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THE IMPACT OF ENTREPRENEURIAL EDUCATION AND EDUCATIONAL ATTAINMENT ON ENTREPRENEURIAL ACTIVITY: EVIDENCE FROM SELECTED HIGH-INCOME ECONOMIES

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Abstract. Entrepreneurship has become an important tool for job creation, economic growth, improvements in productivity and production, and innovation. Therefore, key country and individual-level factors driving entrepreneurship have been explored in the related literature. Furthermore, entrepreneurial education has been extensively scheduled in primary, secondary, and tertiary education programs by many countries. This study explores the impact of entrepreneurial education at primary and secondary education levels, higher education levels, and general education levels on early-stage entrepreneurial activity in selected high-income countries over the period of 2003 to 2018, through panel cointegration and causality analyses. Causality analysis revealed that entrepreneurial education and general education had a significant impact on early-stage entrepreneurial activity in the short run. The cointegration analysis disclosed that both entrepreneurial education at basic and higher education levels, respectively general education level positively affected the early-stage entrepreneurial activity in the long run.

Keywords: entrepreneurial activity, entrepreneurial education, general education level, causality analysis, cointegration analysis, panel data.

JEL Classification: A20, I20, J24, L26, M13.

Introduction

Entrepreneurship is widely recognized as a significant driver of innovation, job creation, competitiveness and competition, and economic development and growth (Audretsch, 2007; Stoica et al., 2020).

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The benefits of entrepreneurship for each society can be categorized into 3 main categories: firstly, it induces economic growth by providing new job opportunities and fostering employment, by increasing productivity and competition; secondly, it drives innovation by introducing new products, services, new technologies; and thirdly, it creates social change by successfully breaking traditions, generating alternative solutions to old products or services, and by improving life quality.

Given that it provides so many benefits to the society, it is important to identify and assess the key factors that foster or hinder entrepreneurial activity. Extended studies focused on various factors such as: cultural factors (Martínez-Rodriguez et al., 2020; Méndez-Picazo et al., 2021), social factors (Martínez-Rodriguez et al., 2020; Méndez-Picazo et al., 2021), economic factors (Martínez-Rodriguez et al. 2020; Méndez-Picazo et al., 2021), political factors (Cepel et al., 2019; Zonouzi et al., 2021), technological factors (Kastrati, 2015; Claudino et al., 2017) legal factors (Nawaser et al. 2011; Ghani et al., 2011), and psychological factors (Isiwu & Onwuka, 2017; Kurjono et al., 2020).

The popular view that entrepreneurs "are born not made" (Nguyen et al., 2021) that was adopted for a long period of time by individuals, has been gradually replaced by the idea that entrepreneurs "are made through their life" (UKEssays, 2018) so everyone has the potential to become an entrepreneur. Starting from this idea, that entrepreneurs are not born and are shaped by many factors that contribute to the development of necessary skills, qualities, knowledge to become successful, and recognizing the key role that they are playing in each society, we consider that more research needs to be carried out to analyze these factors. The attention must be focused on those factors that can be used in different entrepreneurship development programs and strategies to contribute to entrepreneurial success. In this context, education can play a major role in the entrepreneurial process and policymakers and different international organizations such as the Organization for Economic Co-operation and Development [OECD] can collaborate with representatives of national education systems and education institutions "to promote entrepreneurship teaching and learning opportunities", as the OECD (2021) points out.

Prior studies that analyzed the impact of education on entrepreneurial activity provided divergent views: most researchers pointed out that entrepreneurship education enhances entrepreneurship attitudes, intentions, skills, or knowledge (Jena, 2020; Mukhtar et al., 2021) but there is evidence that some education programs failed to succeed in fostering entrepreneurship (Oosterbeek et al., 2010).

Analyzing articles about the relationship between entrepreneurial education and entrepreneurship, three major trends have been noticed: some researches focused more on the design of entrepreneurship education curriculum rather than on analyzing the impact of entrepreneurial education on entrepreneurial activity (Nabi et al., 2018; Penaluna et al., 2020), others analyzed the influence of different entrepreneurial education training programs on entrepreneurial activity based on single-country research (Hassi, 2016; Hernández-Sánchez et al., 2019), while other studies only focused on some university programs (Wei et al., 2019; Boldureanu et al., 2020). Michelacci and Schivardi (2020) linked education with the entrepreneurs' earnings, pointing toward the fact that the higher the degree of graduated studies, the higher the premium of entrepreneurs, compared to employees.

