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Impact of ICT and Globalization on Educational Attainment: Evidence from the New EU Member States

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Abstract: Education is a critical factor underlying the social and economic development of countries and their citizens. Therefore, the specification of factors affecting educational attainment is crucial for the planning and implementation of optimal educational policies. The objective of the article is to research the influence of information and communication technology (ICT), proxied by the ICT index and globalization index on educational attainment in the new EU Member States over the term of 2000–2018 by means of the causality and cointegration test. The causality test points out a unilateral causality from ICT to educational attainment and a bidirectional causality between ICT and globalization. In other words, ICT has a significant effect on educational attainment, but globalization influences educational attainment by way of ICT in the short term. On the other hand, the cointegration test uncovers a positive effect of ICT on educational attainment at panel level and in Croatia, Czechia, Poland, and Slovakia in the long term, while globalization has a positive effect on educational attainment in Bulgaria, Hungary, Lithuania, and Poland. The findings of the cointegration test also support those of the causality test and denote that both ICT and globalization can be effective instruments for improving educational attainment, depending on countries' current human and physical capital and education policies.

Keywords: information and communication technology; globalization; educational attainment; causality analysis; cointegration analysis

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1. Introduction

Educational attainment is a key factor for the economic, social, cultural, and institutional development of countries, and is also important at individual level by facilitating access to stable employment and higher paying occupations, being considered the surest path to overall wellbeing. The indicator is calculated in terms of completed years of school and qualification achieved [1]. Furthermore, "quality education" was determined as one of the sustainable development goals [2] and is closely related to all other sustainable development goals. It is also critical for the implementation of such goals, because education is a main input of human capital, human development, environmental awareness, innovation, and technological development. Therefore, education has an important place in the current and future economic and social status of all countries and their citizens. Global primary school enrolment (% gross—"the ratio of total enrolment, regardless of age, to the population of the age group that officially corresponds to the level of education shown") increased to 101.71 in 2019 from 89.05% in 1970, global secondary school enrolment (% gross) rose to 76.19 in 2019 from 41.16% in 1970, and global tertiary school enrolment (% gross) increased to 40.24% in 2020 from 10.06% in 1970 [3–5]. The figures presented point out that,

worldwide, there has been significant progress in primary, secondary, and tertiary school enrolment during the 1970–2020 period. However, educational attainment exhibits considerable discrepancies among countries and also within a country. The return of education also varies among countries. The return rate of education was 13.3% in advanced countries such as East Asia, South Asia, and the Pacific, compared to 6.6% in Sub-Saharan Africa and 6.5% in Latin America [6].

Due to the multiple benefits that education brings to each society, investigating determinants of educational attainment must be a priority for researchers and policymakers around the globe. In this context, previous studies found that a mix of social, cultural, economic, academic, and other factors such as attitudes and background characteristics have an important role in improving educational attainment. [7,8]. However, the globalization process as of the 1970s and recent advances in ICT can play a major role in fostering teaching and learning processes. ICT involves software, hardware, networks, and media for acquisition, storage, processing, transmission, and display of information [9]. The ICT sector is defined as the combination of manufacturing and service industries which electronically acquire, transmit and present data and information [10]. ICT affects all sectors from small–medium businesses, firms, international trade, and healthcare to education, via the provision of cheaper and faster communication and access to information [11]. There are many benefits associated with using ICT in education, starting from the fact that it can be a supportive education tool for promoting and improving learners' skills and knowledge [12] by providing them with facile access to educational materials [13], by creating the opportunity to discover new fields of interest and new insights [13], and by developing their capabilities, creativity and autonomy [14].

Globalization is used to express the increasing mutual economic, social, cultural, and political dependence of countries, mainly resulting from international trade, technology, flows of individuals, investment, and information [15]. The globalization process affects several fields such as economics, health, tourism, and education. In this context, teaching methods have become more interconnected and have considerably changed with the contribution of the shift from industrialization to the information society, with teaching programs being amply revised considering the growing interaction in nearly every field in the world. Thus, access to information and technology has grown immensely due to globalization [16].

