promoting the growth of a high-performing ecosystem for digital education and second improving digital capabilities for the digitalization. Six pillars support the European Education Area: educators, university education, a greater Europe in the world, inclusiveness and gender equality, quality, and green and digital transformations (European Commission, 2020).

II.2.3. V4 countries

At the point of the transition from communism to a democracy, the educational systems in Czechoslovakia, Hungary, and Poland were just slightly different, but the related ecological,

political, and social institutions have evolved dramatically since 1989 (Chase, 1998). There were also Communist Party-defined and closely supervised curriculum guidelines, research objectives, and requirements for filling teaching positions, as well as a unitary system of conventional higher education. These had a highly centralized higher education system, with attempts to balance the quantity of graduates with the number of jobs, and with educational credentials being more important in job application than actual knowledge or skills. The demand for high-quality higher education and severe financial constraints have long clashed in post-communist Central Europe, particularly during the 1990s when pressures for reform on the sector's higher education institutions were at their peak (Kwiek, 2012).

The transitional shock on the labor market was caused by the move toward general schools and the rising demand for postsecondary education. General education provided greater possibilities for employment and higher income prospects than specialized training when faced with unexpected restructuring and uncertainty regarding the skills in demand (Walterová, 2018). Also, the proportion of young people who continue to tertiary, higher education is significantly rising.

From the communist era, all the above-mentioned countries inherited relatively constrained tertiary education access and substantial funding for vocational education. Apart from a recent decline in Hungary and Slovakia, the number of students enrolling in tertiary education has gradually climbed in all nations since the 1990s (Dakowska, 2015).

Despite the aforementioned similarities, the V4 nations have different policies in terms of their current state of development and the types of measures they have implemented. The reports indicate that Hungary appears to be a regional leader. Following discussion on the effectiveness of higher education, a complicated policy encompassing a wide variety of initiatives was developed (Stiburek - Vlček - vec, 2017).

These initiatives include adjustments to the tuition fee policy, information support and advisory services for students and candidates, as well as the inclusion of dropout and completion statistics in external quality assurance procedures. Although there were improvements made to study success in Poland and the Czech Republic, their scope and number were more constrained. Finally, Slovakia has only passed a small number of measures thus far, and the issue is generally low on the government priority list (Stiburek - Vlček - vec, 2017).

Since 1990, the educational systems in all four mentioned nations have undergone a significant decentralization. While decentralization was delayed and only partially implemented in

Slovakia, important reforms were introduced in the Czech Republic, Hungary, and Poland in the middle of the 1990s. While in Poland and Hungary the majority of authority was granted to local governments, in the Czech Republic schools were allowed a great deal of autonomy. Most quality-related capabilities were kept at the central level in Poland (Walterová, 2018).

Local governments play a significant part in the system in every nation. However, the municipal government is more disorganized in the Czech Republic, Slovakia, and Hungary. Compared to the other three countries, Polish towns have significantly more administrative and financial capabilities to run schools (Walterová, 2018).

Regarding student tracking, the four countries' educational systems are different from one another. While early student specialization path tracking is permitted in the Czech Republic, Slovakia, and Hungary (after grades 4 or 5), all Polish pupils must complete lower secondary school (grade 9) before being placed on an academic or vocational track (Walterová, 2018).

Standardized tests are given in schools in Slovakia, Hungary, and Poland but not in the Czech Republic. Slovakia only gives one test (in grade 9), whereas Hungary and Poland assess students' abilities on multiple occasions throughout their academic careers. The test results are intended to be a diagnostic tool for schools in each of the three nations, but only in Poland and Hungary may they also be used to hold schools accountable (Walterová, 2018).

All countries have laws governing the teaching profession. Poland oversees teacher education, sets required teaching hours, supervises pay, and outlines the promotion system. The promotion of teachers' careers appears to be less clear in the Czech Republic, Slovakia, and Hungary (Walterová, 2018).

In comparison to other occupations needing a university degree, teachers' pay is more desirable in Poland than it is in the other three nations. Furthermore, Poland has one of the lowest legal teaching hours among OECD nations and the lowest statutory teaching hours overall (Walterová, 2018).

The central governments of the four countries set the basic curricula for schools, although the degree of autonomy given to schools varies throughout the four systems. The Czech Republic and Hungary have relatively general core curricula, and schools are free to use a variety of instructional strategies. But in 2011, a recentralized curriculum began to be implemented in Hungary. Over the course of the whole study period, Poland and Slovakia have maintained the most control over the school curriculum (Walterová, 2018).

A similar characteristic is that, the vocational route predominated over general upper secondary education in all of the countries under consideration. According to the central planners in each country, the structure of upper secondary education matched the requirements of socialist economies (Walterová, 2018).

II.2.3.1. Poland

Education is required from the age of five to sixteen in Poland. Polish secondary education is extensive, there is student tracking beginning at age 16, and there is low class repetition rate. Of all OECD nations, Poland has one of the highest percentages in the 25 to 34-year-old cohort who have completed at least upper secondary education. In Poland, there are also a high number of students enrolled in programs that combine tertiary education with vocational training (VET). While Poland's schools have less liberty when it comes to allocating resources.

Although only tertiary level education is required, practically all lower secondary teachers take part in a pre-service teacher-training program that lasts five years and includes a mandated teaching practicum (OECD, 2015b).

Since 1989, two concurrent processes have taken shape: the extensive privatization of higher education and the increasing European future in the education (Dakowska, 2015). Prior to the 1990s, the majority of secondary school students attended various sorts of vocational schools, and only a very small number of them had access to further education (Jakubowski, 2010). After 1990, there was an expansion of private universities, which led to issues with study quality and pupils' reputational concerns (Sojkin - Bartkowiak - Skuza, 2012).

The government completed its first reform in 1999, the same year the Minister of Education unveiled a plan for change. Three key goals were established: assuring equitable opportunities, enhancing educational quality, and elevating the educational standards of society by increasing the number of persons with secondary and higher education (Jakubowski et al, 2010). The reformers believed that primary schools, particularly in rural areas where there were few schools, would help Poland improve the quality of its education. The new lower secondary schools would have more students (at least 150), better facilities, and teachers with the necessary qualifications working there (Jakubowski et al, 2010). A key factor in assuring the quality of the educational system was the implementation of national comparison exams at the conclusion of each educational stage. Poland has also expanded the general curriculum of technical schools and enhanced assistance for pre-primary education. As a result of all the revisions, the minimum length of compulsory comprehensive education has increased from eight to at least ten years (Jakubowski, 2015). Polish education has greatly improved after the

changes of 1999. The country performing near or above the OECD average show the largest improvement in average performance (Jakubowski, 2015).

The curriculum underwent significant revision in 2008, which initiated the next set of adjustments. While the 1999 reform concentrated on addressing inequities in access to high-quality general education, the 2008 reform altered how students were taught in all schools, regardless of program or ability level, (Jakubowski, 2015). The new curriculum reduced the requirement for knowledge mastery and placed more emphasis on problem-solving, analytical abilities, and even "soft" qualities like teamwork (Jakubowski, 2015). New types of evaluation changes were also included in the reforms. Since 2009, the previous, rather bureaucratic monitoring system has been gradually phased out and replaced with the new school assessment system (Jakubowski, 2015).

Several significant changes were made in 2008, and these have been addressed by the new curriculum, which was introduced in 2016. Notably, the new curriculum has lifted the 2008 practice of combining some subjects into interdisciplinary blocks for students specializing in other subjects (Jakubowski, 2021). The long-term goal of the Strategy for the Development of Human Capital 2020 was to raise the standard of higher education and better match educational opportunities with labor market demands.

The early education reform initiative began in 2009 and finished in 2015. It expanded access to nursery education to children aged 3 and 4 and made education for 5-year-olds mandatory. Overall, the changes increased the length of mandatory comprehensive education from eight to ten years (Jakubowski, 2021).

The Ministry of National Education and the Ministry of Science and Higher Education oversee the Polish educational system, which is also locally run by a three-tiered public administration system. The Centre for Education Development helps educational institutions like schools fulfill their legal obligations and boost performance. It aids instructors in enhancing their pedagogical abilities. The National Centre for Supporting Vocational and Continuing Education and the Educational Research Institute are additional organizations tasked with raising standards and advancing the development of national education policies. The Education Superintendent Offices carry out regional implementation of national education policy. Their primary responsibility is the pedagogical supervision of the public and private schools, as well as the teacher preparation facilities, located in their area. The Central Examinations Commission coordinates the efforts of the regional examination branches and creates the external student evaluations. The Minister of Science and Higher Education receives advice

from the General Council of Science and Higher Education. The level of tertiary education is evaluated by the Polish Accreditation Committee. Through consultation, the Students' Parliament of the Republic of Poland, the Conference of Rectors of Nonuniversity Higher Education Institutions, the Rectors of Academic Schools in Poland, and the National Representation of Doctoral Students take part in system-level governance. Association groups and labor unions like the Polish Teachers' Union and headmasters' organizations like the National Association of School Management Staff are examples of additional stakeholders (OECD, 2015b).

The Polish education system stands out in Central and Eastern Europe in terms of funding. Salary increases at all levels averaged 50% between 2006 and 2012. To prevent unfavorable selection into the profession, the youngest teachers received the largest increases (Jakubowski, 2015). According to the OECD (2015b), the Ministry should keep working to expand enrollment in early childhood education, especially in rural areas, in order to achieve educational parity also it must lessen the skills gap in the labor market, maintain the quality of its VET system, and boost adult learning while raising adult reading and numeracy levels (OECD, 2015b).

II.2.3.2. Czech Republic

Pre-primary through tertiary education is offered in the Czech Republic. Along with education, extracurricular activities, and school meals, it also includes support services. Children between the ages of three and six receive a pre-primary education in kindergartens (Greger - Walterová, 2018). From the ages of six to fifteen, compulsory schooling generally lasts nine years. Students receive grades between 1 and 5 and are evaluated orally or through marks. Primary school dropout rates are extremely low (less than 1%), and only one stage allows for grade repetition. Almost everyone in this age group enrolls in upper secondary education after finishing primary school (Greger - Walterová, 2018).

The deconstruction phase is used to describe the initial, earliest stage of educational transformation, which only lasted a few months immediately following the political turn in 1989 (Greger - Walterová, 2018). The primary objective of this time was to immediately address the most obvious educational deficiencies brought on. De-ideologizing legal communist documents, including curriculums, and privatization were two of the most significant tasks of the beginning of the transformation. Secondary schools and higher education institutions were no longer required to admit a set quota of students as a result of the economic reform and the elimination of the state economic planning system, and they started

to make decisions about their own fields of study and education as well as the number of applicants they could accept (Vecová, 2000).

Between 1991 and 2000, there were gradual shifts brought about by communist organizational, pedagogical, and legislative changes. The majority of the reforms were spontaneous, emerging from the field of education, and later, they were founded on unstructured measures. After 1989, public spending on education grew gradually before peaking in 1995 (Greger - Walterová, 2018). The government packages put forth in the spring of 1997, which sought to maintain a balanced state budget and, as a result, imposed drastic spending cuts, had a detrimental effect on the education budget as well (Greger-Walterová, 2018).

The government's long-term strategy document (White Book (2001), set a goal to raise public spending on education to 6% of GDP. Although spending has increased after 2001, it did not reach 6% of GDP until 2018 (Greger - Walterová, 2018). Additionally, the document suggested the introduction of a maturity exam the implementation of which continued until the Education Act of 2004. It also called for a gradual fusion of two previously existing branches of education (selective high school and primary school stage 2), with internal differentiation within primary schools. The new Education Act also included the new matriculation exam that was suggested in the White Book (Greger - Walterová, 2018).

The Long-Term Plan for Education and the Development of the Educational System (MYES 2010, planning for 2011–2015), sought to enhance the quality and efficacy of the educational system in a number of areas, including vocational education and training, and assessment and evaluation (OECD, 2013).

A comprehensive plan for student success wasn't first published in the Higher Education Development Framework until 2014. The European Commission demanded that the issue be included in a strategic framework before the European Structural and Investment Fund operational programs were approved, which in large part forced the innovations (Stiburek - Vlk - vec, 2017).

The Higher Education Development Framework's recommendations were continued and expanded upon in the Strategic Plan for 2016–2020. In comparison to all previous documents, this one includes a quantitative goal of 60% of the initial courses that began in 2015 to be successfully completed within the normal timeframe plus one year. Early school exit is still a minor policy item on the agenda (Stiburek – Vlk – Švec, 2017).

The Czech Republic sought to conduct top-notch research through the Operational Program Research, Development, and Education (2014–20). It also structurally transforms the economy toward to one based on skilled labor. In order to better align VET curricula with employers' needs, a long-term education plan (2019–2023) was adopted in June 2019 (OECD, 2020)

Czech education is supported by a wide range of institutions. The task of creating a national education policy and long-term policy objectives that serve as a roadmap for the system at all educational levels falls under the purview of the Ministry of Education, Youth, and Sports (OECD, 2020). The National Pedagogical Institute of the Czech Republic (NPI) creates methodological tools and supports for educators and institutions, offers professional development, and oversees curriculum reform (OECD, 2020). The Czech School Inspectorate evaluates the standards of educational establishments (except for higher education) and carries out monitoring and analysis for system level reporting. Strengthening external evaluation for school improvement is a goal of the Czech School Inspection Strategy (2014–20) (OECD, 2020). In addition to creating assessments and tests for secondary school exit exams, the National Accreditation Bureau for Higher Education also plans to create tools for evaluating and self-evaluating primary and secondary schools (OECD, 2020; Greger - Walterová, 2018). The higher education industry is supported by the Centre for Higher Education Studies, a public research center (OECD, 2020). The National Agency for European Educational Programmes (NAEP) is a hub for international services to schools and students, the organization in charge of overseeing EU education initiatives, and supports the growth of European school networks (Greger – Walterová, 2018).

