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Empirical Study towards the Drivers of Sustainable Economic Growth in EU-28 Countries

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Abstract: This study aims at empirically investigating the drivers of sustainable economic growth in EU-28 countries. By means of panel data regression models, in the form of fixed and random effects models, alongside system generalized method of moments, we examine several drivers of real gross domestic product (GDP) growth rate, as follows: higher education, business environment, infrastructure, technology, communications, and media, population lifestyle, and demographic changes. As regards higher education, the empirical results show that expenditure per student in higher education and traditional 18–22 year-old students are positively linked with sustainable economic growth, whereas science and technology graduates negatively influence real GDP growth. In terms of business environment, total expenditure on research and development and employment rates of recent graduates contributes to sustainable development, but corruption perceptions index revealed a negative association with economic growth. As well, the results provide support for a negative influence of infrastructure abreast technological measures on economic growth. Besides, we found a negative connection between old-age dependency ratio and sustainable economic growth.

Keywords: sustainable development; economic growth; fixed and random effects models; system GMM; EU-28

1. Introduction

The 2030 Agenda for Sustainable Development [1] aims at addressing the key challenges for the 21st century towards people, planet, and prosperity. Sustainable development pursues to satisfy the demands of current generations without undermining the ability of next generations to accomplish their own necessities. The three related pillars, namely economic, environmental, and social, should be necessarily addressed via supportive policies in order to attain sustainable development. Among the sustainable development goals (hereinafter "SDGs") figure the quality education, resilient infrastructure, as well as peace, justice, and strong institutions. Likewise, the headline targets agreed within the Europe 2020 strategy [2] cover education, employment, innovation, climate change, and energy sustainability, as well as fighting poverty and social exclusion. As well, it is acknowledged that educational improvements support employability, lessens poverty, whereas research and development joined with resources that are more efficient engender competitiveness and creates jobs. Therefore, a smart growth is essential towards developing an economy based on knowledge and innovation, being requisite more effective investments in education, research, and innovation. Moreover, there are concerns about developing a connected digital single market [2], which can create up to EUR 250 billion of additional growth in Europe, also generating multiple new jobs for younger job seekers, as well as a vibrant knowledge-based society [3]. Accordingly, the Digital Economy and Society Index (hereinafter "DESI") was promoted. DESI is a composite index that summarizes appropriate indicators on Europe's digital performance and pursues the

evolution of EU member states regarding digital competitiveness, comprising the following dimensions: connectivity, human capital, use of Internet, integration of digital technology, and digital public services. In fact, education emphasizes one of the most significant human capital investments forasmuch productivity can be augmented by investing more in education. Labor is the most abundant factor of production, whilst physical capital scarcity is the main obstacle facing the nation, the enhancement of quality related to labor being vital to accelerate economic growth. Seetanah [4] noticed that education promotes economic growth and improves people's lives by increasing the efficiency of the labor force, fostering democracy, improving health, and reducing fertility, as well as enhancing equality.

The Global Shapers Annual Survey 2017 employed by World Economic Forum [5] revealed that the most serious issues globally are as follows: "climate change/destruction of nature, large scale conflict/wars, and inequality (income, discrimination)". Consequently, many challenges apart from education issues come in sight [5]. The United Nations Research Institute for Social Development noticed that socially sustainable development supposes ensuring material well-being (such as good health, education, and access to the goods and services necessary for decent living), as well as social, cultural, and political achievements [6]. Trade openness reveals the benefit of the learning effect by the means of high technology imports from developed countries, being tied with a high level of knowledge transfer, which, in turn, boosts embracing of computer technology. In addition, computer skills and competencies improve productivity and determine the increase of the wages. Likewise, education could not emerge without a proper infrastructure. Contrariwise, the development of international trade and worldwide business competition has been accompanied by growth in corruption. In fact, the issue of corruption entails the damaging of the moral character of individuals [7]. Thus, a lack of education could enlighten the public official's claim for a bribe, whereas educations of short period or suspicious quality may also limit the employment opportunities of the community [8]. As well, education leads to reduced birth rates through its impact on reduced population growth [4]. As such, the central question of this paper is as follows: do the goals established in 2030 Agenda for Sustainable Development [1] influence economic growth? Accordingly, the paper's main objectives are: (i) to assess the influence of higher education on economic growth; (ii) to appraise the effect of business environment on economic growth; (iii) to estimate the impact of infrastructure & technology on economic growth; and, (iv) to set out if population lifestyle and demographic changes influence economic growth. For this purpose, annual observations for EU-28 countries and panel data analysis were used. To the best of our knowledge, this is the first study that examines the influence of several variables with respect to SDGs (such as quality education—Goal 4, decent work and economic growth—Goal 8, industry, innovation, and infrastructure—Goal 9, reduced inequalities—Goal 10) on economic growth.

The remainder of this manuscript is structured as follows. The second section highlights the results of previous related studies. The third section describes the research sample, selected variables, alongside empirical methods. The empirical findings, including descriptive statistics and correlation analysis, as well as the output of the estimated panel data regression models, are showed within section four. Last section concludes the study and provides policy implications.

2. Prior Literature

2.1. The Impact of Education on Sustainable Economic Growth

The fourth SDG entails "ensuring inclusive and equitable quality education and promoting lifelong learning opportunities for all" [1]. Education drives more healthy and sustainable lives, also contributing to a more peaceful world as an outcome of encouraging forbearance amongst nations. Therewith, education diminishes inequalities insofar as educated persons can get high-paying jobs. Also, well-educated workers are imperative in order to fulfill complex jobs and adjust quickly to their changing medium and the growing needs of the manufacturing network [9].

The importance of the link between education and growth is underlined by the neo-classical theory, as well as endogenous growth theory in late 1980s and early 1990s. The neo-classical theory

shows that a one-off permanent increase in the stock of human capital results in a one-off rise in the economy's growth rate until the economy reaches the new higher steady state. In the model of Romer [10], human capital is perceived as a factor facilitating research and development, whence technological growth is heightened. Further, Lucas [11] levied human capital as a factor of production. As such, the accumulation of knowledge by people, either with intentional efforts [11] or with learning by doing [12], support the productivity of labor and capital, being the driving force of economic growth. In line with augmented neo-classical model, a one-year increase in average education raises the level of output per capita by between three and six percent, whereas an over one percentage point faster growth based on the new-growth theories [13].

Barro [14] reported that the growth rate of real gross domestic product (hereinafter "GDP") per capita is positively related to school enrollment rates. De Meulemeester and Rochat [15] underlined Granger-causality running from higher education to economic development in Japan, United Kingdom (UK), France, and Sweden, suggesting that education can stimulate growth only if its curriculum is outlined towards such a purpose, whilst social, political, and economic structures alongside the technological level of the society are such that graduates can use their knowledge. Asteriou and Agiomirgianakis [16] pointed out in Greece a positive long-run relationship between enrollments rates in primary, secondary, and higher education and the GDP per capita. Petrakis and Stamatakis [17] revealed that primary and secondary education contribute significantly to growth in least developed countries (hereinafter "LDCs"), whereas growth in OECD economies hangs on higher education. Psacharopoulos and Patrinos [18] showed that the average rate of return to an additional year of schooling is 10 percent, and that education leads the highest returns in low- and middle-income countries. In the same vein, Self and Grabowski [19] noticed in India a strong causal link between economic growth and primary education, weak evidence of a link between growth and secondary education, and no link at all between growth and tertiary education. Hanushek and Woessmann [20] pointed out that the cognitive skills of the population are strongly related to individual earnings, to the distribution of income, and to economic growth. Onward, Pereira and St Aubyn [21] reinforced that primary and secondary education has a positive and significant effect on growth, though tertiary education does not contribute significantly to economic growth in Portugal. By employing a meta-regression analysis to 57 studies with 989 estimates, Benos and Zotou [22] provided evidence supporting a large publication selection bias regarding a positive influence of education on growth.