Stoica et al. (2020) discussed the drivers of economic growth, linking knowledge, entrepreneurship, and economic growth.

Education has always been perceived as an investment in human capital, consequently, being a determining factor of economic sustainable growth. In this line, Liao et al. (2019) found that local financial investment in education plays a positive and statistically significant role in promoting sustainable economic growth. Furthermore, a tremendous number of studies have linked to each other education and economic growth.

In this context, the authors' intention is to make a contribution to the related literature in two ways. First, this study analyzes the effect of entrepreneurial education during primary, secondary, and tertiary education levels on the early-stage entrepreneurial activity at the country level and for a period of 16 years unlike most of the empirical studies presented in the literature review section, as most of the studies have investigated the same research topic for specific samples (especially students) in a country with one-time surveys. Secondly, the study analyzes the relationship among entrepreneurial education during primary, secondary, and tertiary education levels, educational attainment, and early-stage entrepreneurial activity at both country and panel levels by means of second-generation causality and cointegration tests taking heterogeneity and cross-sectional dependence into consideration.

Entrepreneurship plays a crucial role in countries' economic development, therefore, identifying and analyzing factors that can foster entrepreneurial activities can help policymakers to identify essential elements for improving national entrepreneurship strategy. Entrepreneurship must be actively supported by dedicated policy initiatives and actions but these must be adopted based on existing research findings in this field.

Starting from the Quadruple Helix Model of innovation we can identify four actors involved in the innovation activities: public authorities, academia, industry and society. All must be actively involved and need to collaborate in order to accomplish certain outcomes. The dynamic interactions between these actors can foster entrepreneurship. The results of our research can help us to understand better how entrepreneurship education can influence early-stage entrepreneurial activity, can provide support for people involved in the academic process to redesign educational courses to provide useful information and encourage graduates to enter into the business environment, can help governments to design and implement proactive public programs and policies that enhance the performance of education outcomes and motivate individuals to become entrepreneurs.

Starting from the idea that entrepreneurs can be formed using adequate educational programs and activities (Martin et al., 2013; Hassi, 2016) the authors aim at investigating if entrepreneurship education affects entrepreneurial activity by conducting an empirical analysis using a sample of ten high-income economies. High-income countries generally have a better entrepreneurship ecosystem, and, in turn, are usually at the top of the entrepreneurship rankings. In this context, the United States of America, the United Kingdom, and Ireland were among the top ten countries with the highest entrepreneurship index in 2018 and the other countries were also at the top (Global Entrepreneurship Development Institute, 2018). Therefore, the effect of entrepreneurial education and educational attainment on early-stage entrepreneurial activity in a sample of high-income countries was explored. Analysing countries that have specific strategies to promote entrepreneurship education can

help us to understand better the role of education in fostering entrepreneurship development and to offer practical solutions for low and middle-income countries.

The rest of the paper is structured as follows: firstly, a review of prior literature is conducted, secondly, data is presented, and the methodological issues are discussed, thirdly, the empirical approach is presented, and, lastly, the main findings and conclusions are presented.

1. Scientific literature review

1.1. Entrepreneurship education

Entrepreneurship education plays a vital role in enhancing a country's competitiveness and economic growth (Korez-Vide & Tominc, 2016; Rusu & Dornean, 2019) by providing a mix of entrepreneurial competencies and skills, experiential learning, mindset changing (Wilson, 2008; Boldureanu et al., 2020). In this context, it is important for countries to understand the importance of entrepreneurship education from an early age and to find proper tools and methods to promote and support entrepreneurship education.

In 2015, world leaders adopted the 17 Sustainable Development Goals (SDGs) included in the 2030 Agenda for Sustainable Development (United Nations [UN], 2015). Two of these goals (SDG4.4 and SDG8.3) contribute to tackling the economic and social challenges by considering entrepreneurship a key element that can facilitate growth, promote innovation, increase adoption of new technologies, change the old consumption patterns, enhance social cohesion, etc. (Filser et al., 2019). These goals focus on entrepreneurial skill development process that can be accomplished by using a variety of methods for education and training, by improving cognitive and non-cognitive skills, by promoting policies that encourage entrepreneurship (UN, 2015).