The main objective of this paper is to investigate the effect of ICT and globalization on educational attainment in the sample of new EU Member States, because these states experienced an institutional, social and economic transformation, integrated with the world, and also implemented institutional and economic reforms to meet the criteria for EU membership. As a result, all new EU Member States experienced significant improvements in globalization and ICT penetration, as seen in Table 1. The employment of digital technologies in education and training has been a policy priority of the EU meant to decrease the skills gap in labour markets, foster the digital education ecosystem, and adapt individuals to digital transformation [17]. In this context, the first-generation digital education policies of the 1990s focused on infrastructure development such as the rate of computers per student and broadband access [18]. Later, the focus of digital education policies was directed towards the integration of education with digital technologies to improve innovation and competitiveness within the Lisbon Strategy and the eLearning Action Plan [19,20]. The second-generation policies currently focus on the development of digital competences in teachers and learners [18]. The EU digital education policies have made a contribution to improvements in education in the EU Member States.

Table 1. Course of education, ICT, and globalization indices in the new EU Member States (2000, 2018).

Countries	Year	Education Index	ICT Index	Globalization Index
Bulgaria	2000	0.677	6.960032	69
	2018	0.779	15.7407	80
Croatia	2000	0.656	7.660203	64
	2018	0.803	18.67002	81
Czechia	2000	0.741	8.282485	75
	2018	0.89	22.4174	85
Estonia	2000	0.808	9.610152	71
	2018	0.882	23.23563	83
Hungary	2000	0.736	7.714211	77
	2018	0.819	20.21085	84
Latvia	2000	0.707	6.829222	60
	2018	0.883	18.48101	81
Lithuania	2000	0.758	7.019495	64
	2018	0.89	18.25015	82
Poland	2000	0.777	6.51453	68
	2018	0.866	20.29027	80
Romania	2000	0.654	5.009991	63
	2018	0.762	15.02908	79
Slovakia	2000	0.712	7.154469	67
	2018	0.824	17.86054	82
Slovenia	2000	0.795	9.392931	68
	2018	0.899	21.02446	81

Source: UNDP [21], UNCTAD [22], KOF Swiss Economic Institute [23].

The article aims to make a contribution to the empirical literature in two ways: firstly, it will be one of the first studies to analyse the short and long-run interaction among ICT, globalization, and educational attainment at the macro level, and secondly, the use of the econometric tests given the dataset characteristics leads us to relatively more robust findings. The general structure of the article is as follows: the related literature is summarized in Section 2, the data and methods are explained in Section 3, econometric analyses and discussions are presented in Section 4, and the conclusions are drawn in Section 5.

2. Literature Review

Education is a critical factor for economic, social and institutional development. Therefore, the determinants of educational development have been extensively researched in the related literature. In this context, many micro and macro-level factors such as demographic characteristics, family background, cognitive skills, school resources (class size, information technology in the classroom, teacher experience, etc.), real GDP per capita, income inequality, poverty, and financial development have been documented as the determinants of educational development [24–30].

In addition to all these factors that have been extensively analysed, ICT and globalization are currently affecting everyday lives, which is why it is important to determine their influence on the education system. However, until now, the educational impacts of ICT and globalization have been investigated by relatively few scholars. ICTs have become an essential component of our lives and have a large potential to affect every stage of education by

improving its effectiveness and efficiency, increasing inclusive education, accelerating and cheapening access to information and improving education standards by decreasing the gaps in education quality between schools in urban and rural regions [31,32]. It is therefore necessary to analyse their real impact on education in different countries and propose measures that can help other countries to redefine and transform their educational systems by integrating ICT into the teaching-learning framework. ICT can make a contribution to education attainment by improving access to every level of education through distance learning, while also enhancing the sustainability of education through the balance instilled between learning and work time.