In terms of funding, it is important to note that average per-pupil expenditure is increasing steadily at all levels of education, but still not at the targeted level. At the same time, spending on education as a share of GDP is low and is concentrated primarily at secondary level, where the returns are highest. Teaching careers are characterized by low pay and low social status, which undermines the chances of a steady supply of new teachers (OECD, 2020).

II.2.3.3. Slovak Republic

Unlike the other V4 countries, the early childhood education typically begins in the Slovak Republic at age 2, with enrollment rates for children aged 3 to 4 falling below the OECD average. The age range for compulsory education is six to sixteen. Low rates of level repeat exist in Slovakia. Regional schooling (kindergartens, primary schools, high schools, vocational schools, and primary art schools) and college education make up the two main categories of Slovakia's contemporary educational system (OECD, 2015c).

Following the political shift of 1989, the system of school administration underwent a dynamic democratization towards self-government. The Ministry of Education released the base of the new system in 1990 under the banner Spirit of School. There were no legislative, organizational, or curriculum decision that could have a significant impact on the standard of education (Kosova - Porubsk, 2018).

The Konštantín, a strategic plan created by the Ministry of Education in 1994, attempted to create a vision of educational development for the following ten years with the goal of achieving qualitative and quantitative changes that would bring Slovak education closer to European norms. Goals like increasing the number of students accepted at higher education institutions were first established here (Kosova - Porubsk, 2018).

The project dubbed "Millennium" has been the most successful. A group of educational specialists took the initiative to explore for a potential societal and political agreement on the development of a national education program. This was adopted by the administration in 2001 under the name The National Programme of Education, and the national parliament followed suit in 2002. Focus was placed on reviving educational research, changing curricula, decentralizing management and finance of schools, and improving the caliber of instruction in foreign languages (Kosova - Porubsk, 2018).

The New Educational Act was Slovakia's most comprehensive education reform law from 2008, which undervalued the particular contribution written what language makes to children's language and cognitive development as well as their later academic success (Petrová – Zápotocná, 2018).

State preschool education program (SPEP) was a new national preschool curriculum that was put into place in 2008, which decentralized educational policy by giving preschools the autonomy to choose how they would meet the common core standards outlined in the national curriculum (Petrová - Zápotocná, 2018).

In Slovakia, cultivating critical thinking has long been a top emphasis. This was described in the SPEPs that were renewed in 2015 and 2008 (Breka, Valentová, Lanari, 2022). Reexamination of the school-based literacy methods was required due to an increasing number of young people lacking the fundamental reading abilities needed for higher education.

The Slovak educational system is managed by three distinct levels of public administration: the national government, regional and municipal governments, and schools. Pre-primary, primary, secondary, and higher education policies are established at the national level by the Ministry of

Education, Science, Research, and Sport of the Slovak Republic. The MoE establishes the educational framework, oversees the school network, allots funding, and monitors student progress and school compliance.

The National School Inspectorate oversees the quality of pedagogical planning and material-technical conditions on behalf of the state. The National Institute of Education is responsible for the methodological management of schools and the educational activities of teachers. The National Institute for Certified Educational Measurements coordinates Slovak participation in international tests as well as administers, produces, and monitors national exams. Plans and ideas for expanding vocational education are developed and put into action by the National Institute of Vocational Education. The Institute also conducts surveys on the state of the labor market and the demands of the national economy. The Methodology and Pedagogy Center plans and executes educational programs for the teaching and support staff employed by schools and educational institutions (OECD, 2015c)

On the one hand, many teacher training incentives have been introduced in the country, but the expenditure on educational institutions as a percentage of GDP for all levels of education shows one of the main reasons leading to a low quality of education in Slovakia according to international comparisons (Kosova – Porubský, 2018).

II.2.3.4. Hungary

Pre-primary schooling begins at age 3, and an above-average percentage of children between the ages of 3 and 4 are enrolled. Grade repetition is rare, and school attendance is required for all children between the ages of six and sixteen. Comprehensive education normally lasts from ages seven to fifteen. The four-year, six-year, and eight-year upper secondary general school, the upper secondary vocational school, and the vocational school are the three main courses for the level of study. Although secondary completion is high, the tertiary attainment rate is still low. With increased duties in elementary and secondary education in recent years, the central government is in charge of overseeing the educational system (OECD, 2015a).

The foundation of the market economy presents a challenge for education (Papp - Hajós, 2014), however the systematic reform of the Hungarian educational system began as early as in the latter years of the communist rule (Radó, 2021). After Hungary's administrative structure underwent a broad overhaul in 1990, the education system was decentralized (Act on Local Governments). Primary school maintenance was transferred from local councils to self-governing municipalities (Walterová, 2018). As decentralized professional and administrative units of the Ministry of Education, regional educational authorities were also established by the

law. The National Core Curriculum's ratification in 1995 marked the end of the first stage of structural decentralization (Radó, 2021). Priority was placed on the relationship between vocational education and the labor market even before the system transition (Papp - Hajós, 2014).

In addition to overseeing the two-tier curriculum regulation system's three-year implementation process, the socialist-liberal coalition government mandated mid-term planning at the county level in 1996. This was done between 1995 and 1998. Additionally, in 1997, in-service teacher training were given quality assurance, and school evaluation specialists working for self-governments were given state certification (Radó, 2021). In contrast to the modest criticism of the Bologna objectives and the new two-cycle training at the time, the modernization components were nearly unanimously despised. The main themes of the comments were the introduction of two-cycle training that is now required and the criticism of the roles that initial education plays in further education and vocational training. According to the ministry, running a mixed system and enforcing national specificities would effectively imply undermining the country's ability to join the unified European higher education system (Szolár, 2010).

Since Hungary's admission to the EU in 2004, its approach to policymaking has evolved as a result of having access to relatively sizable amounts of EU subsidies for educational development. Large-scale central development plans that were backed by connected gradual institutional reforms took the place of policy aims primarily being implemented through institutional changes. The 2003 strategy for one parliament term and the 2006 midterm strategy for the following EU fiscal cycle served as the foundation for these development programs (Radó, 2021).

The government passed a new Act on Vocational Training as well as an "Act on National Upbringing" in 2011. All earlier laws governing education were replaced by the two new ones. The widespread centralization, the transition to political and administrative control, and the elimination of schools' organizational, financial, and professional autonomy were the new system's most significant structural features. A new local departments of the Klebelsberg School Maintaining Authority, which were leaders of newly constituted concentrated educational management authority with discretionary operational decision-making abilities (Walterová, 2018; Radó, 2021).

Large-scale teacher resistance from 2015 until 2016 prevented Hungary from implementing any traditional policies. Because of this, all government-initiated changes to education during the most recent phase were merely minor technical adjustments intended to reduce the

unavoidable inefficiency of the centrally controlled system without reexamining its primary structural characteristics developed between 2011 and 2015. The publication of a new National Core Curriculum, which was unveiled in 2016 as part of the communication push to satisfy the teacher's movement, was the only exception to this pattern. The newly implemented curriculum heavily emphasized indoctrinating students with conservative-Christian ideologies (Radó, 2021).

The federal government and 198 municipal school districts jointly oversee the system of public education in Hungary. The Ministry of Human Capabilities oversees schools and higher education since it establishes the national curriculum, chooses and develops textbooks, determines teacher pay and career paths, and allocates funding for public elementary and secondary schools. Vocational education and training, including adult education and VET centers, are governed by the Ministry of National Economy. The Educational Authority administers international and national student evaluations and tests as well as the audits and analyses required by the Act on National Public Education performing legal and professional management. The National Public Education Council, the Ministry of Human Capabilities' professional advisory organization, gives recommendations for decisions, primarily regarding curriculum evaluation and the content of schoolbooks. In Hungary, public schools are maintained by the Klebelsberg Institution Maintenance Center. This include hiring instructors, providing instructional materials, assessing the efficacy of school-based pedagogy, and coordinating professional development.

The findings indicate that the Hungarian educational system is becoming more selective. Even if the Hungarian educational system was already one of the most selective in 2000, by 2006 we had achieved the highest rankings in all of the ability categories (Csapó - Molnár - Kinyó, 2009).

The fundamental goal of government administration and universities, which are important in preparing future entrepreneurs, is to stimulate entrepreneurial activity in response to the economic issues Hungary is currently confronting. In Hungary, entrepreneurship education places a strong emphasis on preparing students for life beyond the classroom (Illés - Dunay - Jelonek, 2015).

III. Methodology

The aim of our research is to examine the role of education in economic growth, with a focus on East Asia, Europe and the Visegrad Group (Visegrad Group or V4 countries consisting of Slovakia, Czechia, Poland and Hungary). This is necessary because education can be a fundamental element of long-term economic development and sustainable growth, which makes its study essential for the modern state. As a result, I have identified three main key approach in our paper, the examination of which could lead to a precise response by the government of the Visegrad countries what metrics should be used to optimize spending on education to maximize growth.

The first research question is to identify which aspect of education affects growth. This is a necessary topic to explore because the literature assigns the aspects ambiguous roles, so clarifying this could be an important point for future discussion. Second research question focuses specifically on East Asia, looking at which variables of education differ between Europe and East Asia, and what has been the key to East Asian success. The third research focuses on the Visegrad Group countries. It examines exactly in what metrics this region is lagging and what improvements these countries can make.

III.1. Data

To collect the data, I carried out secondary data collection by country. The advantage of this method is that long-term trends can be observed, and results can be compared across countries. I used hard data, which are optimal for statistical research. I aimed for simple indicators, as this allows to observe the exact effects of each variable.

III.1.1. Data sources

In the analysis I used several databases and the country categorization system to create different dummies. I found most of the data from the World Bank Database (WB), which has an extensive database of education and other variables. The Penn World Table (PWT) database is available between 1950 and 2019 containing data on the relative levels of income, output, input, and productivity (Feenstra, Inklaar & Timmer, 2015). For the PISA scores I used the OECD database, while the HDI index was pulled from the UNDP and DESC databases. To create different dummies, I used the UN classification.

III.1.2. Data description

Category	Name	Source	Type	Definition
Country and regional descriptions	code	<i>PWT</i>	<i>String</i>	3-letter ISO country code
	country	<i>PWT</i>	<i>String</i>	Country name
	year	<i>PWT</i>	<i>Year</i>	
	EA	<i>UN</i>	<i>Dummy</i>	Dummy variable: 1 for East Asia, 0 for EU countries
	V4		<i>Dummy</i>	Dummy variable: 1 for Visegrad countries, 0 for other countries
Other variables	rgdpe	<i>PWT</i>	<i>millions USD</i>	Expenditure-side real GDP at chained PPPs (in mil. 2017US\$)
	pop	<i>PWT</i>	<i>millions</i>	Population (in millions)
	14%pop	<i>WB</i>	<i>%</i>	Population ages 0-14 (% of total population)
	intropop	<i>WB</i>	<i>USD</i>	Charges for the use of intellectual property, payments (BoP, current US\$)
	poverty	<i>WB</i>	<i>%</i>	Poverty headcount ratio at \$2.15 a day (2017 PPP) (% of population)
	RD_percent	<i>WB</i>	<i>%</i>	Research and development expenditure (% of GDP)
	HDI	<i>UNDP, DESC</i>	<i>unit</i>	Human Development Index
Government fundings	gov_c	<i>WB</i>	<i>millions USD</i>	Government expenditure on education, constant PPP\$ (millions)
	gov_%	<i>WB</i>	<i>%</i>	Government expenditure on education as % of GDP (%)
	gov%_p	<i>WB</i>	<i>%</i>	Government expenditure on primary education as % of GDP (%)
	gov%_s	<i>WB</i>	<i>%</i>	Government expenditure on secondary education as % of GDP (%)
	gov%_t	<i>WB</i>	<i>%</i>	Government expenditure on tertiary education as % of GDP (%)
Enrollment rates	enroll_p	<i>WB</i>	<i>%</i>	School enrollment, primary (% net)
	enroll_s	<i>WB</i>	<i>%</i>	School enrollment, secondary (% net)
	enroll_t	<i>WB</i>	<i>%</i>	School enrollment, tertiary (% gross)
Pupil-Teacher ratios	ptratio_p	<i>WB</i>	<i>unit</i>	The average number of pupils per teacher in primary school
	ptratio_s	<i>WB</i>	<i>unit</i>	The average number of pupils per teacher in secondary school
	ptratio_t	<i>WB</i>	<i>unit</i>	The average number of pupils per teacher in tertiary school
Other education related variables	PISA_reading	<i>OECD</i>	<i>unit</i>	PISA reading scores
	hc	<i>PWT</i>	<i>unit</i>	Human capital index, based on years of schooling and returns to education
	pupils_voc_s	<i>WB</i>	<i>unit</i>	The number of secondary students enrolled in technical and vocational education programs, including teacher training.
	pupils_s	<i>WB</i>	<i>unit</i>	Total number of pupils enrolled at secondary level in public and private schools.