Worldwide, universities offer a wide range of entrepreneurship courses and programs but we need to start to cultivate entrepreneurial behavior since primary and secondary school.

Many countries launched national strategies to embed entrepreneurship into the formal educational system starting from primary and secondary education and continuing with tertiary education (European Education and Culture Executive Agency [EACEA], 2012). Generally, in primary education, entrepreneurship is not taught as a standalone subject but learning objectives are established associated with entrepreneurial knowledge, attitudes and skills (EACEA, 2012). Unlike primary education, in secondary education, entrepreneurship has become a compulsory topic in some countries (EACEA, 2016).

Over half of Europe's countries allocate EU and national funding to entrepreneurship education (EACEA, 2016) but to achieve the desired outcomes a combination of measures are required: incorporation of entrepreneurship education into the national school curriculum, using specific methods for teaching and learning, establishing specific teaching qualification standards for professors.

1.2. Outcomes of entrepreneurship education

Starting from the definition of entrepreneurship education provided by the Quality Assurance Agency for Higher Education that defines it as "the application of enterprise behaviors,

attributes and competencies into the creation of cultural, social or economic value. This can, but does not exclusively, lead to venture creation" (QAA, 2018) we can deduce that people can follow different entrepreneurship programs, courses and can improve their entrepreneurial knowledge, skills, competencies but not necessary these will enhance employability or will encourage entrepreneurship.

After the firsts entrepreneurship programs provided by U.S. colleges and universities (University of Michigan since 1927, Harvard Business School beginning 1947, University of Texas at Austin since 1964 (The Princeton Review Staff, 2014) at the end of the 20th Century, such specialized higher education programs have grown worldwide at a very rapid pace (Solomon, 2007) providing support and encouraging the emergence and development of a large variety of entrepreneurial initiatives (Nabi & Liñán, 2011). In fact, this is their main purpose, and this is their differentiation feature from regular business education programs: "to generate more quickly a greater variety of different ideas for how to exploit a business opportunity, and the ability to project a more extensive sequence of actions for entering business" (Solomon, 2007). It is important not only to include entrepreneurship education into the school curriculum but also to assess its impact on entrepreneurial outcomes. Evaluating the effectiveness of entrepreneurial education can provide valuable insights into all parts involved in educational reform.

The link between entrepreneurship education and entrepreneurial activity has been examined before by experts and researchers and different results have been reported.

One of the first in-depth longitudinal studies addressing the impact of entrepreneurial education on entrepreneurial outcomes was conducted by Matlay (2008) who analyzed the career path of a total of 64 graduates students from the United Kingdom over the 1997–2006 period and suggested there is a gap between the graduates' needs for entrepreneurship education and their actual outcomes in terms of entrepreneurial skills, knowledge, and attitudes.

A research conducted on several groups of business and non-business students from several Croatian universities (Zoran & Krečar, 2015) concluded that those subjects who had been enrolled in entrepreneurship classes presented higher entrepreneurial intentions as compared to non-business students.

Stamboulis and Barlas (2014) explored the determinants of entrepreneurship by employing a sample of 169 students that attended the entrepreneurship education program at the University of Thessaly and discovered that the entrepreneurship program changed the students' entrepreneurship perception positively.

Likewise, Doğan (2015) analyzed the impact of entrepreneurial education on entrepreneurship intentions on a sample 83 students enrolled in the Business Administration program from Istanbul University and revealed a positive relationship between the entrepreneurship course grade and the students' entrepreneurial intentions. Welsh et al. (2016) investigated the impact of entrepreneurial education on entrepreneurship using a sample of 671 students taking business and entrepreneurship courses in a South-Eastern University from Turkey and disclosed that entrepreneurial education had a significant influence on the students' entrepreneurial intentions, motives, and attitudes.

Gică and Dobrovolska (2017) investigated a sample consisting of 250 bachelor and master students from France, Germany, Poland, Romania, Russia, and the United Kingdom and

concluded that the level of education directly impacts both self-esteem and proactiveness and confirmed that entrepreneurial education leads to business initiation.