Samari and Atashak [33] explored the impact of ICT and e-learning on educational output using a sample of students from Peyam-e-Noor University from Iran and revealed a positive impact of ICT on educational output. Nisar et al. [34] also explored the effect of ICT on education in Pakistan based on a sample of 429 respondents from five universities and colleges and revealed that ICT had a positive contribution to educational efficiency.

Aristovnik [35] focused on the effect of ICT on educational output in selected EU and OECD members through the data envelopment analysis technique and reached the conclusion that a significant impact of ICT on educational output exists in countries such as Finland, Norway, Belgium, and Korea.

Fernandez-Gutierrez et al. [36] tackled the effect of ICT use on the performance (maths, reading, and science) of the 61,042 students from 2195 secondary level schools in 13 Spanish regions and revealed the positive effect of ICT use on educational outcomes in science. Lastly, Gimenez and Vargas-Montoya [37] explored the effect of human capital on the interaction between ICT and students' outcomes using a total of 363,412 students from 13,215 schools in 48 countries through a hierarchical linear model and discovered a positive impact of human capital stock on ICT usage in learning.

The globalization process can affect educational attainment through various channels. Firstly, globalization can lead to a convergence among educational institutions and methods by facilitating the transfer of knowledge, know-how, etc. between teachers and students. Secondly, globalization increases the demand for education and fosters the improvement of efficiency and quality of education [38], encouraging people to reach higher education, because greater skills mean better incomes, considering labor mobility as a consequence of globalization and cross-border investments [39,40]. Thirdly, globalization has made a contribution to educational development by creating opportunities for better incomes for highly skilled individuals, which in turn will encourage them to invest in education and foster sustainable economic growth [41–43].

Anka [44] explored the effect of globalization on education outcome in Nigeria and Pakistan and revealed that globalization positively affected school enrolment and learning opportunities in these countries. On the other hand, Liu [45] researched the interaction between trade policy and educational attainment in China over the 1990–2004 period and revealed a positive effect of trade liberalization on high school attainment but did not find any effect on college education. Kalsoom et al. [46] explored the impact of globalization on higher education using a sample of 200 university teachers from Lahore universities and reached the conclusion that globalization raised competition in education, introduced high quality material for teaching and learning, increased collaboration among researchers in the world, and enhanced computer-assisted learning, but also led to more plagiarism and piracy, and to the erosion of local culture and values.

The literature mostly refrains from establishing concrete links between either ICT usage or the impact of globalization on educational attainment in the sense accepted by the present study. Moreover, while vulnerable groups are considered in some of the literature on European education [47], there are few references to the connections between the latter and ICT or globalization from the standpoint of sustainable education.

Education in East-Central Europe is differentiated in the literature through a series of factors stemming from late post-communist reform, underfunding and poor technological endowment. Dobbins et al. [48] used survey data from Poland, Czechia, Hungary and Slove-

nia to exhibit the rather slow involvement of important stakeholders in the management of higher education in this part of the continent amid democratic transition and a prominent urban-rural cleavage indicative of the area but did not tackle the effects of globalization on such transformations. In a study on the potential of East-Central European countries in terms of digitalization, Simakhova et al. [49] resorted to the Network Readiness Index and the Global Digital Readiness Index to show that ICT competencies amongst teachers in the region are lower compared to Western Europe. However, countries such as Czechia, Poland, Slovakia and Hungary have high potential for the digitalization of education, while Romania and Bulgaria are characterized by middle potential. A series of recommendations pertaining to the sustainability of education should, nevertheless, stem from such findings, while the matter of educational attainment is largely absent from the content. Stefanova and Velichkov [50] tested the efficiency of tertiary education expenditure in EU Member States from East-Central Europe by applying an efficiency frontier approach, set against the background of the multiannual indicators established by the Europe 2020 Strategy. Their conclusions underlined the need to increase the pursuit of quality in tertiary education in the countries examined, so as to foster economic development. The indicators presented reveal significant discrepancies between the EU taken as a whole and several countries in the East-Central area, with respect to tertiary education attainment, which is indicative of the performance gaps between the older and the newer Member States. However, since references to secondary education are found in the Europe 2020 Strategy solely from the standpoint of the school dropout phenomenon, the literature does not make sufficient connections between the latter indicator and globalization or ICT-based education.