With regard to the influence education has on future wealth of individuals, there is not a consensus. The human capital theory has been suggested that education raises wages since it increases the productivity of employees, thus establishing a boost of productivity in the benefit of society. Contrariwise, the screening hypothesis highlighted that education has no effect on labor productivity, being used as a signaling device that corporations employ to select the more skilled labor force, the benefit of educational investment being smaller. Further, the life cycle and permanent income hypotheses supposed that individuals try to maximize their welfare by balancing a lifetime stream of earnings with a lifetime pattern of consumption. Solmon [23] stated that school quality influences lifetime earnings of all students regardless of the level of development of their nations. Krueger and Lindahl [24] found that increases in schooling raise workers' income. Lin [25] ascertained that one additional percent of higher education stock increase real output by 0.19%, whilst engineering and the natural sciences majors exhibited the most conspicuous role in the Taiwan's economic development. Martins and Pereira [26] revealed that returns to schooling are higher for the more trained persons, and that within-group wage inequality is higher for graduates than for non-graduates. Chevalier [27] reported the highest within-subject wage variation in Maths, IT, Architecture, Law, Business, Finance and Economics degrees, and the least in Linguistics, Education, Psychology, and "other" degrees. Moreover, Nickell [28] proved that each year of schooling up to 12 years lessens the estimated period of unemployment by over 4%, whereas the achievement of qualifications at regular levels or above decreases the expected unemployment time by 12%. Farber [29] reported that job losers with higher levels of education register higher post-displacement employment rates, being more likely to be

re-employed full-time. Likewise, Riddell and Song [30] reinforced that education raises re-employment rates of the unemployed, with large effects being reported in the neighborhoods of 12 and 16 years of schooling.

There are different views of the influence foreign study has on developing countries. For instance, Ahiakpor [31] examined dependency theory, which underlines that the connection of LDCs with more developed industrialized countries has operated to the LDCs loss. In fact, the skills developed in industrial countries are not suitable in the economy of LDCs since the last nations are capital-poor, even if labor rich. Based on the institutionalization theory, foreign education ensures prestige or authority to returning students, regardless of the quality of foreign education, which often leads to better access to political and social privilege. Sutton and Rubin [32] pointed out that students that were spending time abroad have benefited in terms of improved language skills and better cultural understanding. Hence, Mechtenberg and Strausz [33] proved that internationalization could also improve economic productivity due to the cultural knowledge that students achieve in foreign education.

2.2. The Impact of Business Environment on Sustainable Economic Growth

The Goal 8 out of the 2030 Agenda for Sustainable Development [1] highlights the need to "promote sustained, inclusive and sustainable economic growth, full and productive employment and decent work for all". The occurrence of this objective emerged forasmuch stable and well-paid jobs support poverty removal, as well as a fair globalization. For instance, the European Commission embraced the Circular Economy Package [34], which aims to support global competitiveness, maintain sustainable economic growth, and create new jobs. In the same vein, according to World Business Council for Sustainable Development [35], businesses can satisfy the human needs by developing novel technologies, promoting efficiency, producing jobs, and granting wide access to solutions. Thurik and Wennekers [36] noticed entrepreneurship as a driver of economic growth, competitiveness, and job creation. As well, by covering low-income societies in their value chains, corporations can achieve their purposes in terms of growth and profitability, whilst developing better societies in which they operate [35]. Nadia and Teheni [37] argued that business regulations might have a positive effect on growth by eliminating particular market failures and improving economic efficiency, but also a negative effect through substantial costs and unwanted distortions.

Unfortunately, the quality of education outcome is mitigated by the global phenomenon of corruption that hinders economic development. Getz and Volkema [38] argued that corruption is encouraged in highly hierarchical and pyramidal cultures with high power distance ranking. According to Heyneman [39], "education corruption" emphasizes the abuse of authority for personal and/or material gain. Mauro [40] found that corruption lowers economic growth. Later on, Mauro [41] revealed a negative association between corruption and government spending on education, arguing that education emerges as a repellent target for rent-hunters since its provision does not entail high-technology inputs to be delivered by oligopolistic suppliers. Mo [42] noticed that political instability, the level of human capital, and the share of private investment, are the channels through which corruption affects economic growth. Beets [8] indicated relatively low rates of literacy, relatively low school enrollment percentages, and relatively more students for each teacher in primary schools within those states with the highest levels of perceived corruption. Delavallade [43] reported that a high level of corruption alters the structure of public expenditure in favor of energy, defense, public order, culture, and at the expense of social sectors, such as education, health, and social protection. Cheung and Chan [44] found that as more people attend tertiary education the lower its impact of corruption across countries, being argued that students recognize the importance of social responsibility and morality through the knowledge they gather in higher education. Moreover, higher education should be seen as a moral enterprise that provides knowledge and experience to students in order to undertake ethical responsibilities and preserve their value correctness [45]. In the long run, there was uncovered that high levels of education corruption are detrimental towards

total factor productivity through decreasing the level of human capital and reducing the rate of its accumulation [46].

2.3. The Impact of Infrastructure & Technology on Sustainable Economic Growth

The purpose to "build resilient infrastructure, promote inclusive and sustainable industrialization and foster innovation" depicts the Goal 9 from the 2030 Agenda for Sustainable Development [1]. Infrastructure shows a noteworthy role towards connecting European markets by supplying the ways of moving goods and passengers [47]. According to World Economic Forum [9], a wider and efficient infrastructure is crucial towards effective economy operating. Hence, effective transport manners let contractors to receive timely their goods and services to market, whilst supporting the circulation of workers to the most appropriate jobs. Likewise, strong telecommunications grids enable the quick stream of information, which drives the overall economic efficiency [9].

Air and road transport cause wider activity through connectivity. For instance, in Peru, Gertler and Glewwe [48] showed that an increase in travel time to a local school was negatively correlated with the probability of school attendance, being reported an enrollment rate of 56% for children within one hour of a school, 42% for 1–2 h, 29% for 2–4 h, and 25% for more than 4 h. Lavy [49] highlighted that the access to a road in rural Ghana increases the likelihood of a child from that village of going to a primary school by 4.3% for children aged 5–12 and 8.8% for children aged 9–12. As well, Marazzo, et al. [50] provided evidence for a strong positive reaction of passenger-kilometer due to a positive change in GDP, whereas Pradhan and Bagchi [51] revealed bidirectional causality between road transportation and economic growth in India. According to Hu, et al. [52] a 1% increase in the air passenger traffic cause an increase of 0.943% in GDP.

The greatest impact of telecommunications infrastructure is on information diffusion and organizational efficiency [53], being reinforced by the endogenous growth model of Romer [10], which enlightens that balanced growth is positively influenced by knowledge spillover. By the means of high-speed Internet connections, people could enrich their knowledge and skills through multifarious resources. Therewith, social networking sites expose individuals to various cultural values. Von Hippel [54] argued that high-speed Internet facilitates involvement in community-lead open source projects. Hence, Choi and Yi [55] suggested that the Internet is presumed to support the spillover effect of knowledge across nations, wielding a positive and significant role in economic growth. Krueger [56] observed that workers who use a computer earn a 10 to 15 percent higher wage rate. By investigating a sample of 27 Central and Eastern European nations over the period 1990–1995, Madden and Savage [57] established a positive link between the investment in telecommunication infrastructure and economic growth. In addition, Lloyd-Ellis [58] confirmed that the spread of Information and Communication Technologies (hereinafter "ICT") increases worker productivity and lessens income disparity. Madon [59] claimed the requirement to afford wider connectivity that would increase global information infrastructure and support positive changes in socio-economic development. Accordingly, Leung [60] reported a significant association between Internet connectedness and information literacy. Based on the evidence from 21 OECD countries over 1970–1990, Roller and Waverman [61] unveiled a significant positive causal link between investment in telecommunication infrastructure and subsequent economic performance.

Vu [62] revealed a statistically significant relationship between growth and ICT, revealing that penetration of personal computers, mobile phones, and Internet users have a significant causal effect on growth. Yousefi [63] noticed that ICT contributes to the growth of high and upper-middle income groups, but it fails to provide support for lower-middle income group countries. In the same vein, Farhadi, et al. [64] reported a positive link between growth rate of real GDP per capita and ICT use index, but the impact of ICT use on economic growth was greater in high income group rather than other groups.

As opposed to previous studies, Acemoglu [65] asserted that the technological developments affected the structure of wages and determined an increase in income inequality in most developed

nations. As such, Noh and Yoo [66] showed a negative link between Internet adoption and growth for countries with high-income inequality.

2.4. The Impact of Population Lifestyle and Demographic Changes on Sustainable Economic Growth

The tenth SDG aims to "reduce inequality within and among countries" [1] and claims for applying the SDGs for all segments and ages of society, especially for vulnerable groups, such as older persons. The United Nations Development Programme [67] emphasized that older persons could have a significant role in fields like "economic development, unpaid care work, political participation, social capital". Aside from the positive effects, Directorate-General for Research and Innovation [68] noticed that older populations lessen the tax base, thus diminishing average per capita state revenues and rising the average tax burden.