Table 2: Definition, source and unit of measurement of variables - Source: Own edit

The basic country profile data are from the World Penn database. From here, the 3-letter ISO country codes, the Expenditure-side real GDP and the population index were used. These general data were further supplemented with the East Asia dummy for the UN classification, and the dummy for the Visegrad countries.

In addition, I used various control variables from the World Bank site. The *poverty* variable is a poverty headcount ratio at \$2.15 a day for those below. The *RD_percent* variable examines the research and development expenditure of the % of GDP. The *intropop* variable is the total charges for the use of intellectual property. The *14%pop* is the population aged 0-14 years as a percentage of the total.

I measured five major education categories: government funding, enrollment rate, pupil-teacher ratio, vocational pupils and PISA reading scores. I have measured the government funding category in 5 different ways for a better understanding. Separately, I have included government expenditure on education measured in constant PPP dollars. In addition, the whole education, primary, secondary, and tertiary education expenditure is also included as a share of total GDP. For the enrollment rate. I measured the percentage at three different levels: primary, secondary,

and tertiary. While for the latter two I took the net value as a basis, which is the ratio of children of official school age who are enrolled in school to the population of the corresponding official school age. For tertiary education, however, a gross value was available, which is the ratio of total enrollment, regardless of age, to the population of the age group that officially corresponds to the level of education shown. The pupil-teacher ratio is measured at three levels: primary, secondary and tertiary.

A reliable international exam process for assessing students' academic performance is the PISA (Programme for International Student Assessment). The PISA test, which gauges students' math, reading, and science proficiency, also assesses their capacity to explore what they have learned and apply it to both familiar and unfamiliar contexts (Jerrim, 2015). I used reading PISA scores in the research.

In addition to the general school variables, more complex indices were collected, including education and other parameters: *hc* and *HDI* variables. The variable *hc* is taken from the World Penn database. The variable is based on years of schooling and returns to education, but since it is calculated from several different measures, it can have mixed effects. The HDI index is a widely used measure that includes 3 dimensions: long and healthy life, knowledge and decent standard of living (Human Development Reports, n.d.). As it only partially predicts education, it is more suitable as a general well-being indicator than as a measure of education. It is important to highlight that Macau does not measure this data, but the government has been collecting it separately since 2002, which can be found on the Government of Macau Special Administrative Region Statistics and Census Service website (DCES, 2021).

Two metrics were collected to measure vocational. *pupils_voc_s* is the number of secondary students participating in vocational training on the World Bank site and *pupil_s* is the number of students participating in total secondary education.

III.1.3. New variables

Newly created variables	rgdpe_pc	<i>GDP per capita</i>	<i>unit</i>	The rgdpe divided by the population
	gov_pc	<i>Governmental budget per capita</i>	<i>unit</i>	The gov_c divided by the population
	%_vocational_s	<i>The ratio of the vocational training in the secondary level</i>	<i>%</i>	The pupils_voc_s divided by pupils_s

Table 3: Definitions of the newly created variables - Source: Own edit

I created the variable *rgdpe_pc*, which is Expenditure-side real GDP at chained PPPs divided by the population number. Both variables are in millions, so the division gives the variable GDP per capita, which is used as the dependent variable in further models.

The value of governmental constants does not describe the governmental budget so well, as population can strongly influence its assessment. To eliminate this, I create the variable to measure the governmental budget per capita (*gov_pc*), with the ratio of the variables *gov_c* and *pop*.

To calculate the secondary vocational pupil rate (*%_vocational_s*), I needed the variables *pupils_voc_s* and *pupils_s*. The former is the number of secondary vocational pupils in technical and vocational education programs, including teacher training, while the latter secondary education pupils is the total number of pupils enrolled at secondary level in public and private schools. I divided the number of secondary vocational pupils by the total number of pupils, which gave me the variable I wanted to measure.

III.1.4. Observed countries and period

I used data from two areas, the European Union and East Asia. I collected data from a total of 27 countries from the European area, which were Austria, Belgium, Bulgaria, Cyprus, Czech Republic, Germany, Denmark, Spain, Estonia, Finland, France, Greece, Croatia, Hungary, Ireland, Italy, Lithuania, Luxembourg, Latvia, Malta, Netherlands, Poland, Portugal, Romania, Slovakia, Slovenia, and Sweden. As data were available from all these countries, all were included in the research.

In the East Asia region, there are 9 in total country: China, China, Hong Kong SAR, China, Macao SAR, Japan, Mongolia, Republic of Korea, Democratic People's Republic of Korea and Taiwan. The Democratic People's Republic of Korea is not part of the general data collection, for which reason no data were available for any of the variables, and the data that were available are of questionable reliability. For these reasons, the country is not included in the survey. Another problem that arises is that the World Bank does not consider Taiwan as a separate country and therefore it is not included in the Global Development Indicators as a distinct nation. Taiwan's data is added to the world aggregate and the high-income countries aggregate, while that does not or rarely include to China (World Bank, n.d.). Since data collection would be incomplete and too many injections would lead to a strong bias, it is ultimately not included in the research.

I initially intended collecting data from 1988, but post-socialist countries rarely, if ever, collected data before 1995. This problem limited the investigation of the last research question, so I finally used data from 1996 onwards. As a result, I used data from 1996 to 2019. In 2020

several countries had incomplete data or not all variables were measured due to the outbreak of the Covid-19 pandemic, which is why they were not included in the research.

III.2. Missing values

One problem occurred that was that many values were missing from the table, which made statistical analysis impossible. To solve this problem and to complete the table, I used two strategies: I split the values into sub-periods and injected average values.

I divided the period 1996 to 2019 into four sub-periods, each covering 6 years. The resulting sub-periods are 1996-2001, 2002-2007, 2008-2013 and 2014-2019. The database contains the average of all values available and measured for a given country within a sub-period.

The problem was that there were still missing values which needed to be addressed. This means that there were countries for which no values were available for any year of the 6-year period.

Variables	Missing values	% of the total	Variables	Missing values	% of the total
<i>EA</i>	0	0%	<i>enroll_p</i>	10	8%
<i>rgdpe</i>	0	0%	<i>ptratio_p</i>	10	8%
<i>rgdpo</i>	0	0%	<i>gov_constant</i>	11	8%
<i>pop</i>	0	0%	<i>gov_%</i>	11	8%
<i>hc</i>	0	0%	<i>ptratio_s</i>	14	11%
<i>14%pop</i>	0	0%	<i>gov%_t</i>	15	11%
<i>RD_percent</i>	1	1%	<i>enroll_s</i>	16	12%
<i>HDI</i>	1	1%	<i>ptratio_t</i>	19	14%
<i>pupils_s</i>	1	1%	<i>gov%_s</i>	20	15%
<i>enroll_t</i>	3	2%	<i>gov%_p</i>	22	17%
<i>%_vocational_s</i>	3	2%	<i>PISA_reading</i>	23	17%
<i>intprop</i>	8	6%	<i>poverty</i>	26	20%

Table 4: Missing values by variable in the total sample - Source: Own edit

There were still several cases of missing values, in total there were 132 values as variables, which were used in 4 sub-periods in 33 countries. The threshold was set above the 20% value, so the poverty variable was not included. However, *gov%_s*, *gov%_p* and *PISA_reading* variables also had missing values above 15%, so although they are part of the research, this will also be treated as a caveat later.

To solve the remaining missing value problem, we can impute data to the database. Imputation means that the missing data is artificially replaced afterwards by a value that is assumed to be similar. Standard statistical analyses can then be performed on the resulting complete database. In mean imputation, the missing values are replaced by the mean of the variable. The advantage of imputation by mean is its simplicity and ease of use. However, it has the disadvantage of

underestimating the variability of the items. This can be improved by splitting observations into more homogeneous groups and imputing with within-group sub-averages (Oravetz, 2008).

To use that typology, I have broken down the countries into separate groups by location. The basic hypothesis is that countries by location move and evolve closer together. To determine these accurately, I used the UN geometer, produced by the United Nations Statistics Division (UN, n.d.).

Group number	Geographical region	Number of countries	Countries
0	Eastern Asia	6	China, China, Hong Kong SAR, Japan, Republic of Korea, China, Macao SAR, Mongolia
1	Western Europe	6	Austria, Belgium, France, Germany, Luxembourg, Netherlands
2	Southern Europe	8	Croatia, Cyprus, Greece, Italy, Malta, Portugal, Slovenia, Spain
3	Northern Europe	7	Denmark, Estonia, Finland, Ireland, Latvia, Lithuania, Sweden
4	Eastern Europe	6	Bulgaria, Czech Republic, Hungary, Poland, Romania, Slovakia

Table 5: UN regionalization of all countries used in the sample – Source: Own edit

I calculated an average by subperiod for each of the following groups, substituting values for missing values. The only missing value between 1996 and 2001 was poverty for region 4. Since this variable will not be part of our research because of the number of missing values, there is no need for further correction.

III.3. Research question

The data are time-series in my database, so I used panel regression to analyze them. Table 6 shows the methodology used per research question.

	Research question 1	Research question 2	Research question 3
Research questions	Which aspect of education affects growth?	Which variables of education differ between Europe and East Asia?	In what metrics the V4 countries are lagging?
Variables name (type)	The dependent variable (scale) is the Expenditure-side real GDP Independent variables are educational (scale) and control variables	The dependent variables (scale) are the educational characteristics, and the independent variable is the East Asian dummy (nominal)	The dependent variables (scale) are the educational characteristics, and the independent variable is the Visegrad countries dummy and the East European dummy (nominal)
Methodology	Panel regression with fixed and random effect, including time trend and lagged variables	Panel regression with fixed and random effect	Panel regression with fixed and random effect, Two sample (paired) t-test

Table 6: The methodology used to examine the research questions – Source: Own edit

The first research question is ‘Which aspect of education affects growth?’ I examined the question using panel regression, where the dependent variable is Expenditure-side real GDP. I used Hausman test to decide whether a fixed effect, random effect or CE model best describes our data. During the research, several regressions were run that included time trended, period

dummy and lagged variables to find the best fitting model. The model selection is the RMSE indicator, which is available in both FE and RE models.

The second research question focuses on how East Asia diverges from Europe. I ran separate regressions for each educational variable, using the East Asia dummy as the independent variable. I also used two sample (paired) t-test estimation to see if there is a difference between the average of the two regions.

The third research question focused on whether the Visegrad countries differ in any of the variables in our sample. I ran separate regressions for each educational variable, using the Visegrad 4 dummy as the independent variable.

III.3.1. Panel Regression

I used panel regression to simultaneously examine the effect of variables across time points. When the same unit cross-section is measured at various times, the panel regression combines cross-section data and time series. In our case, panel data are statistics from a group of nations that were observed over a predetermined length of time. In the case of T time periods and N unit the total observation units for panel data will be $T \times N$ (Zulfikar & STp, 2018).

Since I am using a panel database, it is important to determine whether fixed effect (FE), random effect (RE) or common effect (CE) regression will describe our data and temporality. To judge this, we test our data with Hausman and LM tests.

III.3.1.1. Hausman test

Either the RE estimator or the FE estimator can be reliably used to estimate the coefficients of the model. If we are confident that the individual-specific effect is indeed unrelated to the explanatory variables, we would pick the RE estimator. The Hausmann test is typically used to determine this. It is important to note that the test cannot account for time-fixed effects and is only valid under homoscedasticity (Schmidheiny & Basel, 2011).

Hypotheses of the test:

H_0 : Both the fixed effect and random effect estimation models produce similar coefficients.

H_1 : The fixed effect and random effect estimation models do not produce similar coefficients.

After completing the Hausman test with reviews, we must draw the following conclusion: If the Hausman test accepts H_0 or a p value greater than 0.05, then the random effect technique should be used. The Lagrange multiplier test is then used to determine whether random effect

or Common effect is still our preferred option. If the Hausman Test returns an H_1 or a p value of 0.05, the random effect technique is used (Zulfikar & STp, 2018).

III.3.1.2. Lagrange multiplier (LM) test

LM test (Lagrange multiplier test) needs to be utilized to examine whether the random effect model is better compared to the Common Effect (PLS) technique. (Zulfikar & STp, 2018).

Hypotheses of the test:

H_0 : The random effect is insignificant ($\sigma_\varepsilon^2 = 0$).

H_1 : The random effect is significant ($\sigma_\varepsilon^2 \neq 0$).

The optimal estimating approach is Common Effect if the p-value of the LM test is larger than 0.05 and H_0 is accepted. Receiving H_1 from the LM test means that the best estimation technique is the random effect (Zulfikar & STp, 2018).

III.3.1.3. Random effects model

The residuals in the random effects model may be connected through time, between individuals, or across cross sections. All individual differences are captured by the intercept parameters, but these individual intercepts are viewed as random draws. The individual-specific effect in the random effects model is a random variable that is unrelated to the explanatory variables (Schmidheiny & Basel, 2011).