3. Data and Method

The article investigated the influence of ICT and globalization on educational attainment in the new EU Member States during the 2000–2018 term by means of causality and cointegration tests. In the econometric model, educational attainment was proxied by the education index, which is awarded values between 0 (lowest education level) and 1 (highest education level), as used by UNDP [21]. The education index is calculated by the average schooling years for adults aged 25 or more, and by expected schooling years for school-age children [21]. Therefore, educational attainment was represented by the education index of UNDP [21]. On the other hand, ICT was represented by the ICT score of UNCTAD [22], although some researchers have proxied ICT through multiple indicators such as the rate of individuals using the internet, fixed-broadband subscriptions, and mobile cellular subscriptions [51,52]. Since the ICT score indicates the accessibility and integration of communication systems in a country, it is calculated based on internet accessibility, mobile phones and fixed-line users, and server security [53]. As for globalization, it was proxied by the globalization index, extensively used in the literature (e.g., Gurgul and Lach [54], Khan et al. [55]), provided by the KOF Swiss Economic Institute [23]. The globalization index is based on economic, social, and political globalization and is awarded a value between 0 and 100 (higher values represent a higher globalization level) (see Savina et al. [56] for detailed information about methodology issues). The data sources of the variables were presented in Table 2 and all series were annual, while the period selected for our study was 2000–2018 because the ICT index was already available during this interval. In the analyses, logarithmic forms of educational attainment, ICT penetration, and globalization were employed. The software packages of EViews 11.0, Gauss 12.0, and Stata 15.0 were utilized for econometric analyses.

Table 2. Dataset definition.

Variable	Abbreviation	Data Source
Educational attainment	EDU	UNDP [21]
ICT penetration	ICT	UNCTAD [22]
Globalization	GLOB	KOF Swiss Economic Institute [23]

The EU has attempted to integrate education with digital technologies as of the late 1990s. First, the EU-applied policies meant to develop the ICT infrastructure of the Member States, and then focused on the development of competences in teachers and learners [18]. Therefore, the study aims to investigate the influence of ICT policies implemented by the EU, together with globalization, on educational attainment with the following econometric model. In the econometric model, the EU public policies related to digitalization and sustainability was represented by the ICT index, because digitalization is extensively employed in education through ICT and ICT also facilitates the governments and firms to develop sustainable applications and systems. Furthermore, educational attainment was proxied by the education index, which is a combination of realized and expected schooling.

$$\mathrm{EDU}_{it} = f(\mathrm{ICT}_{it}, \mathrm{GLOB}_{it}) \;\; (i = 1, 2, \ldots, 11; t = 2000,\ 2001, \ldots, 2018) \tag{1}$$

In this context, the hypotheses of the study are as follows:

Hypothesis 1 (H1). *There is a relationship between ICT penetration and educational attainment*.

Hypothesis 2 (H2). *There is a relationship between globalization and educational attainment*.

The new member states of the EU are Bulgaria, Croatia, Czechia, Estonia, Hungary, Latvia, Lithuania, Poland, Romania, Slovakia and Slovenia. The summary characteristics of the series are reported in Table 3. The mean of education index was 0.8072 but exhibited no significant changes among the states. The mean of ICT index and globalization level were, respectively, 14.1649 and 76.6173, but both ICT and globalization considerably changed among the countries during the studied period, as seen in Table 3.

Table 3. Descriptive statistics of the dataset.