Populations growing older lead to a significant reduction of human capital stock at an aggregate level and lower the productivity potential of society. The human capital theory and the life cycle of earnings advocate that an increasing life expectancy conduct to more investments in education and more labor supply, and accordingly to faster income growth [69]. In fact, it was revealed a significant effect of income and education in decreasing infant mortality, being claimed that the relationship is causal, but no significant impact of income on life expectancy [70]. Feyrer [71] found that changes in the age structure of the workforce are significantly correlated with changes in aggregate productivity. Hondroyiannis and Papapetrou [72] showed that in the long run, an increase in the old-age dependency ratio and a decrease in the fertility rate will impair the overall economic performance of the economy. Futagami and Nakajima [73] noticed that population aging may encourage more investment in human capital, which has a positive impact on economic growth. As such, Cervellati and Sunde [74] suggested that lower mortality determines parents to spend more time on their own education, thus dedicating less lifetime to work and reduce fertility. Thus, Jayachandran and Lleras-Muney [75] reported that for every additional year of life expectancy, literacy rises by 0.7 percentage points (2%) and years of education growth by 0.11 years (3%).

Kubzansky, et al. [76] showed that low levels of education were associated with poorer psychological function, less optimal health behaviors, poorer biological conditions, and larger social networks. Hence, De Walque [77] demonstrated that educated persons are less likely to smoke and among those who began smoking, they are more likely to have stopped. Moreover, according to the theory of allocative efficiency, better educated choose a more productive set of health inputs. Grimard and Parent [78] underlined that more education considerably increases the likelihood of never smoking. Christopoulou, et al. [79] found that a 1% rise in economic growth is related with an average drop in the smoking prevalence rate of 0.02 percentage points for women and 0.07 percentage points for men. In contrast, Schaap, et al. [80] contended a positive link between ever-smoking rates and GDP, for women 25–39 years, particularly for women that are more educated. In addition, Li and Guindon [81] provided evidence that a 10% increase in GDP per capita raises the likelihood of being a current smoker by at least 2.5% and possibly significantly more. Withal, there was revealed a positive link between GDP and the probability of a young person in a low- and middle-income country being a current smoker. On the contrary, Tenn, et al. [82] remarked that a supplementary year of education does not have a causal effect on smoking.

3. Data and Research Design

3.1. Sample Selection and Variables Description

Our broadest dataset includes the EU-28 member states, spanning primary the period from 1977 to 2014. Table 1 presents the variables comprised in the empirical investigation. The selected sample is unbalanced because there are countries showing missing data for several years, also data availability being dissimilar for the employed variables. Therefore, the time span of the study was reduced to the period 2002–2012, due to unavailability of data.

Table 1. Description of the variables.

Variables	Definitions	Period
Panel A: Variables regarding economic growth		
(1) Growth	Real GDP Growth (% growth).	'77–'14
Panel B: Variables regarding higher education		
(2) ALR	Adult Literacy Rate (% of population aged 15+). A person is literate who can, with understanding, both read and write a short simple statement on his or her everyday life.	'80–'14
(3) ESHE	Expenditure per Student in Higher Education in Purchasing Power Parity Terms (international dollar). (log values)	'90–'14
(4) HES	Higher Education Students (Incl. Universities) ('000). (log values)	'90–'14
(5) Stud	Traditional 18–22 year-old students ('000). Young people/adults aged 18–22 distinct from young adults who have left the educational system, in that they have not entered the world of work and are thus closer in lifestyle and purchasing power to Teens, yet different in that they are experiencing greater freedom. (log values)	'77–'14
(6) IStud	Mobility of students in Europe—Incoming students ('000). (log values) [tps00064]	'01–'12
(7) OStud	Mobility of students in Europe—Outgoing students ('000). (log values) [tps00064]	'01–'12
(8) ST	Science and technology graduates—Tertiary graduates in science and technology per 1000 inhabitants aged 20–29 years ('000). (log values) [tps00188]	'01–'12
Panel C: Variables regarding business environment		
(9) CPI	Corruption Perceptions Index (Score). It relates to perceptions of the degree of corruption as seen by business people and country analysts, and ranges between 10 (highly clean) and 0 (highly corrupt).	'95–'14
(10) GCI	Global Competitiveness Index (Score). It measures the microeconomic and macroeconomic foundations of national competitiveness, taking into account 12 subjects—Institutions, Infrastructure, Macroeconomic stability, Health and primary education, Higher education and training, Goods market efficiency, Labor market efficiency, Financial market sophistication, Technological readiness, Market size, Business sophistication and Innovation. All of them are given different weights, which varies across countries to evaluate the stage of economic development of each. Final score is obtained by averaging sub-indices, according to all 12 subjects. The score of each sub-index is from 1 to 7, where the best score is 7.	'06–'14
(11) TERD	Total Expenditure on R&D (US$ mn, Current Prices, Fixed 2014 Exchange Rates). (log values)	'81–'14
(12) ERRG	Employment rates of recent graduates (%). This indicator presents the employment rates of persons aged 20 to 34 fulfilling the following conditions: first, being employed according to the ILO definition, second, having attained at least upper secondary education (ISCED 3) as the highest level of education, third, not having received any education or training in the four weeks preceding the survey and four, having successfully completed their highest educational attainment 1, 2 or 3 years before the survey. [tps00053]	'02–'13
Panel D: Variables regarding infrastructure		
(13) APT	Airline Passenger Traffic (mn passenger-kilometres). The sum of the products obtained by multiplying the number of passengers carried on each flight stage by the stage distance. (log values)	'80–'14
(14) PCU	Passenger Cars in Use ('000). Number refers to the total number of new and used passenger cars in the register of road transport vehicles. (log values)	'77–'14
Panel E: Variables regarding technology, communications, and media		
(15) ACT	Annual Cinema Trips per Capita (Number). (log values)	'89–'14
(16) IS	Internet Subscribers ('000). The number of household and business Internet subscribers including dial-up, leased lines and fixed (wired) broadband. (log values)	'95–'14
(17) IU	Internet Users ('000). Internet users are people aged 5+ with access to the world-wide network via home, work Internet enabled computers, Internet cafes or mobile phones. (log values)	'90–'14
(18) MTR	Mobile Telecommunication Revenues (% of telecom revenue).	'96–'14
(19) OA	Online Adspend (US$ mn, Current Prices, Fixed 2014 Exchange Rates). The amount spent on Internet advertising per year. (log values)	'01–'14

Table 1. *Cont.*

Variables	Definitions	Period
(20) PBIEC	Possession of Broadband Internet Enabled Computer (% of households). The percentage of households with a broadband Internet connection via home computer.	'93–'14
(21) PCTV	Possession of Cable TV (% of households). All systems that distribute television signals by means of coaxial or fiber-optic cables with a frequency-conversion device connected to the television in which subscribers pay a specified monthly service charge in addition to an initial installation fee.	'77–'14
(22) PMT	Possession of Mobile Telephone (% of households). All mobile telephones which use digital or analogue narrowband networks.	'90–'14
(23) PSTVS	Possession of Satellite TV System (% of households). All systems which use a broadband network intended for the distribution of television, sound and data signals received directly from one or more satellites.	'77–'14
(24) PT	Possession of Telephone (% of households). All telephone sets including at least a telephone transmitter, a telephone receiver and the wiring and components immediately associated with these transducers, a switch hook, a built-in telephone bell, and a dial.	'77–'14
Panel F: Variables regarding population lifestyle and demographic changes		
(25) SPF	Smoking Prevalence Among Female Population (% of female adult population). The percentage of total adult female population who report that they are daily smokers. Adult means 18 years old in all countries.	'99–'14
(26) SPM	Smoking Prevalence Among Male Population (% of male adult population). The percentage of total adult male population who report that they are daily smokers. Adult means 18 years old in all countries.	'99–'14
(27) OADR	Old-Age Dependency Ratio (%). Indicates the percentage of persons older than 65 per persons aged 15–64.	'77–'14

Source: Authors' processing based on Euromonitor and Eurostat definitions.