There are hence two residual components in the random effect model. The initial one is the residual, which combines cross sections and time series. The second residual is a unique residual that always exists and is a random property of the i-th unit observation. The following is the panel data regression equation for the random effects model.

Heteroscedasticity is removed when the random effect model is used. In principle, the random effect model is different from the common effect and fixed effect, especially since this model is not estimated using ordinary least squares but maximum likelihood or general least squares (Zulfikar & STp, 2018). This is the reason why the model selection is done with RMSE indicator.

RMSE criteria is the residuals' standard deviation (prediction errors). The distance between the data points and the regression line is measured by residuals, and the spread of these residuals is measured by RMSE. In other words, it provides information on how tightly the data is clustered around the line of best fit. The RMSE formula compares the observed and the expected value, with the formula below:

$$RMSE = \sqrt{(f - o)^2}$$

Where f is the expected values or unknown results and the o is the observed values or known results (Glen, n.d.). A value of 0 indicates a perfect fit, so in model selection, the closer the value is to 0, the more preferred it is (Moriassi et al, 2007).

III.3.2. Two sample (paired) t-test

The two-sample t-test determines whether there is a statistically significant difference between the means of a probability variable in two different samples. The null hypothesis of this model is that the two variable means are statistically equivalent. An alternative explanation is that there is a significant statistical difference between the means of the two variables.

Hypotheses of the test:

H_0 : The expected values of the probability variables X and Y are equal ($E(X) = E(Y)$)

H_1 : The expected values of the probability variables X and Y are not equal ($E(X) \neq E(Y)$)

IV. Results

Data were analyzed using Excel, Stata and SPSS statistical software. The chapter is structured as 4.1 Summary Statistics, followed by 4.2, which presents the various modelling prior data in preparation for the regression. Chapters 4.3-4.5 explore the three research questions.

IV.1. Summary Statistics

The general presentation of the variables was done using a time series plot. This should be emphasized because it does not detract from the panel nature of the data. In all cases, the EU, East Asia and global samples were plotted for comparative purposes.

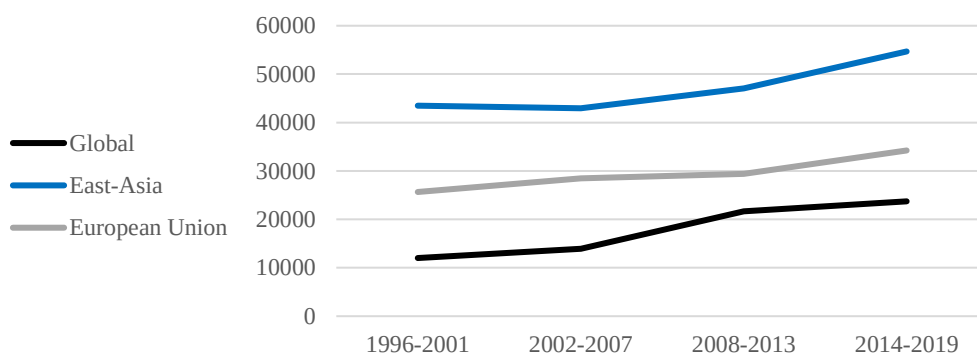


Figure 1: Governmental spending in PPP, US\$ - Source: World Bank – Own calculation and edit

When analyzing governmental spending in US\$, there were significant differences between countries. It is worth noting that East Asia spends relatively the more on education, while Europe spends less, but still above average. However, the average government budget per capita would probably provide more insight about the structure of the spending.

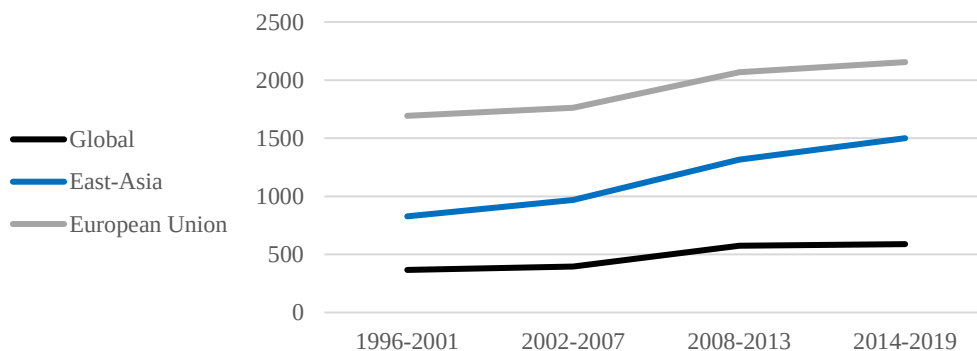


Figure 2: Governmental spending per capita PPP, US\$ - Source: World Bank, Penn World Table – Own calculation and edit

Per capita education costs in US\$ give a completely different picture. The EU countries spend a significant amount of money on PPPs per capita. While in 1996 it was 4.6 times the world

average, by 2015-2019 it was 3.7 times. East Asia spends much less per capita, but nearly 2.5 times the world average. It is worth looking at how much is spent on education as a share of GDP in general and at different levels of government.

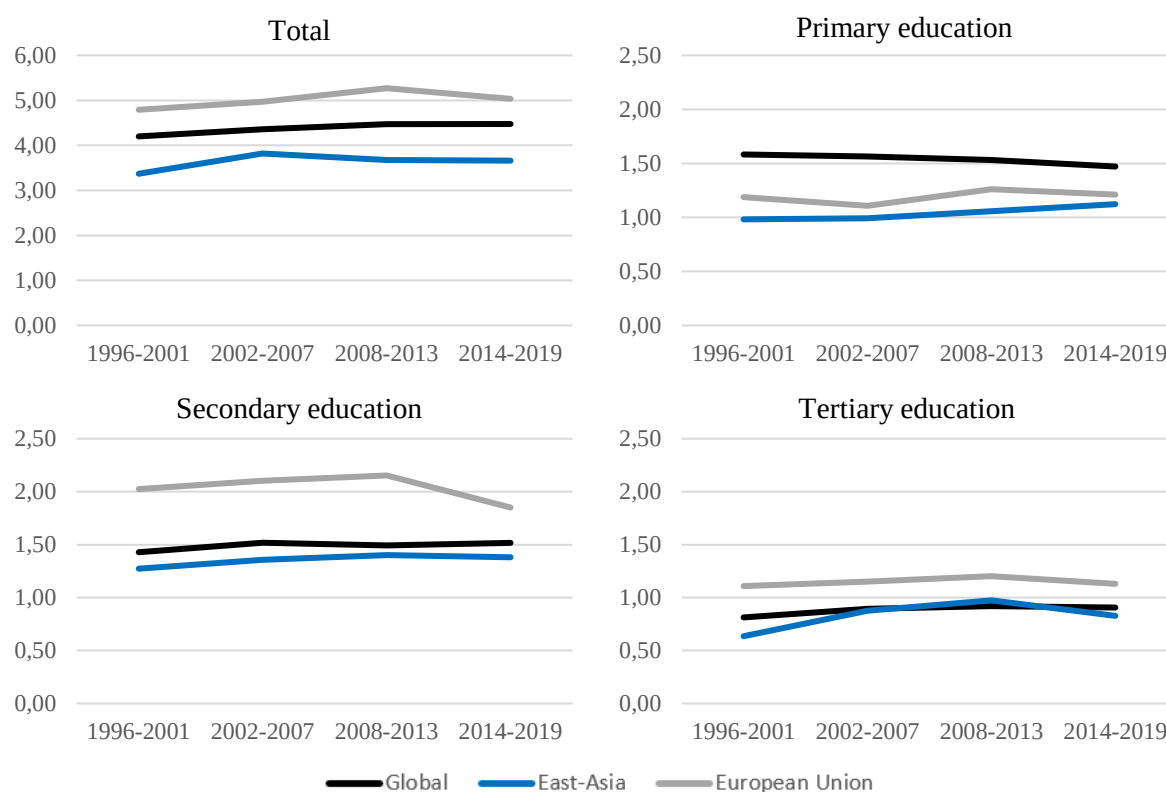


Figure 3: Governmental spending in % of the GDP by levels of education - Source: World Bank – Own calculation and edit

When looking at total education, Europe spends the most as a share of GDP, while East Asian countries spend below average. It is also interesting to look at spending at separate education levels, as this gives a more accurate picture of where regions are focusing their efforts. It is interesting to note that both the European and East Asian regions spend less on primary education as a share of GDP. In contrast, the Europeans spend well above average of their GDP on secondary and tertiary education. Percentagewise, it is visible that while both primary and tertiary education are spent below 1.5%, secondary education is spent above 2%. By contrast, East Asia spends below average everywhere except tertiary education. It is worth noting, however, that many developing countries do not collect data, so the average is more likely to include high-income and middle-income countries.

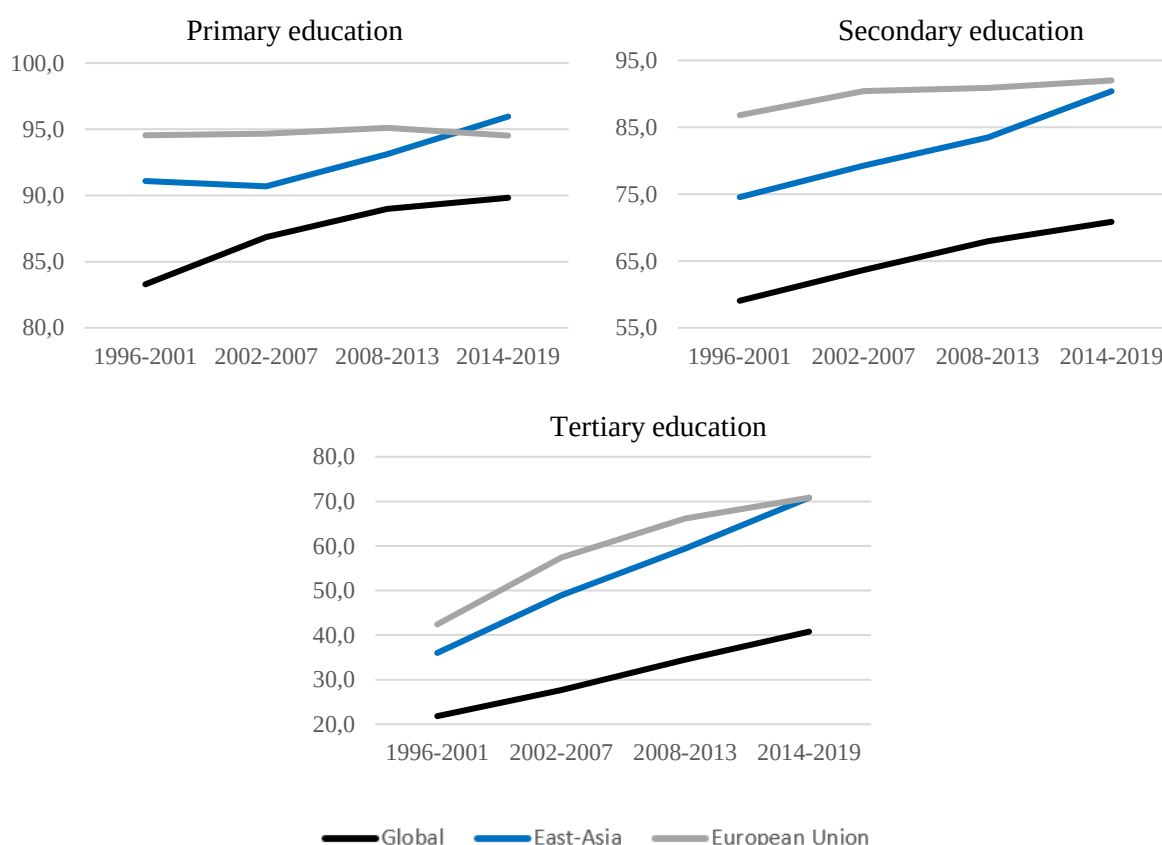


Figure 4: Enrollment rates by levels of education – Source: World Bank – Own calculation and edit

Both the European Union and East Asia are performing above the global average enrollment rate. There is a strong convergence between the two between 2014 and 2019. East Asia scored higher than primary education in the last period, with an enrollment rate of 96%, while in Europe it is a constant 95%. In secondary and tertiary education, too, East Asia catches up with the European continent between 2014 and 2019, with participation rates hovering around 92% for the former and 70% for the latter.