Characteristics	EDU	ICT	GLOB
Mean	0.8072	14.1649	76.6173
Std. Dev.	0.0587	4.1654	5.5446
Maximum	0.899	23.2356	85.2069
Minimum	0.654	5.0099	60.0324

In the applied section, the cross-sectional dependence and heterogeneity were firstly investigated, and then the entity of unit root in three variables was explored. At the next stage, the long-run interaction among ICT, globalization, and education was investigated by means of the Westerlund and Edgerton [57] cointegration test. The cointegration test takes into consideration the availability of structural break, heterogeneity, cross-sectional dependence, heteroscedasticity, and autocorrelation [57].

The panel and cross-sectional coefficients in the cointegration analysis were predicted via the augmented mean group (AMG) estimator of Eberhardt and Teal [58], with respect to heterogeneity and cross-sectional dependence. The estimator of AMG figures in the entity of common factors and dynamic effects of the three series gives efficient consequences for unbalanced panels and can be utilized in a condition of endogeneity [59]. Lastly, causal interaction among ICT, globalization and education was investigated by means of the causality test of Dumitrescu and Hurlin [60], an improved version of the conventional Granger causality test in a condition of heterogeneity.

4. Results and Discussion

In the applied part of the article, cross-sectional dependence and heterogeneity among the series of ICT, globalization, and educational attainment were firstly explored for the specification of unit root, causality, and cointegration tests. The entity of cross-sectional dependence denotes that any shock in a country in the panel also affects the other countries in the panel, and the entity of cross-sectional dependence is extensively detected in the

globalized world [61]. Accordingly, cross-sectional dependence was examined by tests of LM, CD, $LM_{adj.}$ by Breusch and Pagan [62], Pesaran [63], and Pesaran et al. [64], respectively, and the results of those tests are depicted in Table 4. The results of the cross-section dependence tests pointed out the cross-sectional dependence due to a decline in the null hypothesis at 1% as a consequence of the three tests in Table 4. For this reason, a unit root test, cointegration and causality tests, which give robust results under the entity of cross-sectional dependence, should be utilized.

Table 4. Results of the cross-sectional-dependence tests.

Test	Test Statistic	*p*-Value
LM	152.4	0.0000
CD *	2.713	0.0067
LM_{adj} *	19.03	0.0000

* two-sided test.

The homogeneity test checks whether the slope coefficient in the cointegration equation varies among the cross-sections. Therefore, specification of homogeneity is important when selecting the causality and cointegration tests and estimator. The availability of homogeneity was explored by the homogeneity tests of Pesaran and Yamagata [65] and the findings of both tests are depicted in Table 5. The null hypothesis (entity of homogeneity) was rejected, and the entity of heterogeneity was reached.

Table 5. Results of homogeneity tests.

Test	Test Statistic	*p*-Value
$\widetilde{\Delta}$	11.007	0.000
$\widetilde{\Delta}_{adj.}$	12.387	0.000

The entity of unit root in LNEDU, LNICT, and LNGLOB was investigated by means of the Cross-Sectional IPS [66] (CIPS) test by Pesaran [67] owing to the cross-sectional dependence among the three series, and the results of the test are depicted in Table 6. The test findings indicate that LNEDU, LNICT, and LNGLOB were I (1).

Table 6. Results of the CIPS unit root test.

Variables	Level		First Differences	
	Constant	Constant + Trend	Constant	Constant + Trend
LNEDU	−2.101	−2.420	−3.265 ***	−3.636 ***
LNICT	−2.017	−2.068	−4.164 ***	−4.416 ***
LNGLOB	−2.066	−2.171	−4.258 ***	−4.229 ***

*** It is significant at 1% significance level.

The long run interaction among ICT, globalization, and educational attainment was investigated by means of the Westerlund and Edgerton [57] cointegration test because of the economic crises during the period studied, the heterogeneity, cross-sectional dependency, and the cointegration test results are shown in Table 7. The traditional cointegration test with no shift pointed out an insignificant cointegration interaction among ICT, globalization, and educational attainment. However, the test with level and regime shifts denoted a significant cointegration among the three series because the null hypothesis of insignificant cointegration interaction was refused. Moreover, the structural breaks in Table 7 uncovered that the EU integration process, Eurozone debt crisis, and global financial crisis led to structural breaks.