Real GDP growth is employed as a proxy for sustainable economic growth. GDP is an assessment of the economic activity, set as the value of all goods and services produced less the value of any goods or services used in their achievement. The annual growth rate of GDP volume is calculated via a chain-linked approach in order to afford comparisons of the dynamics of economic development both over time and amongst economies of various dimensions. Consequently, the selected variable towards sustainable development shows several drawbacks, being as well recognized that GDP "is not a measure of economic welfare" [83], inasmuch as "the welfare of a nation can scarcely be inferred from a measure of national income" [84]. For instance, GDP neglect many benefits and costs of economic activity [85], and does not reveal any distinction between transactions that increase wellbeing and those that decrease it [86], ruling out the deals accomplished outside the formal market [87]. The "threshold hypothesis", as proposed by Max-Neef [88], points out that for every nation occurs a period wherein economic growth entails a betterment in life quality, but merely up to a point beyond which, if there is more economic growth, quality of life worsen. Commission on the Measurement of Economic Performance and Social Performance [89] acknowledged that when there are wide shifts in inequality, GDP might not yield a fair valuation of the state, in which most people find themselves, consequently the use of a dashboard of indicators being recommended. Aiming to support the previously mentioned view and to surpass GDP shortcomings, indexes such as Index of Sustainable Economic Welfare [90] (hereinafter "ISEW"), Genuine Progress Indicator [86] (hereinafter "GPI"), or Sustainable Net Benefit Index [91] (hereinafter "SNBI") have been developed. While GDP does not assess ecological impairment [92], ISEW envisages environmental exhaustion through the costs of using disposable natural resources [93]. Notwithstanding, ISEW has been designed as alternative of GDP, Neumayer [94] argued that it cannot simultaneously behave as an indicator of current welfare and as an indicator of sustainability, also being not a measure of strong sustainability. Stockhammer, et al. [95] criticized ISEW since it only estimate economic welfare and it is a rough survey that offers optimum outcome on longer periods. Withal, Bleys [96] claimed that ISEW methodology turned out to be very subjective. Therefore, the validity of these indexes is still disputed due to their questionable ability to

support the "threshold hypothesis" [97]. Brennan [98] reinforced that the indices are away a holistic and strong theoretical foundation due to a narrow conceptualisation of wealth, namely "human-health capital". However, even if there is admitted the fact that GDP shows several deficiencies, the current paper uses this measure since it comes to be the world's most universal indicator of economic progress, being broadly employed by policymakers, economists, international agencies, and the mass media as the main scorecard of a country's economic health and well-being [86].

Likewise, several measures towards SDGs are considered: higher education (Goal 4), business environment (Goal 8), infrastructure, technology, communications, and media (Goal 9), population lifestyle and demographic changes (Goal 10). The dataset is drawn from Euromonitor International database, except for IStud, OStud, ST, and ERRG, which were retrieved from Eurostat.

3.2. Econometric Framework

Primary, we will explore the causal link between education and growth, as long as the 2030 Agenda for Sustainable Development [1] follows a noticeably rise of the number of youth and adults who have appropriate skills with reference to employment, decent jobs, and entrepreneurship. For this purpose, we adopt the Granger causality approach [21] by running the following bivariate regressions:

$$\text{Growth}_{i,t} = \alpha_i + \alpha_1\text{Growth}_{i,t-1} + \ldots + \alpha_k\text{Growth}_{i,t-k} + \beta_1\text{Education}_{i,t-1} + \ldots + \beta_k\text{Education}_{i,t-k} + \varepsilon_{1i,t} \quad (1)$$

$$\text{Education}_{i,t} = \delta_i + \gamma_1\text{Education}_{i,t-1} + \ldots + \gamma_k\text{Education}_{i,t-k} + \phi_1\text{Growth}_{i,t-1} + \ldots + \phi_k\text{Growth}_{i,t-k} + \varepsilon_{2i,t} \quad (2)$$

In fact, higher education Granger-cause economic growth if predictions of growth based on its own past values and on the past values of variables regarding higher education are better than predictions of growth, based only on its own past values.

Furter, in line with previous studies [44,55,66], we employ panel data fixed-effects (hereinafter "FE") and random-effects (hereinafter "RE") regressions aiming to explore the link between selected drivers and sustainable economic growth, the general model being depicted below:

$$\begin{aligned}\text{Growth}_{i,t} = \beta_0 + \beta_1\text{Education}_{i,t} + \beta_2\text{Business}_{i,t} + \beta_3\text{Infrastructure}_{i,t} + \beta_4\text{Technology}_{i,t} + \\ \beta_5\text{Population}_{i,t} + \eta_t + \varepsilon_{i,t}\end{aligned} \quad (3)$$

where the subscript i refers to the country, the subscript t denotes the time period, $\text{Growth}_{i,t}$ represents the dependent variable, β_0 captures unobserved country-specific effects, β_1:β_5 are the parameters for the explanatory variables, $\text{Education}_{i,t}$ is a vector of the higher education measures, $\text{Business}_{i,t}$ is a vector of variables that are related to business environment, $\text{Infrastructure}_{i,t}$ is a vector of variables towards infrastructure, $\text{Technology}_{i,t}$ is a vector of variables regarding technology, communications, and media, $\text{Population}_{i,t}$ is a vector of variables concerning population lifestyle and demographic changes, η_t are time dummy variables that capture unobserved time-specific effects, and $\varepsilon_{i,t}$ is the error term, which is assumed to be independently and identically distributed. We will select the appropiate type of the regression model, FE, or RE, based on Breusch and Pagan Lagrangian multiplier (LM) test for random effects.

The concern of reverse causality as regards the nexus education-economic growth was noticed by Seetanah [4], inasmuch as causality goes from economic growth to education and not just vice versa. Also, Seetanah [4] emphasized that government policies influence long-run variations in mean educational fulfillment, besides education revealing a signaling effect and requesting more domestic and foreign direct investment to the state, consequently increasing economic growth. Onward, we will consider the generalized method of moments (hereinafter "GMM") estimators that are developed for

dynamic models of panel data. The integration of dynamics into our empirical investigation suppose that Equation (3) be modified as a first-order autoregression model, as below:

$$\begin{aligned}\text{Growth}_{i,t} - \text{Growth}_{i,t-1} = \alpha_t + \lambda\text{Growth}_{i,t-1} + \beta_1\text{Education}_{i,t} + \beta_2\text{Business}_{i,t} + \\ \beta_3\text{Infrastructure}_{i,t} + \beta_4\text{Technology}_{i,t} + \beta_5\text{Population}_{i,t} + \eta_i + \varepsilon_{i,t}\end{aligned} \quad (4)$$

where α_t are the period specific intercept terms to capture changes common to all countries. Further, we can rewrite Equation (4) as follows:

$$\begin{aligned}\text{Growth}_{i,t} = \alpha_t + (\lambda + 1)\text{Growth}_{i,t-1} + \beta_1\text{Education}_{i,t} + \beta_2\text{Business}_{i,t} + \beta_3\text{Infrastructure}_{i,t} + \\ \beta_4\text{Technology}_{i,t} + \beta_5\text{Population}_{i,t} + \eta_i + \varepsilon_{i,t}\end{aligned} \quad (5)$$

Inasmuch as the country-specific effects η_i are correlated with the lagged dependent variable $\text{Growth}_{i,t-1}$, the within-group estimators are inconsistent even if $\varepsilon_{i,t}$ is not serially correlated. Alike Seetanah [4], to eliminate country-specific effects, we take the first differences of Equation (5):

$$\begin{aligned}\text{Growth}_{i,t} - \text{Growth}_{i,t-1} = (\alpha_t - \alpha_{t-1}) + (\lambda + 1)(\text{Growth}_{i,t-1} - \text{Growth}_{i,t-2}) + \beta_1(\text{Education}_{i,t} - \\ \text{Education}_{i,t-1}) + \beta_2(\text{Business}_{i,t} - \text{Business}_{i,t-1}) + \beta_3(\text{Infrastructure}_{i,t} - \text{Infrastructure}_{i,t-1}) + \\ \beta_4(\text{Technology}_{i,t} - \text{Technology}_{i,t-1}) + \beta_5(\text{Population}_{i,t} - \text{Population}_{i,t-1}) + (\varepsilon_{i,t} - \varepsilon_{i,t-1})\end{aligned} \quad (6)$$

or

$$\begin{aligned}\Delta\text{Growth}_{i,t} = (\alpha_t - \alpha_{t-1}) + (\lambda + 1)\Delta\text{Growth}_{i,t-1} + \beta_1\Delta\text{Education}_{i,t} + \beta_2\Delta\text{Business}_{i,t} + \\ \beta_3\Delta\text{Infrastructure}_{i,t} + \beta_4\Delta\text{Technology}_{i,t} + \beta_5\Delta\text{Population}_{i,t} + \Delta\varepsilon_{i,t}\end{aligned} \quad (7)$$

Arellano and Bond [99] developed the first-differenced generalized method of moments estimator under the assumptions that the transient errors are serially uncorrelated, and that the initial conditions are predetermined, thereby the model instrumenting the right-hand-side variables with lags. Onward, due to superior finite sample properties we will use the system generalized method of moments estimator (hereinafter "system GMM"), as introduced forth by Arellano and Bover [100] and Blundell and Bond [101], which combines the set of equations in first differences with appropriate lagged levels as instruments, and with an extra set of equations in levels with appropriate lagged first differences as instruments. The system GMM estimator improves the efficiency and circumvents the weak instruments problem in the first-difference GMM estimator. Also, the data loss that stems from the difference GMM, particularly when using unbalanced panel data, is at its minimum in the system GMM.