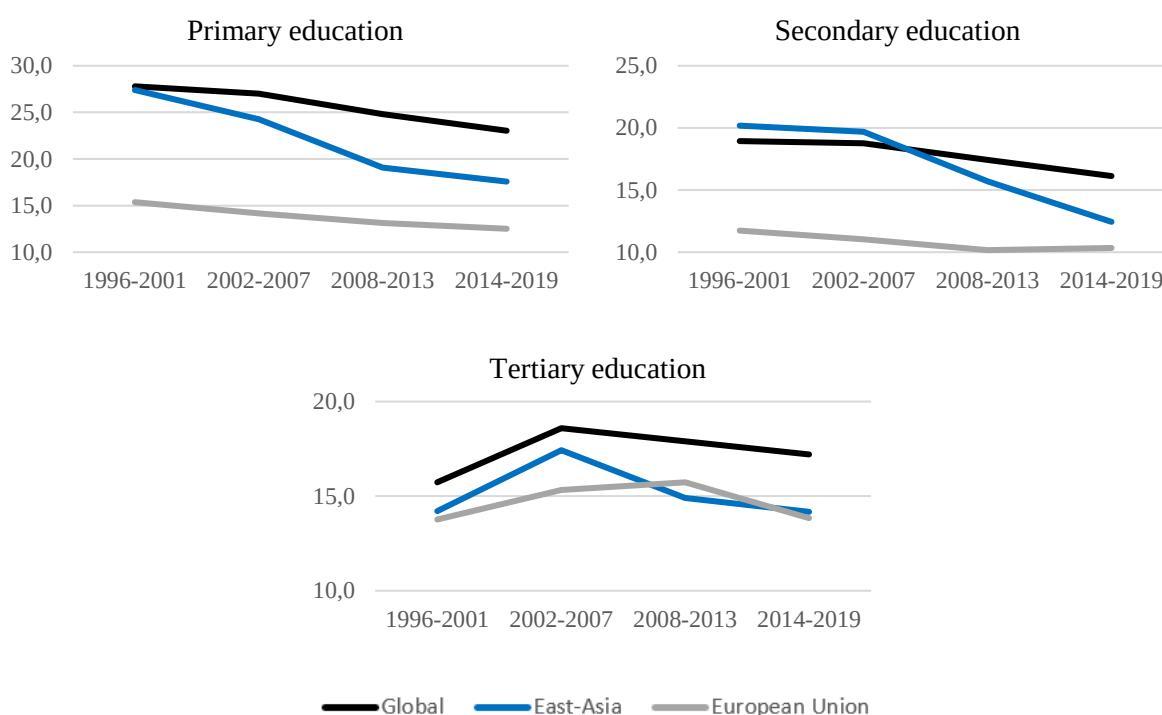


Figure 5: Pupil-teacher ratio by levels of education - Source: World Bank – Own calculation and edit

Pupil-teacher ratios in Europe at both secondary and primary level are lower than the global average and the East Asian average. This means fewer students per teacher, which can mean more personalized education. By contrast, in tertiary education, East Asian ratios are almost identical for the last period, but were not markedly different to begin with, which suggests a data co-movement.

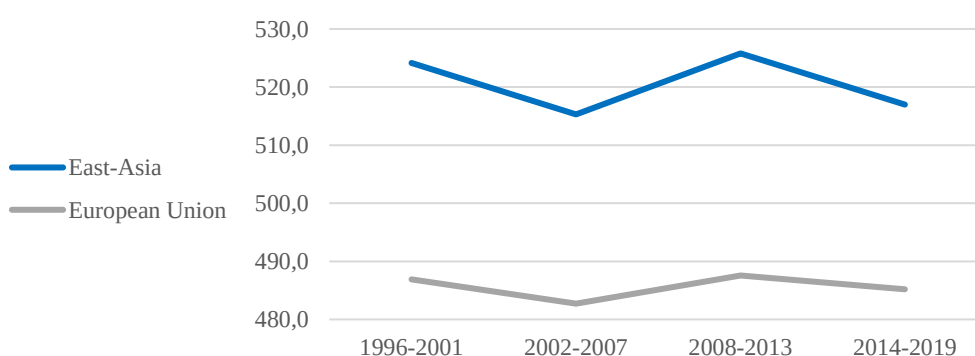


Figure 6: PISA Scores - Source: OECD – Own calculation and edit

For the PISA score, we do not report the global average as this would be highly skewed. Since the research was not designed to include various private country level PISA score collections, the global average would be highly skewed by using just the OECD and East Asian countries. Comparing the two regions, it can be shown that East Asia dominates the PISA scores in the long term. It is important to point out that no value was available for Mongolia, which I have

replaced with the regional average, which biases the data. However, Mongolia's likely lower score would still not eliminate all the differences between the two averages.

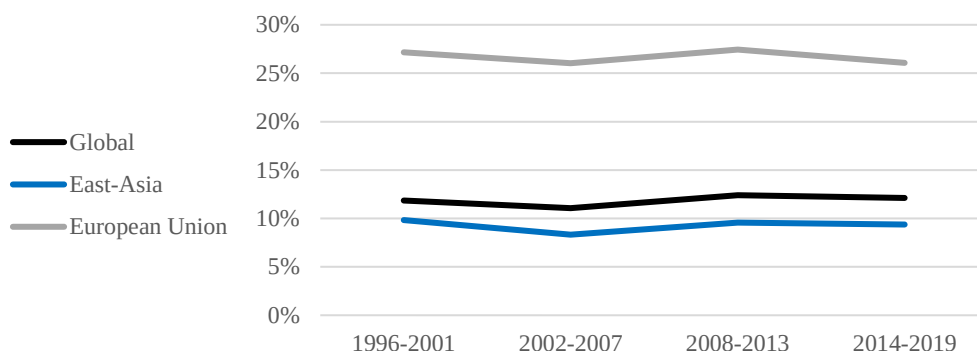


Figure 7: Vocational training % of the secondary education - Source: World Bank – Own calculation and edit

If we look at vocational training, we can see that the European Union and East Asia are well below average. This indicates that the samples have a fundamentally low proportion of students in vocational secondary school, which may later affect lack of significance.

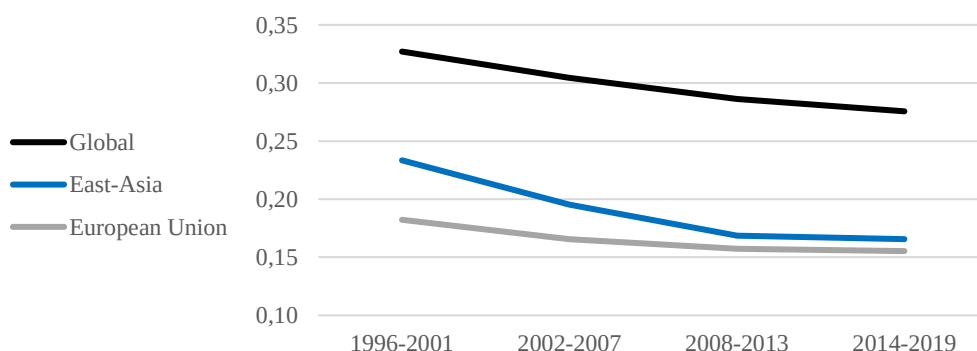


Figure 8: Population under 14 as a percent of the total population - Source: World Bank – Own calculation and edit

It was initially thought that East Asia's population would contain a higher percentage of children under 14. This is true in principle, but if we look at the global average, we see that both regions have significantly lower percentages. This can be explained by the ageing of the developing countries as well as the child-rearing and limitation policies in East Asia.

IV.2. Statistical data modification and test to optimize the panel regression

I created the variable *rgdpe_pc*, which is Expenditure-side real GDP at chained PPPs divided by the population number. Both variables are in millions, so the division gives the variable GDP per capita, which is used as the dependent variable in further models.

IV.2.1. Data normalization

Variable	Skewness	Kurtosis
<i>rgdpe_pc</i>	1.7	7.5
<i>pop</i>	5.4	30.3
<i>hc</i>	-0.5	2.9
<i>RD_percent</i>	0.8	2.6
<i>intprop</i>	4.5	28.1
<i>gov_c</i>	2.1	6.7
<i>gov_pc</i>	1.0	4.3
<i>gov_%</i>	0.5	3.4
<i>gov_p</i>	0.4	2.5
<i>gov_s</i>	0.1	2.4
<i>gov_t</i>	1.1	4.5
<i>enroll_p</i>	-0.8	2.5
<i>enroll_s</i>	-1.3	5.1
<i>enroll_t</i>	0.1	3.8
<i>ptratio_p</i>	1.5	5.4
<i>ptratio_s</i>	1.5	5.5
<i>ptratio_t</i>	1.7	8.2
<i>PISA_reading</i>	-0.8	4.5
<i>HDI</i>	-1.3	5.2
<i>%_vocational_s</i>	0.4	2.5

Table 7: Skewness and kurtosis of the data - Source: Stata – Own edit

When examining the normality of the data, it is important that the dependent variable is always normally distributed for the panel regression to work properly. The optimal kurtosis is 3, while the skewness is optimal between -0.5/+0.5 (Gawali, 2021). Although they differ from the optimal values, I have adopted kurtosis between 2 and 6 and skewness between -1.5 and 1.5. This means that the data do not quite follow the normal distribution.

Based on these criteria, several variables, *rgdpe_pc*, *pop*, *intprop*, *gov_c*, *ptratio_t* variables do not meet the normality requirement. To solve these, we generate new variables, where we take their logarithm as the variables. As a result, we get the new variables *ln_rgdpe_pc*, *ln_pop*, *ln_intprop*, *ln_gov_c* and *ln_ptratio_t*.

Variable	Skewness	Kurtosis
<i>ln_rgdpe_pc</i>	-0.958	4.962
<i>ln_pop</i>	0.491	3.650
<i>ln_intprop</i>	-0.267	2.474
<i>ln_gov_c</i>	-0.164	2.159
<i>ln_ptratio_t</i>	0.069	3.943

Table 8: Skewness and kurtosis after the data transformation - Source: Stata – Own edit

When checked, the new variables meet the criterion and have a near-normal distribution, so no other transformation is needed.

IV.2.2. Hausman test and LM test

Before running the panel regression, it is necessary to decide which of the three types of regression is the optimal one to use for data estimation: Random Effect (RE), Fixed Effect (FE) or Pooled Ordinary Least Square (POLS) regression.

The Hausmann χ^2 test was found to be 17.33, while the p-value is 0.2392. This means that we cannot accept the null hypothesis, therefore RE and POLS are unbiased and more efficient than the FE. Based on these results, we do not prefer to run the fixed effect regression.

To decide whether RE or POLS describes the data better we run Breusch-Pagan Lagrange multiplier test. The χ^2 test is 45.59 and the p-value is 0.000. Based on this I can reject the null hypothesis that the POLS and the RE is the same, that means, there is a panel effect in the data. We run random effect regression on the models run from here.

IV.3. Research question I: What influenced growth?

In the first research question, I am looking for answers to what exactly influences growth. Here I run different random effect regressions. In the first part, I look only at general models, in the second at time trends, and in the third at effects over several periods. For the star mark, the explanation is the * $p < 0.05$, the ** $p < 0.01$, and the *** $p < 0.001$.

IV.3.1. Normal random effect models

I build the analysis around seven models. The dependent variable is GDP per capita, and the independent variables are the various education-related measures. I use control variables such as the HDI index, population, R&D activity, and charges for the use of intellectual property alongside various education policy variables.

It is important to note that since the variable government budget per capita (*gov_pc*) is constructed from the ratio of *gov_c* and *pop*, all three variables cannot be included in the model at the same time, as this would lead to multicollinearity. In addition, the different levels of governmental budgets do not fully linearly multicollinear with the total governmental budget as % of the GDP, but there are only a few small differences. For this reason, the variables *gov_p*, *gov_s*, *gov_t* and *gov_%* are not included at this level.

In the first two regressions, I include all variables, differentiated in the different types of governmental budget, and in the third to seventh models I run narrower models around a single

topic, such as governmental budget (models 1.3, 1.4), enrollment rate (model 1.5), pupil-teacher ratio and PISA (model 1.6) score or vocational training (model 1.7). The standard errors are robust.

Variable	Model 1.1	Model 1.2	Model 1.3	Model 1.4	Model 1.5	Model 1.6	Model 1.7
<i>gov_c</i>	- 0.000			- 0.000			
<i>gov_p</i>	- 0.031			- 0.029			
<i>gov_s</i>	- 0.064			- 0.059			
<i>gov_t</i>	0.012			0.021			
<i>gov_%</i>		- 0.049*	- 0.070**				
<i>gov_pc</i>		0.000	0.000				
<i>enroll_p</i>	- 0.007	- 0.006			- 0.004		
<i>enroll_s</i>	- 0.002	- 0.002			- 0.003		
<i>enroll_t</i>	- 0.007***	- 0.007***			- 0.006***		
<i>ptratio_p</i>	0.003	0.004				0.004	
<i>ptratio_s</i>	- 0.013	- 0.010				0.001	
<i>ptratio_t</i>	0.008*	0.007*				- 0.003	
<i>PISA_reading</i>	0.001	0.001				0.000	
<i>hc</i>	- 0.335***	- 0.335***	- 0.369***	- 0.333***	- 0.334***	- 0.332***	- 0.323***
<i>%_vocational_s</i>	- 0.215	-0.164					- 0.133
<i>HDI</i>	10.119***	10.052***	8.431***	8.385***	10.269***	8.720***	8.380***
<i>pop</i>	- 0.000	- 0.000	- 0.000	- 0.000	0.000	0.000	- 0.000
<i>RD_percent</i>	- 0.020	- 0.024	- 0.037	- 0.055	- 0.053*	- 0.070*	- 0.060*
<i>intprop</i>	0.000*	0.000	- 0.000	0.000			0.000
<i>_cons</i>	3.790***	3.677***	4.588***	4.430***	3.739***	3.819***	4.313***
RMSE	0.088	0.089	0.106	0.101	0.092	0.103	0.101

Table 9: Normal random effect models - Source: Stata – Own edit

In the first model (model 1.1.), I used the constant value of governmental spending and the spending of different levels of education. None of the government budget variables were significant. Among the other education-related variables, the enrollment rate in the tertiary education is negatively affected. Besides this, the higher the pupil-teacher ratio, the higher the growth. The variable *hc* also significantly reduces growth. Among the control variables, the *HDI* significantly increases the value of GDP per capita, which is the most significant value with a significantly high coefficient.