Considering the high unemployment rates among youngsters and the fact that highly educated persons may contribute to the entrepreneurial intention of Portuguese, Silva and Nobre (2018) underlined that universities have the potential to provide the framework for detecting and supporting students who have the potential to become entrepreneurs and, who further, have the capacity to inspire and involve their peers to follow the same path. Focusing on the very high need to provide its young generation (the largest worldwide) occupational opportunities, a study in India, comprising 509 subjects also revealed a strong link between entrepreneurship education and the intent of students to start a business (Jena, 2020).

Another study has been conducted by Vodă and Florea (2019) in two Romanian universities using a sample of 270 subjects and pointed out that locus of control, need for achievement, and entrepreneurial education are among the most important triggering factors associated with new venture creation. Furthermore, they concluded that males are more inclined towards entrepreneurial activities than female respondents, these findings being similar to those reported by (Westhead & Solesvik, 2016).

More recently, Boldureanu et al. (2020) evaluated the role of entrepreneurial education on entrepreneurial activities of the students based on a sample of 30 graduate students who attended the Business Creation course and underlined a positive impact of entrepreneurial education on students' entrepreneurial activities.

Worldwide, there are various programs that have been developed aiming at supporting the entrepreneurship-related educational programs in schools and universities. Among the most known ones are those organized by Junior Achievement (JA), namely the *Junior Achievement Company*, and the Erasmus program for Young Entrepreneurs, which has been found to have a major contribution upon entrepreneurial initiative. Elert et al. (2015) investigated three cohorts of pupils and students who had been involved in the JA program in Sweden, compared them to similar individuals who had not been involved in such programs, and followed them up to 16 years after graduation. They found out that the participation in the *JA Company* program contributed by increasing the subjects' probability to initiate a business, on the long run but could not be associated to their firms' survival (Racolța-Paina, 2016).

When it comes to what triggers individuals to become entrepreneurs, scholars point towards two factors: opportunity and/or necessity, thus, one can identify two types of entrepreneurial activities: opportunity-driven early-stage and necessity-driven early-stage entrepreneurial activities (Stoica et al., 2020). Several control variables were considered by the same authors in their econometric study, such as the investment ratio (measured using gross capital formation as GDP quota), knowledge (assessed through the levels of education and expenditure for research and development), unemployment rate, government expenditures, population growth, and economic openness (Stoica et al., 2020). The existence of a unidirectional causality relationship running from total entrepreneurial activities for female working age population to educational attainment for female aged 15 and over was revealed in the case of 20 high-income OECD countries. For the same sample, the authors also identified a unidirectional causal relation from per capita GDP to total entrepreneurial activity at the level of the total population (Balan et al., 2016). Moreover, entrepreneurship education is

commonly associated with a strong connection with the market and the industry, respectively with the active involvement of practitioners in the knowledge transfer process.

Despite the fact that education is widely associated with economic growth and that many researchers have conducted panel cointegration and causality studies in this respect, only a limited number of studies seem to have approached the impact of entrepreneurial education on entrepreneurial initiatives using panel data analyses. Some studies focused on BRICS countries, linking entrepreneurial activity, economic growth, and employment, and concluded that employment and domestic investments are predicted by both early entrepreneurial activity and the establishment of new ventures.

Following the evidence from analyzed literature, this research investigates the potential link between different levels of education and entrepreneurial activity. Most papers examined the effect of higher education on entrepreneurship and a consensus on the implications of entrepreneurial education on entrepreneurial activity has not yet been reached, therefore we considered necessary a deeper investigation to evaluate the impact of different levels of education on early-stage entrepreneurial activity.

2. Research methodology

2.1. Data

The impact of school and post school entrepreneurial education and educational attainment on early-stage entrepreneurial activity was analyzed on a sample of 10 high-income economies. The early-stage entrepreneurial activity was proxied by the share of nascent entrepreneurs or owner-managers of a new business at the level of the 18–64 years-old population. The entrepreneurial education at school stage was represented by the entrepreneurial education and training at primary and secondary levels. The entrepreneurial education at post-school stage was proxied by the entrepreneurial education and training at higher education level. The data of early entrepreneurial activity, entrepreneurial education at primary and secondary, respectively at higher education levels was collected from the Global Entrepreneurship Monitor database [GEM] (2020a; 2020b). Lastly, educational attainment was represented by the education index, a combination of expected schooling years and mean years of schooling by UNDP (United Nations Development Programme, 2020). All the series included in Table 1 were annual, and the study period was specified as 2003–2018 given the data availability of entrepreneurship education. Data