Two important conditions should be met in order to give reliable predictions of coefficients: the instrumental variables should be valid and there should be no second-order serial correlation between the error terms of the first-differenced equation. To test the validity of the instrumental variables, we will employ the Hansen test. Also, we will use forward orthogonal deviation that deducts the average of all the future available observations of a variable, instead of the first-difference transform that subtracts the previous observation from the contemporaneous one [102]. Besides, Hayakawa [103] showed that the GMM estimator of the model transformed by the forward orthogonal deviation tends to work better than that transformed by the first difference. Moreover, we will employ the two-step instead of the one-step estimator, with robust standard errors in all of the specifications. In fact, two-step estimators use a weighting matrix that makes the two-step GMM asymptotically efficient [104]. Therewith, we have collapsed the instruments to limit instrument proliferation.

4. Empirical Findings and Discussion

4.1. Descriptive Statistics and Correlation Analysis

Table 2 summarizes selected variables. We notice a high mean value that is related to the level of literacy (97.57%), though a reduced mean value corresponding to science and technology graduates by

sex (12.54%). Likewise, we ascertain large disparities among the selected sample, revealed by high standard deviation, regarding ESHE, HES, Stud, TERD, APT, PCU, IS, IU, OA. Moreover, the mobility of students in Europe (both incoming and outgoing students) is low.

Table 2. Descriptive Statistics.

Variables	# Obs.	Mean	Std. Dev.	Min.	Max.
Panel A: Variables regarding economic growth					
Growth	980	2.24	4.09	−32.10	15.80
Panel B: Variables regarding higher education					
ALR	919	97.57	3.32	74.00	100.00
ESHE	546	8140.72	4083.43	1544.30	21,002.50
HES	730	570.61	729.68	0.90	3036.60
Stud	1064	1204.22	1493.33	23.40	6722.70
Istud	321	19.48	34.73	0.00	205.60
Ostud	336	16.97	15.97	0.50	107.20
ST	312	12.54	5.14	2.70	24.80
Panel C: Variables regarding business environment					
CPI	548	6.37	1.93	1.60	10.00
GCI	252	4.72	0.51	3.90	5.80
TERD	760	9423.54	17,145.27	0.70	116,502.90
ERRG	330	78.29	9.60	40.00	95.70
Panel D: Variables regarding infrastructure					
APT	873	24,835.70	46,560.66	31.00	262,002.90
PCU	968	6821.35	10,183.73	56.00	43,881.50
Panel E: Variables regarding technology, communications, and media					
ACT	660	1.55	0.84	0.10	4.40
IS	540	3242.24	5872.12	0.00	30,348.70
IU	657	6249.66	12,061.25	0.00	65,754.50
MTR	614	37.18	19.00	0.20	83.50
OA	371	467.44	1157.23	0.00	8588.10
PBIEC	541	25.44	29.60	0.00	90.30
PCTV	838	26.04	24.70	0.00	89.60
PMT	753	42.68	40.00	0.00	99.90
PSTVS	849	11.47	13.09	0.00	62.90
PT	949	65.43	25.23	7.90	99.60
Panel F: Variables regarding population lifestyle and demographic changes					
SPF	400	22.02	5.06	9.70	38.30
SPM	400	34.50	10.00	12.50	58.30
OADR	1064	21.14	4.00	13.40	32.80

Source: Authors' computations. Notes: Variables' description is provided in Table 1.

Unfortunately, we notice highly corrupt states such as Bulgaria, Croatia, Hungary, Latvia, and Romania argued by values of CPI below three, but also highly clean countries like Denmark, Finland, Sweden registering values of CPI over nine. The employment rates of recent graduates are, on average, 78.29%, nearly the benchmark of 82% settled in the strategic framework Education & Training 2020 [105]. Besides, as regards the mean values, the possession of telephone (65.43%), as well as mobile telephone (42.68%) is greater than the possession of cable TV (26.04%), broadband Internet enabled computer (25.44%), and satellite TV system (11.47%). The smoking prevalence among male population is higher, in mean, than the smoking prevalence among female population.

Further, Table 3 reveals the correlations between variables. We notice strong linear relationships between several variables, the value related to the correlation coefficient being over 0.7. Consequently,

in order to avert the statistical phenomenon of multicollinearity, we will consider the aforementioned variables in separate regression estimations.

Table 3. Correlation Matrix.

Var	1	2	3	4	5	6	7	8	9	10	11	12	13	14
1	1													
2	−0.09	1												
3	−0.25	0.09	1											
4	−0.06	0.23	0.12	1										
5	−0.04	0.1	0.06	**0.95**	1									
6	−0.14	0.22	0.41	0.66	**0.71**	1								
7	−0.12	0.08	0.16	0.68	0.68	0.35	1							
8	−0.13	0.39	0.17	0.26	0.21	0.23	0.21	1						
9	−0.02	0.13	**0.7**	0.05	0.04	0.35	−0.09	0.28	1					
10	0.06	0.3	**0.73**	0.24	0.28	0.49	0.06	0.24	**0.92**	1				
11	−0.1	0.2	0.41	**0.78**	**0.71**	**0.79**	0.68	0.23	0.33	0.52	1			
12	0.15	−0.1	0.54	−0.13	−0.08	0.22	−0.27	−0.01	0.65	0.59	0.16	1		
13	−0.09	0.17	0.42	**0.76**	0.62	**0.87**	0.53	0.31	0.33	0.5	**0.82**	0.18	1	
14	−0.06	0.18	0.2	**0.95**	**0.9**	**0.71**	0.69	0.21	0.11	0.29	**0.85**	−0.08	**0.76**	1
15	0.04	0.02	0.46	0.3	0.25	0.35	0.07	0.34	0.59	0.59	0.34	0.41	0.43	0.33
16	−0.2	0.16	0.43	**0.78**	**0.74**	**0.79**	0.68	0.23	0.2	0.4	**0.88**	0.07	**0.84**	**0.83**
17	−0.14	0.21	0.39	**0.75**	0.62	**0.83**	0.68	0.27	0.17	0.38	**0.81**	0.04	**0.8**	**0.75**
18	−0.07	0.35	0.14	−0.02	−0.15	−0.23	−0.03	−0.01	−0.27	−0.19	−0.03	−0.14	−0.01	−0.01
19	−0.13	0.13	0.45	0.57	0.55	**0.85**	0.46	0.23	0.22	0.47	0.68	0.18	**0.77**	0.56
20	−0.31	0.24	0.55	0.11	−0.03	0.22	0.1	0.42	0.25	0.52	0.21	0.18	0.23	0.1
21	0.1	0.27	0.34	−0.26	−0.24	−0.12	−0.31	−0.13	0.37	0.39	−0.04	0.51	−0.06	−0.16
22	−0.03	0.34	0.48	0.09	−0.17	0.07	0.04	0.35	0.17	0.3	0.12	0.25	0.17	0.06
23	0	0.32	0.36	0.38	0.1	0.42	0.46	0.25	0.11	0.02	0.35	0.07	0.38	0.31
24	0.05	0.18	0.23	0.31	0.23	0.34	0.25	−0.23	0.34	0.28	0.33	0.1	0.35	0.34
25	0.05	0.06	−0.01	0.04	0.05	−0.02	0.13	−0.2	−0.13	−0.23	−0.01	−0.06	0.04	0.01
26	0.22	−0.15	−0.68	−0.26	−0.25	−0.36	0.01	−0.36	−0.65	−0.66	−0.38	−0.46	−0.37	−0.3
27	−0.13	0.33	0.19	0.4	0.23	0.3	0.29	0.19	0.08	0.14	0.4	−0.24	0.33	0.41
Var	**15**	**16**	**17**	**18**	**19**	**20**	**21**	**22**	**23**	**24**	**25**	**26**	**27**	
15	1													
16	0.33	1												
17	0.27	0.98	1											
18	−0.06	0.09	0.19	1										
19	0.23	**0.78**	**0.8**	0.02	1									
20	0.14	0.35	0.41	0.51	0.37	1								
21	0.03	−0.14	−0.08	0.17	−0.13	0.3	1							
22	0.17	0.3	0.39	**0.78**	0.18	**0.77**	0.44	1						
23	0.25	0.45	0.52	0.44	0.35	0.39	0.23	0.62	1					
24	0.35	0.28	0.2	−0.32	0.26	−0.28	0.31	0.06	0.21	1				
25	0.07	−0.01	−0.04	0	−0.08	−0.28	−0.07	−0.19	0.17	0.31	1			
26	−0.49	−0.36	−0.36	0.11	−0.35	−0.45	−0.23	−0.4	−0.25	−0.09	0.29	1		
27	0.12	0.45	0.43	0.32	0.3	0.47	0.28	0.58	0.4	0.46	−0.16	−0.22	1	

Source: Author's computations. Notes: Bold values depict strong correlations. Variables' description is provided in Table 1.