In the second model (model 1.2.), I use new governmental budget variables. Here the variable expressed as a % of GDP has a significant negative effect on growth. This means that the more is spent on the governmental budget, the less is the growth. The *enroll_t*, *ptratio_t* *hc* and *HDI* variables, are remained significant with a same sign.

No new significant variable appears between Models 1.3 and 1.7, which makes their detailed analysis not justified. The lower the Root Mean Squared Error (RMSE) value the better, as it means that we can better predict our model. This suggests that the first model has the best predictive power.

4.3.2. Models with time variables

It is worth looking at different time trends to see if there is a major change over the years. I examined this using two different methods. In the first method, I created a *timetrend* variable that took a value of 1 in the first period, a value of 2 in the second, and so on. The variable received values between 1 and 4. This can help in spotting trends that are commonly over time. If the GDP per capita is basically increasing in all countries during the periods, it helps to filter this out as a control variable. In the second method, I created a separate dummy for each period. Here, the dummies display the effect of years as a control, which helps to filter out different shocks.

Variable	Model 2.1	Model 2.2	Model 2.3	Model 2.4
<i>gov_%</i>			- 0.051*	- 0.047*
<i>gov_pc</i>			0.000	0.000
<i>gov_c</i>	- 0.000	- 0.000		
<i>gov_p</i>	- 0.031	- 0.048		
<i>gov_s</i>	- 0.064	- 0.059		
<i>gov_t</i>	0.012	0.026		
<i>enroll_p</i>	- 0.007	- 0.009*	- 0.005	- 0.007
<i>enroll_s</i>	- 0.002	- 0.001	- 0.001	- 0.001
<i>enroll_t</i>	- 0.007***	- 0.007***	- 0.007***	- 0.007***
<i>ptratio_p</i>	0.003	0.003	0.004	0.004
<i>ptratio_s</i>	- 0.013	- 0.012	- 0.010	- 0.008
<i>ptratio_t</i>	0.008*	0.008*	0.007*	0.007*
<i>PISA_reading</i>	0.001	0.001	0.001	0.001
<i>hc</i>	- 0.339***	- 0.344***	- 0.360***	- 0.364***
<i>%_vocational_s</i>	- 0.213	- 0.276	- 0.150	- 0.199
<i>HDI</i>	10.108***	10.309***	9.912***	10.105***
<i>pop</i>	- 0.000	0.000	- 0.000	- 0.000
<i>RD_percent</i>	- 0.019	- 0.028	- 0.018	- 0.024
<i>intprop</i>	0.000*	0.000	0.000	0.000
<i>timetrend</i>	0.002		0.012	
<i>D_1996</i>		0.031		- 0.005
<i>D_2002</i>		- 0.031		- 0.043
<i>D_2008</i>		0.012		0.003
<i>D_2014</i>		(omitted)		(omitted)
<i>_cons</i>	3.800***	3.804***	3.760***	3.817***
RMSE	0.089	0.086	0.089	0.088

Table 10: Time trend models - Source: Stata – Own edit

The four models were necessary because the values of the governmental variables have to be broken down separately. In the first two cases, governmental constant (model 2.1) and governmental budget by level of education (model 2.2) are included, while in the second two cases, governmental budget per capita (model 2.3) and % of the GDP (model 2.4) are included. In model 2.1 and 2.3, I used a *timetrend* variable, while in model 2.2 and 2.4 I used the dummy per year. The *timetrend* variable does not give better RMSE values or is not significant in the model, so its use is discarded.

In terms of the RMSE criterion, Model 2.2 is lower than the final model (Model 1.1), used in Section 4.3.1, so a more detailed analysis is warranted. The dummy of the periods is not significant, but it modifies the significance of the *enroll_p*. Although initially it had a no effect, with shocks filtered out, it is already significant. Thus, I conclude that it is the shocks associated with these years that cause this change. A tertiary enrollment rate, and pupil-teacher ratio, the *hc* and the *HDI* variables remained significant.

IV.3.3. Models with lag variables

It is important to see whether changes made in one period have spill-over effects in subsequent periods. To investigate this, I used lag variables, which means that I created a new variable that takes the $n-1^{\text{th}}$ values for the n^{th} period. The problem here is that for the first period, you cannot enter the 0^{th} coefficient, as it basically does not exist. Therefore, I deleted the first period from 1996 to 2001 from my sample, reducing the number of periods from four to three years, because this way I could use all lag values properly.

The new variables created to examine the lags are *gov_%_lag1*, *enroll_t_lag1*, *PISA_reading_lag1*, *gov_pc_lag1*. I included *gov_%_lag1* and *gov_pc_lag1* because my basic hypothesis is that changes in the governmental budget have long-run effects. I used the enrollment rate to tertiary education because the number of students going to university can have long-run effects, and graduates enter the labor market after roughly 1 period, and from then onwards they can have an impact on GDP per capita. For the PISA reading score, I included it in the analysis as a curiosity, as I wanted to investigate whether better PISA scores imply better opportunities and higher GDP per capita for the country.

Variable	Model 3.1	Model 3.2	Model 3.3	Model 3.4
<i>gov_%</i>		- 0.086***		
<i>gov_pc</i>		0.000**		
<i>gov_c</i>	0.000*		- 0.000	- 0.000
<i>gov_p</i>	- 0.040		- 0.056	- 0.061
<i>gov_s</i>	- 0.051		- 0.065	- 0.066
<i>gov_t</i>	0.069		0.072	0.060
<i>enroll_p</i>	- 0.008	- 0.006	- 0.008	- 0.009
<i>enroll_s</i>	- 0.011***	- 0.009***	- 0.010***	- 0.010***
<i>enroll_t</i>	- 0.006***	- 0.005***	- 0.006***	- 0.006***
<i>ptratio_p</i>	- 0.002	0.006	- 0.002	- 0.002
<i>ptratio_s</i>	- 0.025***	- 0.023***	- 0.026***	- 0.026**
<i>ptratio_t</i>	0.006*	0.004	0.006*	0.005*
<i>PISA_reading</i>	0.002*	0.001**	0.002*	0.002*
<i>hc</i>	- 0.263***	- 0.289***	- 0.266***	- 0.294***
<i>%_vocational_s</i>	- 0.341	- 0.144	- 0.321	- 0.298
<i>gov_%_lag1</i>	- 0.027			
<i>enroll_t_lag1</i>		0.001		
<i>PISA_reading_lag1</i>			- 0.000	
<i>gov_pc_lag1</i>				0.000
<i>pop</i>	0.000	0.000	0.000	0.000
<i>HDI</i>	10.192***	8.646***	9.987***	10.059***
<i>RD_percent</i>	- 0.038	- 0.022	- 0.037	- 0.030
<i>intprop</i>	0.000***	0.000*	0.000**	0.000**
<i>_cons</i>	4.334***	5.164***	4.418***	4.408***
RMSE	0.064	0.067	0.065	0.070

Table 11: Lag models - Source: Stata – Own edit

When looking at RMSEs, all values are lower than in the previous models. However, the less data and period we use, the higher the predictive value and fit of the model, and therefore the results should be treated with caution.

Overall, Model 3.1 has the best predictive power of the lag models, as it had the lowest RMSE. In this model, the secondary enrollment rate and the secondary teacher pupil ratio appear as significant explanatory variables. Interestingly, a higher secondary enrollment rate will have a negative impact on growth. In addition, PISA reading also appears as a significant explanatory variable. If the test score is positive, GDP per capita will also be higher. The higher the number of students in vocational training, the lower the explanatory variable. Interestingly, among the explanatory variables, *intprop* also appears as a significant value in the first model. The higher the charges for the use of intellectual property, the lower the GDP per capita. This may be because too many regulations and fees may discourage innovation and discourage people from being motivated.

Three lags *enroll_t_lag1*, *PISA_reading_lag1* and *gov_pc_lag1* are not significant in Model 3.2, 3.3 and 3.4, so we must conclude that they do not have explanatory power.

IV.3.4. Final models

Overall, two models should be considered from the 4.3.1, 4.3.2, and 4.3.3 chapter when examining the results for maximum explanatory power. One examines values for 3 periods, the other for 4 periods.

Variable	Model – 2.2	Model – 3.1
Period	4	3
Lag	NO	YES
Time variables	YES	NO
<i>gov_c</i>	- 0.000	0.000*
<i>gov_p</i>	- 0.048	- 0.040
<i>gov_s</i>	- 0.059	- 0.051
<i>gov_t</i>	0.026	0.069
<i>enroll_p</i>	- 0.009*	- 0.008
<i>enroll_s</i>	- 0.001	- 0.011***
<i>enroll_t</i>	- 0.007***	- 0.006***
<i>ptratio_p</i>	0.003	- 0.002
<i>ptratio_s</i>	- 0.012	- 0.025***
<i>ptratio_t</i>	0.008*	0.006*
<i>PISA_reading</i>	0.001	0.002*
<i>hc</i>	- 0.344***	- 0.263***
<i>%_vocational_s</i>	- 0.276	- 0.341
<i>HDI</i>	10.309***	10.192***
<i>pop</i>	0.000	0.000
<i>RD_percent</i>	- 0.028	- 0.038
<i>intprop</i>	0.000	- 0.000**
<i>D_1996</i>	0.031	
<i>D_2002</i>	- 0.031	
<i>D_2008</i>	0.012	
<i>D_2014</i>	(omitted)	
<i>gov_%_lag1</i>		- 0.027
<i>_cons</i>	3.804***	4.334***
RMSE	0.086	0.064

Table 12: Final models - Source: Stata – Own edit

Our first final model considers 4 periods, which may have more explanatory power in the long run. It does not include lags but does include period dummies. The results of the model suggest that 4 significant values influence GDP per capita: *enroll_p*, *enroll_t*, *ptratio_t*, *hc*, and *HDI*. Both enrollment rates are negative, which means that the more people enroll in primary and higher education the lower the GDP per capita. The former is hard to explain, while the latter may be because the higher this rate, the more high-potential young people drop out of the

current period of earning money. The higher the tertiary pupil-teacher ratio, the higher the GDP per capita tends to be. The *hc* index is negatively significant. As for the human capital index, based on years of schooling and returns to education, the higher the years of schooling can affect lower GDP per capita. This can be partly explained by higher school enrolment but is an interesting result overall. An increase in the Human Development Index, used as a control, has a positive effect on GDP per capita. Overall, the model does not specify the data as well as the second model, as it has a lower RMSE variable.

The second model includes 3 periods, which may be more ideal for estimating shorter periods, because it is capture the last 20 years more. It has a significant lag value but no time variables. Since it is optimized for the period 2002 to 2019, it does not include the effects of the 1997 Asian financial crisis in the late 1990s and EU enlargement in the early 2000s. There were fewer major shocks in this period, which may lead to deviations from the 4-period results considered in the first model.

The government budget in million US\$ has low coefficients, but significantly positive. The previous period's governmental budget % of the GDP is not significant. An increase in the enrollment rate for secondary and tertiary education reduces the value of GDP per capita, which is an interesting result. It implies that the fewer people are enrolled in the education, the better the impact on GDP per capita. The pupil-teacher ratio in the secondary education coefficient is negative, which means that the fewer students study with one teacher the higher the GDP per capita. In contrast, the pupil-teacher ratio in tertiary education shows the opposite result. An increase in *PISA* scores increases GDP per capita. In contrast, an increase in the *hc* variable decreases the dependent variable. The vocational training ratio has no effect. Among the control variables, an increase in *HDI* increases GDP per capita and an increase in intellectual property decreases it.

IV.3.5. Results

Overall, the modelling reported variable results. The governmental budget in millions or other governmental variables do not have significance or has a negative effect. However, in the lag model the governmental budget per capita appeared with a low coefficient but a positive value. This should therefore be taken into account in future analyses. Basically, the size of the budget has no effect or a variable coefficient on growth. Only budget per capita and budget % of the GDP predicts a reliable result as a positive influencing variable. This was to be expected from the plots in chapter 4.1. The regions under consideration move explicitly together, with the exception of GDP per capita.

Primary and secondary education enrollment rates are mostly non-significant. It would be worth investigating this with a full sample, as both regions under study have above average values. Especially secondary education shows a significantly (20%) higher regional average. Among the enrollment rates, the tertiary education enrollment rate is the only significant variable, and the first two periods are not affected by the change in growth.

Looking at the pupil-teacher ratio, the basic conclusion is that it makes sense for teachers to work with pupils in smaller groups in secondary education and larger groups in tertiary education.

In addition to this, PISA reading is significant for 3 periods. This is also plausible because while in these periods there are two tests whose average may give a better picture of the situation of students, in the first period, 1996-2001, there was only one PISA test, available in a limited number of countries. The higher the PISA test score, the higher the GDP per capita.