Table 1. Data definition

Variables	Description	Source
TEA	Total early-stage entrepreneurial activity	GEM (2020c)
BSE	Basic-level (primary and secondary level education) entrepreneurial education	GEM (2020c)
HELE	Higher-level (university level) entrepreneurial education	GEM (2020c)
EDU	Education index	UNDP (2020)

The sample of the econometric analysis consisted of ten high-income countries (United States of America, United Kingdom, Spain, Slovenia, Italy, Ireland, Greece, Germany, Croatia, Chile) taking notice of the data presence.

The applied analyses were performed through Stata 15.0, Gauss 10.0, and Eviews 11.0. The main characteristics of the dataset are displayed in Table 2.

Table 2. Descriptive statistics

Characteristics	TEA	BSE	HELE	EDU
Mean	7.996000	1.950062	2.733500	0.831125
Maximum	26.83000	2.820000	3.810000	0.946000
Minimum	2.350000	1.320000	1.890000	0.693000
Std. Dev.	4.779057	0.291771	0.283871	0.066199
Skewness	2.181797	0.504933	0.292425	–0.173346
Kurtosis	7.991399	3.084479	4.568131	1.894151

The following econometric model was formed to analyze the effect of entrepreneurial education and educational attainment on early-stage entrepreneurial activity:

$$TEA_{it} = f\left(BSE_{it}, HELE_{it}, EDU_{it}\right)\left(i = 1,2,\ldots,10;\ t = 2003,2004,\ldots,2018\right). \quad (1)$$

In this context, the authors have formulated three hypotheses for the current research, as it follows:

- **Hypothesis (1)**: There is a relationship between basic-level entrepreneurial education and early-stage entrepreneurship.
- **Hypothesis (2)**: There is a relationship between higher-level entrepreneurial education and early-stage entrepreneurship.
- **Hypothesis (3)**: There is a relationship between educational attainment and early-stage entrepreneurship.

2.2. Econometric methodology

The long-term effect of entrepreneurial education and education on early-stage entrepreneurship was explored using Westerlund and Edgerton (2007) bootstrap panel cointegration test. The second generation of panel data cointegration test was used since can efficiently deal with of cross-sectional dependence and provides robust results even challenges related to autocorrelation and heteroscedasticity are intertwined and data consists of a small sample size. The LM Bootstrap cointegration test developed by Westerlund and Edgerton (2007) considers the null hypothesis of cointegration in panel data. We have the following test equation $\left(LM_N^+\right)$:

$$LM_N^+ = \frac{1}{NT^2}\sum_{i=1}^{N}\sum_{t=1}^{T}\hat{w}_i^{-2}s_{it}^2, \quad (2)$$

where $\left(s_{it}^2\right)$ denotes the partial sums of the error terms and $\left(\hat{w}_i^{-2}\right)$ represents long-term variances.

If results indicate that variables are cointegrated, the next step is to estimate the long-run coefficients by employing the fully modified ordinary least squares (FMOLS) estimator by Pedroni (2000).

The FMOLS corrects the serial correlation and endogeneity bias and takes the heterogeneity into consideration. The FMOLS estimator is an improved version of the ordinary least squares method and corrects the serial correlation and endogeneity bias. The panel FMOLS estimator is as follows:

$$\hat{\beta}^{*}_{GFM} = N^{-1}\sum_{i=\text{“}}^{N}\beta^{*}_{FM_i}, \tag{3}$$

$\beta^{*}_{FM_i}$ indicates the cross-sectional coefficients in the above equation.

The causal interaction among the series was checked through tests of Dumitrescu and Hurlin (2012), Emirmahmutoglu and Kose (2011) and Toda and Yamamoto (1995) causality test. The Dumitrescu and Hurlin (2012) test is robust in case of cross-sectional independency and panel heterogeneity, but the test yields only panel level results. On the other side, Emirmahmutoglu and Koöse (2011) causality test is an extended version of (Toda & Yamamoto, 1995) causality test for heterogeneous panels and also considers cross-sectional dependence and yields panel and country level results. Furthermore, the causality between series for each country was checked by Toda and Yamamoto (1995) causality test.