Table 7. Results of the Westerlund and Edgerton [57] cointegration test.

Model	$Z_{\varphi}(N)$	*p* Value	$Z_{\tau}(N)$	*p* Value
No shift	−1.150	0.125	−0.305	0.380
Level shift	−3.774	0.000	−2.392	0.008
Regime shift	−2.789	0.003	−1.397	0.041
Country	Structural breaks (level shift)		Structural breaks (regime shift)	
Bulgaria	2006		2002	
Croatia	2010		2010	
Czechia	2014		2012	
Estonia	2013		2013	
Hungary	2010		2010	
Latvia	2003		2003	
Lithuania	2008		2008	
Poland	2012		2012	
Romania	2011		2011	
Slovakia	2010		2002	
Slovenia	2011		2011	

The long run coefficients were estimated by the AMG estimator due to cross-sectional dependency and heterogeneity, and the estimated long run coefficients are exhibited in Table 8. The panel long run coefficient revealed that ICT positively affected education. On the other hand, the cross-sectional long run coefficients revealed that ICT positively affected education in Croatia, Czechia, Poland, and Slovakia and globalization had a positive effect on education in Bulgaria, Hungary, Lithuania, and Poland.

Table 8. Results of cointegration coefficient estimation.

Countries	LNICT	LNGLOB
Bulgaria	0.0437	0.3436 **
Croatia	0.1805 ***	−0.2347
Czechia	0.0749 ***	0.1990
Estonia	0.0379	0.1306
Hungary	0.0211	0.4735 **
Latvia	0.0224	0.2153
Lithuania	−0.0226	0.4357 **
Poland	0.1329 ***	0.6902 ***
Romania	0.0220	0.6539
Slovakia	0.2354 ***	−0.0278
Slovenia	0.0141	0.0921
Panel	0.0693 ***	0.1446

*** and ** it is, respectively significant at 1% and 5%.

Theoretically, both ICT and globalization are expected to positively affect educational attainment and outcome in the short and long term. However, the empirical findings have denoted that the effect of ICT and globalization on educational attainment can vary depending on the countries' economic development, human capital, infrastructure and technology, owing to the interdependence among these factors, ICT penetration, and globalization. In this context, all the new EU Member States have experienced a significant improvement in ICT penetration, but Croatia, Czechia, Poland, and Slovakia had a positive educational impact of ICT during the period studied. However, Estonia, Hungary, Latvia, Lithuania, and Slovenia already had good educational attainment in 2000, while Bulgaria and Romania need to further improve ICT penetration for a positive educational impact thereof. Furthermore, Aristovnik [35] revealed that the impact of ICT on education varied among EU and OECD members in keeping with our findings. Such findings are also consistent with those by Fernandez-Gutierrez et al. [36] and Gimenez and Vargas-Montoya [37]. As a consequence, theoretical considerations and empirical findings have indicated that

countries' absorptive capacity of positive educational impact of ICT mainly depends on their human and physical infrastructure levels. However, threshold level of country specific characteristics can vary depending on current educational attainment level. Therefore, countries can achieve the positive educational implications of ICT after reaching their specific threshold level and, in turn, foster economic and environmental sustainability through improvements in educational attainment in the long run, if they continue to improve the integration between ICT and education.