An interesting result is that *hc* had a negative impact on GDP per capita in all periods. The share of vocational training had no effect in most models.

IV.4. Research question II - Difference between East Asia and Europe

In the second research question, I examine the variables on which East Asia differs from the European region. I ran a separate random effect regression where the variables were the dependent variables, and the independent variable was the East Asian dummy.

Variable	Coefficient	P-value
<i>ln_gov_c</i>	0.072	0.917
<i>gov_%</i>	-1.384	0.002
<i>gov_pc</i>	-766.626	0.058
<i>gov_p</i>	-0.154	0.291
<i>gov_s</i>	-0.679	0.000
<i>gov_t</i>	-0.321	0.052
<i>enroll_p</i>	-2.003	0.277
<i>enroll_s</i>	-8.114	0.000
<i>enroll_t</i>	-5.394	0.477
<i>ptratio_p</i>	8.273	0.000
<i>ptratio_s</i>	6.180	0.000
<i>ln_ptratio_t</i>	0.065	0.605
<i>PISA_reading</i>	34.959	0.000
<i>%_vocational_s</i>	-0.174	0.000

Table 13: Difference between the East Asian and the European countries - Source: SPSS– Own edit

When we look at the government budget, we look at several different variables. The $\ln$ government expenditure on education, constant PPP\$ ($p=0.917$) is not significant. In contrast to the absolute value, the % is significant. The government expenditure on education as % of GDP is significant ($p=0.002$), that means on average 1.384 percentage points lower in East Asian countries, which is a markedly large difference. A governmental budget per capita is also significant ($p=0.058$) in 10 %, in East-Asia is lower with 766 US\$.

For the governmental budget breakdown by level, primary ($p=0.291$) education is not significant. In contrast, the amount spent on secondary education as a % of GDP ($p=0.000$) is significant. East Asian countries on average spend 0.679 percent points less on %. Tertiary education is not significant ($p=0.052$) at 5% significance level, but we could accept it at 10%, which would imply that East Asian countries also spend less on tertiary education.

When examining the enrolment rate, primary ($p=0.277$) and tertiary ($p=0.477$) education did not differ significantly from the European sample. The first reason may be that the enrolment rate for primary education is markedly high in all the countries studied, with little variation. In contrast, the fluctuation of tertiary education in Europe is also high, which is the reason why no significant result was obtained. However, secondary education is significantly ($p=0.000$) different in East Asia. The results show that this region will have an enrolment rate 8.12% points lower compared to Europe.

If we look at the pupil-teacher ratio, the result is significant at the primary ($p=0.000$) and secondary ($p=0.000$) level. At the primary level, the average score is 8.27 % points higher in East Asia. This means that there are 8.27 more students per teacher. A similar, although not as high, value is found at secondary level, where the ratio is 6.18% points higher. This means that there are 6.18 more students per teacher at secondary level. In contrast, the $\ln$ tertiary education pupil-teacher ratio ($p=0.605$) does not predict a significant difference, which can be explained by the large multiplication of the European sample.

The PISA reading scores were also significant ($p=0.000$). East Asian countries score close to 35 points on the test. It is important to point out that there was no score available for Mongolia, so averages were available for this country for all periods, which may have skewed this score. However, with the exception of Mongolia, a similar result was obtained, and the construction of other estimates is not the focus of this research.

The ratio of vocational secondary pupils to all students ($p=0.000$) is significantly affected by East Asian countries. In Asia, it is much lower, which parallels the preference for other types of schooling, which is reflected in the PISA scores.

Overall, PISA reading, pupil-teacher ratio in the primary and secondary schools appeared as positively significant elements in the analysis. In contrast, some government spending variables, the enrollment rate in the secondary schools and the vocational secondary students are significantly negatively different in East Asia.

IV.5. Research question III - How is Eastern Europe and the V4 different?

The third research question looks at how Eastern Europe, respectively the Visegrad countries are different, and how can we improve their situation. I analyze this research question in 3 different ways. In 4.5.1 I run panel regressions for both Eastern European and V4 countries. In chapters 4.5.2 and 4.5.3 I focus only on the Visegrad countries, comparing East Asia and V4 countries in the former chapter, while in the latter chapter I analyze the trends related to education in the former one by one.

IV.5.1. Panel regression

First, I ran a panel regression for the V4 countries. In all models, the dependent variable was the different education-related variables, the independent variable was the V4 dummy. In a second round, I ran the same models at the regional level, where the independent variable was the regional dummy. Here, the results have been extended to include Romania and Bulgaria.

Dependent variables	V4		Regional	
	Coefficient	P-value	Coefficient	P-value
<i>ln_gov_c</i>	0.064	0.938	-0.172	0.804
<i>gov_%</i>	-0.296	0.618	-0.742	0.127
<i>gov_pc</i>	-758.523	0.118	-1021.098	0.008
<i>gov_p</i>	-0.271	0.108	-0.376	0.004
<i>gov_s</i>	-0.139	0.564	-0.323	0.102
<i>gov_t</i>	-0.197	0.334	-0.289	0.084
<i>enroll_p</i>	-5.332	0.008	-4.887	0.003
<i>enroll_s</i>	-0.183	0.951	-1.671	0.503
<i>enroll_t</i>	-8.108	0.363	-9.609	0.197
<i>ptratio_p</i>	-1.725	0.460	-0.356	0.858
<i>ptratio_s</i>	-0.950	0.515	-0.482	0.698
<i>ln_ptratio_t</i>	0.147	0.320	0.160	0.196
<i>PISA_reading</i>	-9.283	0.491	-32.978	0.001
<i>%_vocational_s</i>	0.069	0.309	0.076	0.184

Table 14: Difference between the V4 and Eastern Europe and the other sample countries - Source: Stata, – Own edit

In the first case, the only significant variable was primary enrollment rate ($p=0.008$). Here it was significantly lower compared to the other countries in the sample. When Bulgaria and Romania were added to the region, the governmental budget per capita ($p=0.008$), the primary government expenditure % of the GDP ($p=0.004$) and the PISA reading scores ($p=0.001$) also appear as negative variables. To get a more precise comparison of the situation in the countries, I will look separately at the differences with East Asia and the V4 countries and also analyze the Visegrad countries independently.

IV.5.2. Two sample t-test

I used a 2-sample t-test to compare East Asian and V4 countries. In cases where the p-value is lower than 0.05, we can say that there is a significant difference between the two samples. I ran the analysis for the 4th period, between 2014 and 2019.

Variable	Mean – V4	Mean – East-Asia	P-value
gov_c	9 223	9 223	0.112
gov_pc	1 404	1 500	0.088
gov_%	4.58	3.67	0.169
gov%_p	0.95	1.12	0.286
gov%_s	1.68	1.38	0.942
gov%_t	0.89	0.83	0.705
enroll_p	90	96	0.031
enroll_s	89	90	0.753
enroll_t	58	71	0.370
ptratio_p	13	18	0.428
ptratio_s	10	12	0.485
ptratio_t	15	14	0.480
PISA_reading	481	517	0.015
14%pop	15	17	0.060
%_vocational_s	0.28	0.09	0.362

Table 15: Difference between the V4 and East Asian countries between 2014 and 2019 - Source: Stata – Own edit

While government spending, pupil-teacher ratios and vocational training do not differ between the two groups of countries, there are significant differences between the samples in three cases. The primary educational enrollment rate ($p=0.031$) is significantly higher in East Asia, where it is 96%. It is only 90% for the Visegrad countries. PISA reading ($p=0.015$) is the most significant difference. While students in the V4 countries scored on average 481 points, students from the other continent scored more than 35 points higher, at 517 points. In addition to this, the proportion of under-14s ($p=0.060$) also appears as a significant variable at the 10% significance level, but this should be treated with caveats.

IV.5.3. V4 countries separate analysis

This chapter analyses trends by country, showing the main development trends in recent years.

Variable	Period 1	Period 2	Period 3	Period 4	Change
<i>gov_p</i>	0.9 %	1.7 %	1.5 %	1.5 %	71 %
<i>gov_pc</i>	788	983	1197	1342	70 %
<i>gov_c</i>	30 364	37 763	45 844	50 958	68 %
<i>enroll_t</i>	44.0 %	62.4 %	73.0 %	68.0 %	55 %
<i>gov_s</i>	1.1 %	2.0 %	1.7 %	1.5 %	33 %
<i>gov_t</i>	0.9 %	1.0 %	1.1 %	1.1 %	25 %
<i>PISA_reading</i>	479	502	509	509	6 %
<i>ptratio_t</i>	16.9	20.8	20.4	17.4	3 %
<i>enroll_s</i>	90.4 %	92.2 %	90.0 %	92.9 %	3 %
<i>enroll_p</i>	96.6 %	93.8 %	94.7 %	96.0 %	-1 %
<i>ptratio_p</i>	11.1	11.5	9.9	10.2	-9 %
<i>gov_%</i>	5.2 %	5.3 %	5.0 %	4.7 %	-10 %
<i>ptratio_s</i>	13.2	12.1	9.9	9.3	-30 %
<i>%_vocational_s</i>	45 %	27 %	28 %	28 %	-36 %

Table 16: Polish educational changes between 1996 and 2019 – Source: Own edit

Poland has increased its governmental budget; all related variables have increased significantly over the 4 periods. Of these, primary education has seen the largest increase (71%), but secondary (33%) and tertiary (25%) have also increased significantly. In addition, the tertiary enrollment rate increased from 44% to 68%. PISA readings have increased by 6% over 15 years in the country.

The pupil-teacher ratios in the primary and the tertiary levels and the enrollment rate in secondary and primary levels have stagnated. Interestingly, governmental education % of the GDP decreased while the governmental budget increased % at all levels. This means that other education related expenditure decreased. The pupil-teacher ratio decreased significantly at secondary level in Poland. In addition to this, the proportion of students participating in vocational training has also decreased (-36%).

Variable	Period 1	Period 2	Period 3	Period 4	Change
<i>enroll_t</i>	31.5 %	59.6 %	62.7 %	50.0 %	59 %
<i>gov_pc</i>	864	1273	1158	1301	51 %
<i>gov_c</i>	8 871	12 858	11 482	12 673	43 %
<i>ptratio_t</i>	12.8	16.9	16.3	14.5	13 %
<i>enroll_s</i>	83.8 %	89.9 %	89.2 %	89.3 %	7 %
<i>enroll_p</i>	86.0 %	89.4 %	91.4 %	91.1 %	6 %
<i>ptratio_p</i>	10.9	10.2	10.5	11.0	1 %
<i>ptratio_s</i>	10.3	10.2	10.2	10.4	1 %
<i>gov_%</i>	4.6 %	5.4 %	4.6 %	4.6 %	0 %
<i>PISA_reading</i>	480	482	491	473	-2 %
<i>gov_s</i>	1.9 %	2.2 %	1.8 %	1.8 %	-4 %
<i>%_vocational_s</i>	16 %	11 %	15 %	13 %	-19 %
<i>gov_p</i>	0.9 %	1.0 %	0.8 %	0.7 %	-24 %
<i>gov_t</i>	1.0 %	1.0 %	0.9 %	0.7 %	-26 %

Table 17: Hungarian educational changes between 1996 and 2019 - Source: Own edit

Looking at Hungary, enrollment rates increased in all levels, but higher education (59%) increased the most. Government constant increased, but the amount of this support as a percentage of GDP decreased at all levels. This means that the increase in GDP has not been matched by an increase in the budget, as we have seen decreases in secondary (-4%), primary (-24%) and tertiary (-26%).

The pupil-teacher ratio has also increased, which means that there are many more pupils per teacher. While at primary and secondary level this is not particularly high, around 1%, at tertiary education there is an increase of 13%. PISA scores fell, although not significantly (-2%). The share of pupils in vocational training has decreased.

Variable	Period 1	Period 2	Period 3	Period 4	Change
<i>gov_c</i>	3 400	4 284	5 575	6 696	97 %
<i>gov_pc</i>	630	793	1031	1230	95 %
<i>enroll_t</i>	25.1 %	39.5 %	55.6 %	48.3 %	92 %
<i>gov_t</i>	0.8 %	0.8 %	0.9 %	1.0 %	32 %
<i>ptratio_t</i>	11.4	13.8	17.6	14.0	23 %
<i>gov_%</i>	4.0 %	3.9 %	3.9 %	4.2 %	3 %
<i>gov_s</i>	1.7 %	1.9 %	1.8 %	1.7 %	2 %
<i>enroll_s</i>	83.8 %	86.9 %	85.3 %	84.7 %	1 %
<i>PISA_reading</i>	470	468	470	455	-3 %
<i>gov_p</i>	0.9 %	0.6 %	0.8 %	0.9 %	-5 %
<i>enroll_p</i>	88.1 %	84.4 %	84.8 %	82.9 %	-6 %
<i>%_vocational_s</i>	36 %	34 %	34 %	32 %	-11 %
<i>ptratio_s</i>	12.6	12.9	11.9	11.1	-12 %
<i>ptratio_p</i>	18.8	17.5	15.4	15.3	-19 %

Table 18: Slovakian educational changes between 1996 and 2019 - Source: Own edit

Slovakia has seen a significant increase in the governmental constant (97%), but no significant increase in % of GDP (3%). This means that the total amount spent on education has been coupled from GDP growth. Among the educational levels, the tertiary governmental budget grew (32%), the secondary one stagnated (2%) and the primary one decreased (-5%).