Dumitrescu and Hurlin (2012) is the improved version of the Granger causality test for heterogeneous panels and the causality test model is described for the stationary variables of x and y as follows (Dumitrescu & Hurlin, 2012):

$$x_{i,t} = \alpha_i + \sum_{k=1}^{k}\gamma_i^{(k)} x_{i,t-k} + \sum_{k=1}^{k}\beta_i^{(k)} y_{i,t-k} + e_{i,t}; \tag{4}$$

$$y_{i,t} = \alpha_i + \sum_{k=1}^{k}\gamma_i^{(k)} y_{i,t-k} + \sum_{k=1}^{k}\beta_i^{(k)} + e_{i,t}. \tag{5}$$

The statistic test in Equation (6), average of individual Wald statistics is emploted to test the null hypothesis.

$$W_{N,T}^{HNC} = \frac{1}{N}\sum_{i=1}^{N} W_{i,T} \ \left(W_{i,T} \text{ are individual Wald statistics}\right). \tag{6}$$

Dumitrescu and Hurlin (2012) suggest that $\tilde{Z}_N^{HNC}$ test statistic in Equation (7) should be used, because the individivual Wald statistics do no converge to the same chi-square distribution for small T values.

$$\tilde{Z}_N^{HNC} = \frac{\sqrt{N}\left[W_{N,T}^{HNC} - N^{-1}\sum_{i=1}^{N} E\left(W_{i,T}\right)\right]}{\sqrt{N^{-1}\sum_{i=1}^{N} Var\left(W_{i,T}\right)}} \quad N \to \infty, \ N\left(0,1\right). \tag{7}$$

The Emirmahmutoglu and Kose (2011) causality test enables the lag length to differ among cross-sections and reduces the information loss of long run because the test models the variables at level (Emirmahmutoglu & Kose, 2011). The test can be expressed with the

following equations:

$$Y = \varphi_I^Y + \sum_{k=1}^{k_i+d_{\max_i}} A_{11,ik} Y_{it-k} + \sum_{k=1}^{k_i+d_{\max_i}} A_{12,ik} X_{it-k} + \mu_{I,T}^Y; \tag{8}$$

$$X = \varphi_I^X + \sum_{k=1}^{k_i+d_{\max_i}} A_{21,ik} Y_{it-k} + \sum_{k=1}^{k_i+d_{\max_i}} A_{22,ik} X_{it-k} + \mu_{I,T}^X. \tag{9}$$

In the above equations, k is the lag length, d- is the maximum integration level for cross-sections. The critical values for each cross-section are generated from bootstrapping process.

Last, Toda and Yamamoto (1995) developed a method based on VAR model to test the causality between series and integration levels of the series and presence of cointegration relationship among the series is not matter for the validity of the test. The lag length of VAR model (k) and maximum integtation level $\left(d_{\max}\right)$ are critical for the test. A VAR model with lag length of $k+d_{\max}$ is estimated and the the csality analysis is conducted through test of parameter constraints in the model. The VAR model in Equation (10) and (11) is estimated by means of seemingly unrelated regression:

$$y_t = \gamma_0 + \sum_{i=1}^{k+d_{\max}} \alpha_{1i} y_{t-1} + \sum_{i=1}^{k+d_{\max}} \beta_{1i} x_{t-1} + e_{1t}; \tag{10}$$

$$x_t = \gamma_0 + \sum_{i=1}^{k+d_{\max}} \alpha_{2i} y_{t-1} + \sum_{i=1}^{k+d_{\max}} \beta_{2i} x_{t-1} + e_{2t}. \tag{11}$$

The first model tests whether x variable is not Granger cause of y through Wald test conforming to chi-square distribution with degrees of freedom.

4. Empirical analysis

In the econometric analysis section, the cross-sectional dependence and slope homogeneity are important issues that need to be first analyzed. The presence of cross-sectional independence indicates that all cross-sections in the panel are equally influenced by any shocks in a country in the panel. Furthermore, it postulates that no country in the panel is influenced by an economic shock occurring in another country from the panel. On the other side, homogeneity tests check whether constant and slope coefficients vary from country to country. Therefore, our data was tested using the tests introduced by Breusch and Pagan (1980), Pesaran (2004), Pesaran et al. (2008), Pesaran and Yamagata (2008). To reach pertinent conclusions, our data was firstly tested for cross-sectional dependence and the findings were summarized in Table 3. The evidence indicates that the null hypothesis was rejected at the 1% level of significance which indicates the presence of cross-sectional dependency among the series.