The ongoing globalization process has led to significant structural and qualitative changes in education, and new concepts such as knowledge society and economy and lifelong learning have been incorporated into education policies [68]. In addition, the increasing need for a highly skilled workforce, internationalized labour market, and higher income motivate the individuals to increase schooling years. Furthermore, highly competitive environment in the globalized world caused the countries to raise the educational investments for high-technology production with higher value added. On the other hand, globalization has also raised the international education and convergence among higher education institutions and eased the access to information and technology [68,69]. However, the quality of labour requirement by countries is also important for educational attainment, as discovered by Liu [45]. In this context, the positive educational effects of globalization depend on country-specific characteristics such as the current economic and social development level, because countries need a certain threshold level of human and physical infrastructure to obtain positive educational impacts from the globalization process. In the study, we revealed a positive effect of globalization on education in Bulgaria, Hungary, Lithuania, and Poland and the findings were in concordance with the findings of Liu [45] and Kalsoom et al. [46]. As a consequence, globalization can introduce many positive educational implications, but countries' economic and social structures are crucial to absorb the positive educational implications of globalization. Therefore, the insignificant impact of globalization on educational attainment in some countries can be resulted from the human capital qualifications, which the new EU Member States need.

Furthermore, the causality interaction among ICT, globalization, and education was explored via the Dumitrescu and Hurlin causality test [60] and the findings are depicted in Table 9. The causality analysis pointed out a unilateral causality from ICT to education and a bilateral causality between ICT and globalization. In other words, ICT had a significant impact on education in the short run, and also globalization and ICT fostered each other in the short run. As a consequence, globalization can also affect education through fostering ICT in the short run.

Table 9. Results of the Dumitrescu and Hurlin [60] causality test.

Null Hypothesis:	W-Stat.	Zbar-Stat.	Prob.
D(LNICT) ↛ D(LNEDU)	5.33728	3.13107	0.0017
D(LNEDU) ↛ D(LNICT)	2.27593	−0.18239	0.8553
D(LNGLOB) ↛ D(LNEDU)	2.72688	0.30570	0.7598
D(LNEDU) ↛ D(LNGLOB)	3.90500	1.58084	0.1139
D(LNGLOB) ↛ D(LNICT)	5.19349	2.97543	0.0029
D(LNICT) ↛ D(LNGLOB)	6.08052	3.93552	8.E-05

5. Conclusions and Policy Implications

Education is a vital component of social and economic status for both individuals and countries and a significant determinant of human capital, one of the main components of economic growth. Therefore, countries aim to make a contribution to economic and social development through educational investments. The determinants of educational development gain importance from designing and implementing optimal education policies.

In this article, we have researched the educational impacts of ICT and globalization, two crucial components of the 21st century, on a sample of new EU Member States who experienced institutional, economic, and social transformations, through causality and

cointegration tests. The causality analysis revealed that ICT has a significant impact on educational attainment in the short run and globalization also has the potential to influence educational attainment by enhancing ICT penetration. On the other hand, ICT and globalization also positively influenced educational attainment in some of the countries under consideration, depending on country-specific characteristics such as economic development, human capital, infrastructure and technology.

The countries analysed need to increase their absorption of EU structural funds (notably, the European Regional Development Fund) in the area of ICT, by launching dedicated calls for projects meant to endow classrooms at all levels of education with the latest equipment and software used for synchronous and asynchronous teaching. The provisions of the new multiannual framework and recovery package of the EU (2021–2027) include ample allocations for the Cohesion Policy, whose aim is to reduce social and economic disparities between the Member States, with countries such as Poland, Czechia, Slovakia and Croatia serving as the main beneficiaries. Since ICT is already recognized as a horizontal principle of the EU, to be included to a certain extent in all projects sponsored by structural funds, it becomes essential that higher financial thresholds for this indicator be established within the new calls for applications in the educational field. Additionally, the new Erasmus and Horizon Europe frameworks should enable East-Central Member States to enhance their ICT potential with every project sponsored from the Union's budget, so as to close the development gap with Western EU Members in this regard. Such an approach would endow the new EU Member States with a competitive advantage amid globalization, with positive results for the Single Market in terms of human resources.

The theoretical considerations and empirical findings on the educational effects of ICT and globalization indicated that the positive educational impacts of ICT and globalization are considerably varied among countries. Therefore, investments in infrastructure and research and development should simultaneously accompany educational investments to obtain more educational benefits from ICT and globalization.

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