4.2. Empirical Results

The output of Granger causality is revealed in Table 4. The number of lags was selected according to vector autoregressive lag order selection criteria, respectively, Schwarz information criterion. We acknowledge bidirectional causality between higher education, as measured by expenditure per student in higher education, higher education students, outgoing students, and economic growth. Moreover, the results show unidirectional causality running from traditional 18–22 year-old students and incoming students to economic growth. Upsurges of expenditure per student in higher education lead to an increased concern of people towards attainment higher education that determine in turn a rise in the enrollment in higher education. Consequently, the labor force become more trained and skilled, which is vital for the sustainable development of the economy. In addition, outgoing students boost economic growth since studying overseas let them to enlarge their knowledge of other foreign societies and languages in various states rather than their nation. Therewith, incoming students cause real GDP growth since they enhance the knowledge of the destination country.

Table 4. Pairwise Granger Causality Tests.

Null Hypothesis	# Obs.	# Lags	F-Statistic
GROWTH does not Granger Cause ALR	780	3	0.53926
ALR does not Granger Cause GROWTH			**0.84111**
GROWTH does not Granger Cause ESHE	492	2	**9.76438** ***
ESHE does not Granger Cause GROWTH			**13.6982** ***
GROWTH does not Granger Cause HES	674	2	**2.68233** †
HES does not Granger Cause GROWTH			**12.4615** ***
GROWTH does not Granger Cause STUD	896	3	**0.08628**
STUD does not Granger Cause GROWTH			**6.56124** ***
GROWTH does not Granger Cause ISTUD	257	2	**1.13504**
ISTUD does not Granger Cause GROWTH			**3.08125** *
GROWTH does not Granger Cause OSTUD	252	3	**12.0445** ***
OSTUD does not Granger Cause GROWTH			**4.66233** **
GROWTH does not Granger Cause ST	245	2	0.48660
ST does not Granger Cause GROWTH			1.93321

Source: Author's computations. Notes: ***, **, *, † indicates statistical significance at the 0.1%, 1%, 5% and 10% significance level, respectively. Variables' description is provided in Table 1. Bold values depict strong correlations.

Table 5 shows the estimated effect of higher education and business environment on economic growth. We find that science and technology graduates exert a negative and significant influence on economic growth, supported by both FE estimations (Equations (2), (3), (5) and (6)), and system GMM (Equation (11)). In line with Kiley [106], a potential explanation of the negative relationship could ensue from the fact that realizing new investments like computers can enforce extensive adjustment costs to the economy and lower economic growth.

Besides, the negative sign of the relationship also suggests that technological advances drives income inequality since novel technologies demand for high skilled workers detrimental to the rest of labor force. Howbeit, the results show that corruption perceptions index negatively influences growth (Equation (6)), alike Mauro [41]. Corruption depicts a real cost to society, which determines broad insecurity due to misallocation of resources. The trust in public institutions is impaired and the fundamental assignment of providing suitable public services and a conducive setting for private sector development is lessened. Under such circumstances, the willingness and capacity of private businesses to accomplish a long-term development strategy is endangered. Hence, as long as political and economic instability is setting out, sustainable development is hard to acquire [107]. Moreover, total expenditure on R&D (Equation (2)) and employment rates of recent graduates (Equations (1)–(7)) are positively related with economic growth. R&D expenditure positively influences innovation and total factor productivity, hence leading to growth [10,11]. Besides, the employment rates of recent graduates show a positive contribution to real GDP growth on the strength of skilled human capital.

The regression results reported in Table 6 display the relationships between higher education, business environment, and economic growth. According to Breusch and Pagan Lagrangian multiplier test, we rely on random effects regression models. The results show a significant positive link between adult literacy rate and growth (Equations (2) and (3)), since literacy lessens poverty, increases quality of life, and drives sustainable development. Likewise, traditional 18–22 year-old students positively influence real GDP growth (Equation (4)), as consistent with Sianesi and Van Reenen [13] forasmuch as education acquired by individuals affords social returns at the macroeconomic level, yielding further indirect benefits to growth. In addition, airline passenger traffic negatively influence economic growth (Equations (1) and (3)).

Table 5. Estimated panel data regression coefficients of the impact of the higher education and business environment on economic growth.

Variables	FE						System GMM					
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
L.Growth							**0.47 * (2.73)**	**0.40 * (2.43)**	**0.64 ** (3.67)**	0.21 (0.65)	**0.41** * (2.41)	**0.52** * (2.06)
L2.Growth							**−0.33 * (−2.12)**	**−0.38 * (−2.26)**	**−0.30 * (−2.18)**	**−0.33** ** (−3.07)	**−0.25** † (−1.81)	−0.28 (−1.19)
ALR	0.97 (1.17)	0.89 (0.62)	0.78 (1.46)	1.05 (1.31)	0.75 (0.51)	1.24 (0.86)	1.62 (1.26)	1.37 (0.66)	0.61 (0.77)	2.01 (0.88)	1.43 (0.85)	2.20 (1.31)
ESHE			1.35 (1.52)						−3.53 (−0.65)			
HES			0.32 (0.16)			−3.44 (−1.04)			1.17 (0.29)			−4.17 (−0.62)
Stud				3.41 (0.98)	−3.37 (−0.67)					−5.88 (−0.71)	−6.78 (−1.10)	
Istud						0.51 (0.67)						0.58 (0.15)
Ostud						−1.10 (−0.95)						0.50 (0.13)
ST	−1.62 (−1.65)	**−4.47 ** (−3.54)**	**−2.11** † **(−2.03)**	−1.49 (−1.48)	**−4.37 ** (−3.67)**	**−4.13 ** (−2.85)**	−5.03 (−0.93)	−5.35 (−1.41)	−3.89 (−0.93)	−8.17 (−0.77)	**−11.70 * (−2.63)**	−5.41 (−1.44)
CPI	−0.78 (−1.57)			−0.83 (−1.59)		**−0.97** † **(−1.79)**	−1.08 (−0.77)			−3.95 (−1.36)		−1.50 (−0.63)
GCI		0.11 (0.04)			0.39 (0.14)	1.91 (0.58)		1.26 (0.28)			−0.80 (−0.31)	−1.67 (−0.59)
TERD	−1.21 (−1.14)	**3.20** † **(1.86)**					−0.95 (−0.49)	−0.75 (−0.51)				
ERRG	**0.27 *** (5.16)**	**0.27 *** (4.75)**	**0.23 *** (4.88)**	**0.26 *** (4.47)**	**0.31 *** (4.65)**	**0.32 *** (4.98)**	**0.27** † **(2.02)**	0.15 (1.13)	0.10 (0.99)	0.50 (1.47)	0.20 (1.45)	0.11 (0.84)
_cons	−96.87 (−1.14)	−119.05 (−0.91)	**−100.66 * (−2.06)**	**−134.20** † **(−1.73)**	−64.62 (−0.45)	−115.40 (−0.84)	0.00 (.)	−132.97 (−0.67)	0.00 (.)	0.00 (.)	−76.38 (−0.52)	−167.46 (−1.39)
F statistic	**43.10 *****	**27.96 *****	**23.40 *****	**37.22 *****	**23.68 *****	**25.36 *****	**7.57 *****	**3.22 ****	**3.73 *****	**11.71 *****	**12.89 *****	**16.13 *****
R-sq	0.70	0.73	0.69	0.70	0.73	0.73						
LM test (Prob > chibar2)	1.0000	0.1825	1.0000	1.0000	0.1740	1.0000						
Pesaran CD test (Prob)	0.9960	0.6861	0.9516	0.9004	0.6587	0.4503						
AR(1) (*p*-value)							0.006	0.017	0.003	0.027	0.009	0.046
AR(2) (*p*-value)							0.554	0.848	0.455	0.954	0.594	0.843
Hansen Test (*p*-value)							0.522	0.179	0.427	0.227	0.449	0.822
# Instruments							56	62	56	56	57	66
# Obs.	278	183	281	278	183	181	278	183	281	278	183	181
Adjusted period	'03–'12	'07–'12	'03–'12	'03–'12	'07–'12	'07–'12	'02–'12	'06–'12	'02–'12	'02–'12	'06–'12	'06–'12
# Countries	27	27	27	27	27	27	27	27	27	27	27	27