Table 3. Cross-sectional dependence tests (H_0: There is cross-sectional independence)

Test	Statistic Test	p value
Breusch–Pagan (1980) LM	38.786	0.001
Pesaran et al. (2008) $LM_{adj.}$	31.884	0.021
Pesaran (2004) CD	29.026	0.014

Furthermore, the data was tested for slope homogeneity by adopting tests developed by Pesaran and Yamagata (2008) and the results were reported in Table 4. Empirical analysis indicated that the null hypothesis of homogeneity was rejected at 1% significance level, therefore the slopes are heterogeneous.

Table 4. Tests of homogeneity (H_0: Slope coefficients are homogeneous)

Test	Statistic Test	p value
Delta tilde	24.278	0.000
Delta $tilde_{adj.}$	26.913	0.000

The traditional econometric theory generally rests on the assumption that the employed series is stationary (in other words, their variances and means are constant over time) (Hendry & Juselieus, 2001). Therefore, it is important to specify whether the series are stationary or not through unit root tests. In the study, the stationarity characteristics of the series was checked by employing Pesaran (2007) CIPS unit root test approach regarding the existence of cross-sectional dependence and results presented in Table 5 indicate that null hypothesis (the variable is not stationary) was accepted at level, but null hypothesis was rejected after first-differencing of the series and in turn we concluded that all the series were integrated of the same order I(1).

Table 5. CIPS Unit Root Tests (H_0: The series has unit root)

Variables	Level		First differenced values	
	Constant	Constant + Trend	Constant	Constant + Trend
TEA	–1.318	–1.427	–6.452**	–6.881**
BSE	–1.289	–1.364	–6.991**	–7.204**
HELE	–1.147	–1.245	–8.363**	–8.916**
EDU	–1.056	–1.119	–7.909**	–8.103**

Note: ** is significant at 5% significance level

The long relationship between early-stage entrepreneurial activity and education indicators was questioned through Westerlund and Edgerton (2007) LM bootstrap panel cointegration tests and the results were reported in Table 6. The null hypothesis of significant cointegration among the series was accepted because both asymptotic and bootstrap probability values from 10.000 repetitive distributions were revealed to be higher than 10%. Therefore,

there existed a significant cointegration relationship between early-stage entrepreneurial activity, entrepreneurial education indicators, and education.

Table 6. Westerlund and Edgerton (2007) LM bootstrap panel cointegration test (H_0: There is the cointegration relationship among the variables)

LM_N^+	Constant			Constant +Trend		
	Test statistic	Asymptotic p value	Bootstrap p value	Test statistic	Asymptotic p value	Bootstrap p value
	8.316	0.273	0.358	9.227	0.392	0.411

Note: Lag and lead values were taken as 2.

To estimate the cointegrating coefficients we applied FMOLS (Full Modified Ordinary Least Square) method. FMOLS method corrects the deviations resulting from problems of autocorrelation and heteroskedasticity. The cointegration coefficient estimations presented in Table 7 revealed that entrepreneurial education at basic and at higher education levels, and educational attainment respectively affected the early-stage entrepreneurial activity positively. However, the cross-sectional cointegration coefficients disclosed that basic level entrepreneurial education had a positive impact on early-stage entrepreneurial activity in all the countries except for Spain and Germany, entrepreneurial education at higher education level positively affected early-stage entrepreneurial activity in all the countries except for Spain. Lastly, educational attainment had a positive impact on early-stage entrepreneurial activity in all the countries.

Table 7. FMOLS cointegration coefficients by FMOLS method

Countries	BSE	HELE	EDU
United States	0.159**	0.140**	0.155**
United Kingdom	0.139**	0.122**	0.133**
Spain	0.102	0.117	0.138**
Slovenia	0.113**	0.101**	0.119**
Italy	0.131**	0.108**	0.124**
Ireland	0.136**	0.112**	0.141**
Greece	0.109**	0.110**	0.123**
Germany	0.127	0.106**	0.148**
Croatia	0.104**	0.056**	0.120**
Chile	0.113**	0.094**	0.135**
Panel	0.128**	0.107**	0.137**

Note: ** is significant at 5% significance level.