Enrolment rates in tertiary education have almost doubled, while primary and secondary have tended to stagnate (1%) or fall marginally (-5%). Teacher pupil ratios have increased at tertiary level but have also fallen at primary (-19%) and secondary (-12%), which means fewer pupils per teacher. PISA scores fell slightly and the number of students participating in vocational training also fell.

Variable	Period 1	Period 2	Period 3	Period 4	Change
<i>enroll_t</i>	25.4 %	44.6 %	63.2 %	64.6 %	154 %
<i>gov_c</i>	9 513	12 267	14 470	18 524	95 %
<i>gov_pc</i>	922	1194	1374	1742	89 %
<i>ptratio_t</i>	11.70	13.94	25.3	15.5	33 %
<i>gov_%</i>	3.8 %	4.0 %	4.1 %	4.8 %	27 %
<i>gov_p</i>	0.7 %	0.6 %	0.7 %	0.8 %	11 %
<i>ptratio_s</i>	10.6	10.7	11.3	11.2	5 %
<i>enroll_s</i>	88.5 %	89.4 %	87.8 %	90.1 %	2 %
<i>gov_t</i>	0.7 %	0.9 %	0.9 %	0.7 %	1 %
<i>enroll_p</i>	89.1 %	89.2 %	88.5 %	88.7 %	0 %
<i>PISA_reading</i>	492	486	486	489	-1 %
<i>%_vocational_s</i>	39 %	39 %	39 %	38 %	-3 %
<i>gov_s</i>	1.9 %	2.0 %	1.9 %	1.7 %	-9 %
<i>ptratio_p</i>	17.9	16.9	18.74	14.5	-19 %

Table 19: Czech educational changes between 1996 and 2019 - Source: Own edit

In the Czech Republic, the government budget constants doubled, while all levels except the secondary level (-9%) increased, as well as the overall spending in proportion to GDP. Enrolment rates increased by 154% in tertiary education, while stagnating at other levels. Pupil-teacher ratios increased in tertiary education and stagnated at secondary level, while they decreased significantly at primary level. The PISA score and the vocational training number stagnated.

V. Discussion

This chapter aims to summarize the results and put them in context with the literature. It will also outline policy options for the Visegrad countries at the end.

Three primary questions form the structure of the study. How various educational variables affect growth is the first question, which is one that is frequently addressed in the literature. The difference between East Asia and Europe is examined in the second question. The third question looks at the situation of the Visegrad countries, examining which education-related factors they fall short on and how they might advance in the future.

Variable	Q1 Growth	Q2 EA	Q3_a V4	Q3_a Region	Q3_b T-test	Values in the third period: 2014-2019				
						Poland	Hungary	Slovakia	Czech	Top 10
gov_c						50 958	12 673	6 696	18 524	41 155
gov_pc	+	-		-		1 342	1 301	1 230	1 742	3 183
gov_%	-	-				4.7 %	4.6 %	4.2 %	4.8 %	5.1 %
gov%_p				-		1.5 %	0.7 %	0.9 %	0.8 %	1.2 %
gov%_s		-				1.5 %	1.8 %	1.7 %	1.7 %	1.8 %
gov%_t						1.1 %	0.7 %	1.0 %	0.7 %	1.4 %
enroll_p			-	-	-	95.9 %	91.1 %	82.9 %	88.7 %	95.2 %
enroll_s	-	-				92.9 %	89.3 %	84.7 %	90.1 %	90.4 %
enroll_t	-					68.0 %	50.0 %	48.3 %	64.5 %	71.3 %
ptratio_p		+				10.2	11.0	15.3	14.5	11.6
ptratio_s	-	+				9.3	10.4	11.1	11.2	11.2
ptratio_t	+					17.4	14.5	14.0	15.5	11.8
PISA_reading	+	+		-	-	509	473	455	489	502
%_vocational_s		-				28%	13%	32%	38%	23%

Table 20: Summary of results - Source: Own edit

Table 20 summarizes the results given to the research questions and the main parameters. In Q1 the variables that have a significant negative impact on GDP per capita are marked with a "-" sign, while the columns marked with a "+" sign have a significant positive impact. In the second column, minus values indicate that East Asia is negatively different from the European sample, and plus values indicate that it is higher in the region. Columns 3 and 4 split the third research question into two parts, Q3_a V4 shows the difference of the Visegrad countries compared to the sample, while Q3_a Region shows the regional difference. The negative values of the T-test Q3_b indicate that the values for the Visegrad countries are negatively significantly different from the East Asian values.

The second part of the table shows the last period value for the Visegrad countries and the top 10 for the European and East Asian countries respectively. This is based on the top 10 GDP per capita, the countries used are Luxembourg, China, Macao SAR, Ireland, China, Hong Kong SAR, Netherlands, Denmark, Sweden, Austria, Germany, and Belgium.

V.1. Evaluation of the variables

Governmental constants do not appear as a factor affecting growth. However, a much better indicator to examine is the governmental budget per capita, which has a positive impact on growth. This value is lower both in the V4 countries and regionally. In the last period, the Visegrad countries spent less than half as much per capita on education as the 10 countries with the highest GDP per capita. Governmental budget % of GDP has a negative impact on growth, but this effect was very small. It is lower both for East Asian countries and regionally. Among the Visegrad countries, Slovakia deviates the most from the top 10. Interestingly, the levels of governmental budget are not significant in growth. However, the top 10 results are in line with the World Bank (2018), which shows that over time countries are spending an increasing share of their budgets on higher education. The findings of Hsieh - Klenow (2018) that well-performing economies, here the top 10 country, continued to increase spending on primary and secondary level of education, are confirmed.

Of the enrollment rates, this research concluded that primary does not affect growth and secondary negatively affect it. In contrast, the literature advocates universal education (Jimenez - Nguyen - Patrinos, 2012). However, it is important to note that these are essentially high values for most of the countries in the sample, so it is not certain that this result is entirely true for all the countries or just the selected sample. In the case of the V4 countries, these values seem to be very good, but the primary enrollment rate is still significantly lower than in the sample and East Asia.

Tertiary education enrollment rates are significantly lower than GDP per capita. The impact is small, but it is still important to think about the meaning of this. While it is basically seen that the top 10 countries have high enrolment rates, it does not necessarily increase growth. In Hungary and Slovakia, the figures are quite low compared to the others. The literature, on the other hand, finds a different result (McMahon, 1998, King - Levine, 1993, Schofer - Ramirez - Meyer, 2021). This may be due to the lagged effect of university investment or sample restriction in this research.

When looking at the pupil-teacher ratio, the primary level is not significant. It is roughly average for all Visegrad countries, except Slovakia, where it is higher. The increase in the secondary ratio reduces GDP per capita but is significantly higher in East Asia. Looking at the top 10 average, the Visegrad countries' values do not exceed those of the top 10 countries, but a reduction in the ratio could have a positive effect on growth. At the tertiary level, the pupil-

teacher ratio has a positive effect on growth, with a preference for larger group classes at this level.

PISA scores are an indicator of the quality of education, and this has a strong positive impact on GDP per capita. This is consistent with the findings in the literature (Barro, 2001). The East Asian countries perform much better than the sample, compared to which the Visegrad countries perform less well. This is in line with what is found in the literature (World Bank, 2018). The average value of the PISA reading in 2018 was 489 point (World Bank, 2018). When looking at exact scores Slovakia and Hungary have the lowest scores, but Czech Republic is also below average.

The share of young people participating in vocational training at secondary level does not change the GDP per capita. In East Asia, this value is also lower than in Europe, where the ET 2020 program concentrate to improve the quality of the vocational training at secondary level (EUR-Lex, 2015). Among the V4 countries, Hungary has the lowest in this respect. However, Czech Republic, Slovakia and Poland have recommended reducing this rate, if we see the Top 10 countries value. Czech Republic, where the ratio is the largest, has allocated specific resources to the development of vocational training since 2010 (OECD, 2013), which may explain the above average variable in the country.

V.2. Policy recommendation

Overall, in our analysis we conclude that the Visegrad countries should focus on four variables in the first round: *gov_pc*, *ptratio_s* and *PISA_reading*.

First, based on our results, Visegrad countries should primarily implement an increase in the educational budget per capita, as this will promote growth. In the beginning, this would go hand in hand with an increase in the budget per GDP, but in the long run this would be balanced out by GDP growth. This value is particularly low in Slovakia, but in all countries the total educational budget per capita is less than half of the top 10 average.

It is worth noting that the Polish system increased salaries by 50% between 2006 and 2012, a trend that has been observed since (Jakubowski, 2015). However, even this is not enough to keep the governmental budget per capita high. The situation is similar in the Czech Republic, where spending has not yet reached the target (OECD, 2020) These improvements need to be taken further to get the variables right. In Slovakia, the education budget as % of GDP is notably low, which the literature agrees is one of the root causes of the backlog (Kosova - Porubský,

2018). Similar trends are observed in other countries that perform below the OECD average (Shaturaev, 2021).

Second, reducing the pupil-teacher ratio at secondary level could have a positive impact on growth. Basically, in the Visegrad countries, especially in Slovakia and the Czech Republic, the aim should be to have fewer pupils per teacher in the secondary level. Since in most cases the pupil number is given, this can be achieved by increasing the number of teachers. To motivate this, it is necessary to create policies that support the growth of teachers' welfare (Shaturaev, 2021).

Third, improving PISA scores, especially in Slovakia, Hungary and the Czech Republic, should be a priority. All these countries have seen a decline in performance on this variable compared to the 2000s. Increasing this would have a positive impact on GDP per capita. Based on these findings, the recommendation of the research is to rethink and improve the curricula and methodology of education in the Visegrad countries.

Poland is the only country to reach the OECD average PISA scores and the only Visegrad country whose PISA score has not decreased since 2000. This is most likely due to the new curriculum introduced in 2008, which focuses primarily on problem-solving and the development of analytical abilities (Jakubowski, 2015).

Slovakia and Hungary consistently scored below the OECD average. These countries should monitor the number of teachers and their policies, as recommended by the World Bank (2018). In particular, the introduction of monitoring, collaboration and feedback, and the creation of appropriate incentives for teachers would be an important element. In addition, simplifying and facilitating teachers' work should be a priority in these countries' policies. Hungary has a centralized education system with discretionary operational decision-making abilities (Walterová, 2018; Radó, 2021), which in the long run could help to achieve a central-planned increase in the quality of education. In contrast, in Slovakia there are several levels of decision-making and implementation (OECD, 2015c), which makes it more difficult to design and implement policies.

VI. Conclusion

The research is built around 3 key questions. The first research question looks at which aspect of education affects growth. The second research question looks at how Europe and East Asia differ. The third research question asks what metrics the V4 countries are lagging and how this could be improved. These were examined using random effect panel regression and two-sample t-tests.

Interesting results have emerged when examining growth. Growth in government educational budget per capita, tertiary pupil-teacher ratio, and PISA scores are positively influenced the growth. In contrast, increases in governmental budget % of GDP, secondary and tertiary enrollment rates, and secondary pupil-teacher ratio decrease GDP per capita. The constant and the different levels of governmental budgets, the primary enrollment rate, the primary teacher pupil ratio, and the vocational training ratio do not affect growth.

The East Asia region spends significantly less per capita and per GDP on education compared to Europe. The secondary level is also underfunded, which is consistent with the lower enrollment rate at this level. The pupil-teacher ratio is higher at primary and secondary level, but counterintuitively this has had a positive impact on the quality of education, the PISA reading variable. In addition, significantly fewer pupils participate in vocational training than in Europe.

The V4 countries underperform compared to the overall sample in primary enrolment rate as well as compared to East Asia in primary enrolment rate and PISA score. If Romania and Bulgaria are added to the Visegrad countries on a territorial basis, the government budget per capita, the primary governmental budget, is also significantly lower.

The results show that Visegrad countries need to focus on three variables to increase GDP per capita. First, increasing the governmental budget per capita can have a positive impact on the economy. Second, lowering the pupil-teacher ratio at secondary level can promote more personalized education and development, which can then have an impact on growth. Third, PISA reading scores relate to the quality of education, where the region lags. A more successful performance in these tests could be key for better economic performance for the V4 countries.

The results are of use to researchers who study growth, as some of the results differ from the existing literature. Examining new results leads to new kinds of perspectives that may emerge in the future. In addition, the research is of use to policy makers in the Visegrad countries. The

results can be used to create more precise and personalized education policies that can have a long-term impact on growth.

The main shortcoming of the research is the large number of missing variables. Their estimation reduces the relevance of the outcomes. It is recommended to eliminate this hiatus by global organizations in all the less developed countries by collecting a broader range of data. Another shortcoming may be that it does not explain some of the counterintuitive results, but rather acknowledges their existence. A deeper analysis is recommended to explore these values, which is not the focus of the current research.

This study could serve as a basis for future research. The first research question could be complemented with a full world sample to include low-income countries. In addition, the research could be complemented by in-depth interviews with education policy experts to provide more precise policy recommendations for the Visegrad countries.

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