Source: Author's computations. Notes: ***, **, *, † indicates statistical significance at the 0.1%, 1%, 5% and 10% significance level, respectively. The *t*-statistics are given in parentheses and are calculated using robust standard errors. Time period dummies are included in all models, but not reported. Variables' description is provided in Table 1. Bold values depict strong correlations.

Table 6. Estimated panel data regression coefficients of the impact of the higher education and infrastructure on economic growth.

Variables	FE	RE	FE	RE	FE	RE	System GMM		
	(1)		(2)		(3)		(4)	(5)	(6)
L.Growth							**0.67** *** **(4.46)**	0.48 (1.69)	**0.50** ** **(3.09)**
L2.Growth							**−0.52** * **(−2.43)**	−0.04 (−0.25)	−0.13 (−0.99)
ALR	0.22 (0.47)	0.17 (1.51)	0.33 (0.60)	**0.34** *** **(3.90)**	0.32 (0.54)	**0.22** † **(1.89)**	−0.03 (−0.03)	0.84 (0.62)	0.05 (0.06)
ESHE	**2.72** * **(2.37)**	−0.69 (−1.27)					11.32 (1.37)		
Stud	**7.39** * **(2.51)**	−0.04 (−0.19)					**26.38** * **(2.11)**		
Istud			0.48 (0.79)	−0.36 (−1.60)	0.13 (0.22)	−0.21 (−1.18)		0.93 (0.52)	0.40 (0.25)
Ostud			0.16 (0.12)	0.08 (0.27)	−0.03 (−0.03)	0.06 (0.21)		0.70 (0.16)	−3.26 (−0.72)
ST	0.65 (0.71)	0.28 (0.65)	−0.14 (−0.14)	0.19 (0.52)	−0.34 (−0.35)	0.32 (0.98)	4.34 (1.15)	−2.88 (−1.21)	−0.84 (−0.22)
APT	−0.15 (−0.45)	**−0.35** * **(−2.11)**			−0.23 (−0.72)	**−0.36** ** **(−2.59)**	−0.16 (−0.14)		−0.12 (−0.13)
PCU			**−5.44** * **(−2.17)**	−0.28 (−0.84)				−2.36 (−0.54)	
_cons	**−89.02** † **(−1.89)**	−4.85 (−0.43)	12.85 (0.25)	−28.23 ** (−3.05)	−25.95 (−0.45)	−16.44 (−1.36)	0.00 (.)	0.00 (.)	−0.03 (−0.00)
F statistic	**33.98** ***		**32.12** ***		**26.12** ***		**3.71** ***	**4.05** ***	**24.57** ***
Wald statistic		**489.25** ***		**446.42** ***		**462.94** ***			
R-sq	0.64	0.62	0.64	0.63	0.63	0.63			
LM test (Prob > chibar2)	0.0049		0.0000		0.0011				
Pesaran CD test (Prob)	0.9691	0.6298	0.7771	0.7940	0.7953	0.7473			
AR(1) (*p*-value)							0.002	0.191	0.039
AR(2) (*p*-value)							0.171	0.421	0.597
Hansen Test (*p*-value)							0.676	0.335	0.506
# Instruments							57	57	57
# Obs.	310		307		307		310	307	307
Adjusted period	'02–'12		'02–'12		'02–'12		'01–'12	'01–'12	'01–'12
# Countries	27		27		27		27	27	27

Source: Author's computations. Notes: ***, **, *, † indicates statistical significance at the 0.1%, 1%, 5% and 10% significance level, respectively. The *t*-statistics are given in parentheses and are calculated using robust standard errors. Time period dummies are included in all the models, but not reported. Variables' description is provided in Table 1. Bold values depict strong correlations.

Table 7 reports the estimation results of higher education and technology, communications, and media on real GDP growth. The findings reveal a positive influence of expenditure per student in higher education on economic growth (Equation (2)) and reinforce the positive impact of adult literacy rate (Equations (4) and (5)). Consequently, expenditure on education boost productivity, contribute to individual development, and decrease social inequalities. Further, annual cinema trips per capita (Equation (2)), Internet subscribers (Equation (1)), Internet users (Equation (2)), possession of cable TV (Equation (8)) are negatively related to growth, whilst mobile telecommunication revenues (Equation (4)) are positively linked with growth. Possession of telephone (Equations (5) and (10)) reveals a mixed influence on growth.

Table 7. Estimated panel data regression coefficients of the impact of the higher education and technology, communications, and media on economic growth.

Variables	FE	FE	FE	FE	RE	FE	RE	System GMM				
	(1)	(2)	(3)	(4)		(5)		(6)	(7)	(8)	(9)	(10)
L.Growth								**0.80 * (2.51)**	**0.49 † (1.84)**	**0.59 * (2.55)**	**0.63 * (2.34)**	**0.72 * (2.75)**
L2.Growth								−0.23 (−1.10)	−0.16 (−0.83)	−0.19 (−0.63)	−0.27 (−1.04)	−0.24 (−1.14)
ALR	−1.64 (−1.35)	−0.97 (−0.96)	−0.97 (−0.69)	−0.87 (−0.72)	**0.28 * (2.55)**	−1.54 (−1.00)	**0.35 ** (3.09)**	0.83 (0.55)	−3.65 (−0.44)	2.47 (1.57)	−0.70 (−0.35)	1.45 (0.40)
ESHE	2.35 (1.20)	**2.61 † (1.78)**	1.62 (1.10)					3.06 (0.64)	−3.09 (−0.53)	3.84 (0.42)		
HES			2.37 (0.81)							−0.03 (−0.01)		
Stud				3.21 (0.75)	−0.25 (−1.16)						0.42 (0.16)	
IStud						0.43 (0.53)	**−0.38 * (−2.53)**					−0.78 (−0.34)
OStud						−0.44 (−0.31)	0.10 (0.26)					−0.41 (−0.08)
ST	0.76 (0.53)	1.05 (0.96)	0.78 (0.50)	1.20 (1.20)	**1.04 * (1.98)**	0.34 (0.27)	−0.04 (−0.09)	−0.26 (−0.04)	−2.81 (−0.32)	0.18 (0.06)	−0.16 (−0.05)	−2.60 (−0.42)
ACT	−0.73 (−1.15)	**−1.26 † (−1.94)**		−0.44 (−0.56)	−0.70 (−1.63)			−0.93 (−0.30)	−0.24 (−0.08)		−0.34 (−0.16)	
IS	**−1.02 † (−1.72)**							−0.61 (−0.38)				
IU		**−2.32 * (−2.33)**							−1.53 (−0.42)			
MTR				**0.06 † (1.78)**	**0.05 * (2.31)**						0.05 (0.63)	
OA			−0.22 (−0.31)							−1.41 (−0.67)		
PBIEC	−0.03 (−1.12)			−0.01 (−0.52)	0.01 (0.39)	−0.01 (−0.25)	−0.00 (−0.17)	0.003 (0.03)			−0.02 (−0.28)	−0.06 (−0.59)
PCTV	−0.04 (−0.80)		−0.05 (−0.98)	−0.03 (−1.05)	0.01 (0.90)			−0.06 (−0.53)		**−0.16 † (−2.03)**	−0.07 (−0.89)	
PMT				−0.03 (−0.87)	**−0.05 * (−2.37)**						−0.03 (−0.48)	
PSTVS		0.01 (0.13)							0.005 (0.07)			
PT	0.02 (0.54)		0.03 (0.67)			0.02 (0.51)	**−0.03 † (−1.80)**	−0.003 (−0.13)		0.04 (0.59)		**0.07 * (2.27)**
_cons	149.64 (1.30)	91.87 (0.94)	69.25 (0.50)	65.73 (0.53)	**−25.27 * (−2.10)**	153.08 (1.02)	**−28.80 * (−2.49)**	−103.83 (−0.83)	0.00 (.)	−272.48 (−1.61)	70.12 (0.40)	−127.22 (−0.36)
F statistic	**63.59** ***	**51.49** ***	**40.05** ***	**43.35** ***		**36.20** ***		**16.46** ***	**11.66** ***	**4.34** ***	**175.21** ***	**3.80** ***
Wald statistic					**1150.83** ***		**728.98** ***					
R-sq	0.66	0.65	0.65	0.66	0.65	0.64	0.63					
LM test (Prob > chibar2)	0.1616	1.0000	1.0000	0.0218		0.0019						
Pesaran CD test (Prob)	0.5054	0.5383	0.8587	0.3918	0.2580	0.6491	0.4769					
AR(1) (*p*-value)								0.004	0.164	0.000	0.089	0.138
AR(2) (*p*-value)								0.474	0.706	0.767	0.467	0.467
Hansen Test (*p*-value)								0.968	0.796	0.922	0.961	0.724
# Instruments								63	65	61	63	59
# Obs.	287	287	261	286		285		287	287	261	286	285
Adjusted period	'02–'12	'02–'12	'02–'12	'02–'12		'02–'12		'01–'12	'01–'12	'01–'12	'02–'12	'01–'12
# Countries	25	25	24	25		25		25	25	24	25	25

Source: Author's computations. Notes: ***, **, *, † indicates statistical significance at the 0.1%, 1%, 5% and 10% significance level, respectively. The *t*-statistics are given in parentheses and are calculated using robust standard errors. Time period dummies are included in all models, but not reported. Variables' description is provided in Table 1. Bold values depict strong correlations.

The negative effect of Internet on growth, as reported in Table 7, is in line with that of Acemoglu [65], as well as Noh and Yoo [66], by way of prevailing income inequality across many of the EU-28 countries, alongside the social issue of digital divide or digital split. The positive effect on growth related to telecommunications, alike Madden and Savage [57], as well as Roller and Waverman [61], is argued by reduced cost of production, besides increased revenues and employment derived from rises in information and knowledge, which in turn, lead to an efficient cooperation and coordination.

Further, the regression results reported in Table 8 reveal the associations between higher education, population lifestyle and demographic changes, and economic growth.

Table 8. Estimated panel data regression coefficients of the impact of the higher education and population lifestyle and demographic changes on economic growth.

Variables	FE	FE	RE	FE	System GMM		
	(1)	(2)		(3)	(4)	(5)	(6)
L.Growth					**0.56 *** **(2.50)**	**0.64 **** **(3.67)**	**0.59 †** **(1.80)**
L2.Growth					**−0.29 †** **(−1.84)**	−0.24 (−1.48)	−0.19 (−1.13)
ALR	−0.99 (−0.77)	−0.74 (−0.50)	**0.37 ***** **(3.47)**		1.41 (0.44)	0.64 (0.22)	
ESHE	1.71 (1.12)				2.45 (0.32)		
HES	2.26 (1.06)				3.79 (0.37)		
Stud		**7.15 **** **(2.91)**	−0.04 (−0.27)			0.94 (0.23)	
IStud				0.32 (0.46)			−0.62 (−0.21)
OStud				−0.12 (−0.09)			−2.19 (−1.66)
ST	−0.37 (−0.32)	0.90 (0.94)	0.10 (0.20)	−0.49 (−0.44)	−5.26 (−1.12)	0.36 (0.04)	−0.71 (−0.26)
SPF		0.03 (0.35)	**−0.08 †** **(−1.79)**	−0.03 (−0.45)		−0.05 (−0.21)	0.18 (0.43)
SPM	**0.14 †** **(1.79)**	0.12 (1.53)	**0.08 †** **(1.91)**	**0.16 *** **(2.32)**	0.10 (0.25)	0.21 (0.35)	0.10 (0.18)
OADR	−0.14 (−0.34)	−0.26 (−0.66)	**−0.19 *** **(−2.47)**	−0.07 (−0.20)	−0.06 (−0.08)	0.42 (0.54)	−0.36 (−0.12)
_cons	71.55 (0.57)	27.52 (0.19)	**−30.11 ***** **(−3.82)**	0.04 (0.00)	−173.02 (−0.43)	0.00 (.)	17.08 (0.18)
F statistic	**47.62 *****	**88.79 *****		**44.21 *****	**5.89 *****	**4.46 *****	**8.37 *****
Wald statistic			**1007.98 *****				
R-sq	0.65	0.65	0.64	0.64			
LM test (Prob > chibar2)	1.0000	0.0057		1.0000			
Pesaran CD test (Prob)	0.7167	0.8678	0.5568	0.6898			
AR(1) (*p*-value)					0.014	0.028	0.032
AR(2) (*p*-value)					0.727	0.732	0.673
Hansen Test (*p*-value)					0.451	0.545	0.807
# Instruments					59	59	59
# Obs.	287	287		285	287	287	285
Adjusted period	'02–'12	'02–'12		'02–'12	'01–'12	'01–'12	'01–'12
# Countries	25	25		25	25	25	25

Source: Author's computations. Notes: ***, **, *, † indicates statistical significance at the 0.1%, 1%, 5% and 10% significance level, respectively. The t-statistics are given in parentheses and are calculated using robust standard errors. Time period dummies are included in all models, but not reported. Variables' description is provided in Table 1. Bold values depict strong correlations.

The positive effect of adult literacy rate on real GDP growth in strengthened (Equation (2)). Also, we notice that smoking prevalence among female population negatively influences growth (Equation (2)), alike Christopoulou, Lillard and de la Miyar [79], but smoking prevalence among male population shows a positive influence on real GDP growth (Equations (1)–(3)), in line with previous studies [80,81]. Besides, we confirm Hondroyiannis and Papapetrou [72], since old-age dependency ratio negatively influences economic growth.

Furthermore, according to the Pesaran CD (cross-sectional dependence) test employed in order to test whether the residuals are correlated across the EU-28 countries, we notice no cross-sectional dependence in all of the estimated models.

5. Concluding Remarks and Policy Implications

A sustainable nation cannot develop properly short of a minimum degree of literacy and knowledge from its citizens. The acknowledgment of economic outcomes that are related to higher education is fundamental for policymakers since education reveals both personal benefits, such as raised salaries and employability skills, as well as external returns like augmented labor market productivity or improved democracy. Otherwise, poor education implies substantial costs for society as regards public expenditure, corruption, wellbeing, and economic growth. Also, contemporaneous period of economic growth entails a technology-based approach, alongside policies towards infrastructure investments. Whilst, quality infrastructure allows for the accomplishment of social, economic, and political purposes, an underdeveloped infrastructures restricts the access to public services and to establish an important boundary to doing business.

Current paper revealed that adult literacy rate, expenditure per student in higher education, traditional 18–22 year-old students, total expenditure on research and development and employment rates of recent graduates are positively related with real GDP growth in EU-28 countries. Contrariwise, there was figured a negative influence of infrastructure, technology, and demographic changes on economic growth. Inasmuch as education depicts a fundamental government responsibility, legislators should design proper financing tools that will increase enrollment, particularly amongst the poor. Besides, contemporary era registered a shift from resources and manufacturing centered economies to economies based on information, knowledge, and skills. As policy implications, every EU-28 state should pin down the suitable equilibrium between promoting overall equity and giving powerful economic motivations. For instance, the governments should establish policies that encourage mobility of students, but also their return within motherland in order to benefit from their gathered knowledge. The private sector should be emboldened in order to invest in education and hire recent graduates. Withal, non-governmental organizations should highlight the importance of education within regional communities. Likewise, governments should consider infrastructure a higher priority, while encouraging innovation and creating business opportunies via suitable regulations.

The limitations of the study come from using GDP as a measure towards sustainable economic growth inasmuch as GDP does not cover any extents of welfare, comprising just market transactions, omit externalities, aside from the fact that it does not depict wealth distribution, alongside what is being produced. As future research avenues, current study may be extended by using alternative measures to GDP, like ISEW. As well, more SDGs may be covered. Therewith, the empirical analysis may be performed by grouping the examined countries based on their income level.

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