The cointegration coefficients disclosed that educational attainment together with entrepreneurship-oriented education at basic and higher education levels in the countries had a significant positive impact on the early-stage entrepreneurial activity in the long run. The

findings were found to be consistent with the findings in the relevant literature, although the related literature has generally conducted similar research at regional and school levels.

The causality among early-stage entrepreneurship, basic level entrepreneurial education, higher-level entrepreneurial education, and educational attainment level was questioned through Dumitrescu and Hurlin's (2012) test and the results were denoted in Table 8. The causality analysis revealed a significant bilateral causality between higher-level entrepreneurial education and early-stage entrepreneurship and a unilateral causality from educational attainment to early-stage entrepreneurship. In this context, especially entrepreneurship-oriented education at higher education level and educational attainment had a significant impact on the early-stage entrepreneurial activity in the short run.

Table 8. Dumitrescu and Hurlin (2012) Granger causality test

Null hypothesis	Test	Test statistic	p value
DBSE ↛ DTEA	Whnc	2.684	0.105
	Zhnc	2.509	0.118
	Ztild	2.157	0.120
DTEA ↛ DBSE	Whnc	2.274	0.145
	Zhnc	2.109	0.188
	Ztild	2.056	0.176
DHELE ↛ DTEA	Whnc	6.963	0.000
	Zhnc	6.882	0.000
	Ztild	6.714	0.000
DTEA ↛ DHELE	Whnc	5.918	0.000
	Zhnc	5.493	0.003
	Ztild	5.315	0.000
DEDU ↛ DTEA	Whnc	8.326	0.000
	Zhnc	8.205	0.000
	Ztild	8.178	0.000
DTEA ↛ DEDU	Whnc	1.496	0.275
	Zhnc	1.312	0.317
	Ztild	1.275	0.264

The causality among early-stage entrepreneurship, basic level entrepreneurial education, higher-level entrepreneurial education, and educational attainment was also questioned through Emirmahmutoglu and Kose's (2011) causality test, taking cross-sectional dependence and heterogeneity into consideration and the test findings were displayed in Table 9. The panel-level causality revealed a unilateral causality from basic level entrepreneurial education and higher-level entrepreneurial education to early-stage entrepreneurship and a bilateral causality between early-stage entrepreneurship and educational attainment.

On the other side, the country level causality analysis revealed:

– a significant unilateral causality from basic-level entrepreneurial education to early-stage entrepreneurship in Croatia and Slovenia,

Table 9. Emirmahmutoglu and Kose (2012) causality test results

Countries	BSE ↛ TEA		TEA ↛ BSE		HELE ↛ TEA		TEA ↛ HELE		EDU ↛ TEA		TEA ↛ EDU	
	Test statistic	p value	Test statistic	p value	Test statistic	p value	Test statistic	p value	Test statistic	p value	Test statistic	p value
Chile	3.644	0.303	1.425	0.700	26.582	0.000	4.861	0.182	4.446	0.108	1.664	0.435
Croatia	16.012	0.001	0.820	0.845	4.885	0.087	1.056	0.590	1.690	0.639	2.043	0.563
Germany	0.229	0.632	0.007	0.933	0.754	0.385	0.007	0.936	2.152	0.542	0.576	0.902
Greece	0.143	0.705	0.047	0.829	0.832	0.362	0.084	0.772	0.490	0.484	1.493	0.222
Ireland	1.114	0.774	9.993	0.019	4.629	0.201	1.821	0.610	0.844	0.358	0.001	0.972
Italy	1.424	0.233	0.901	0.342	0.079	0.778	0.375	0.540	0.382	0.537	4.674	0.031
Slovenia	6.522	0.038	0.327	0.849	5.881	0.053	0.109	0.947	2.739	0.434	9.833	0.020
Spain	6.100	0.107	9.568	0.023	16.968	0.001	3.018	0.389	7.751	0.051	7.334	0.062
United Kingdom	4.933	0.177	2.719	0.437	10.193	0.017	2.238	0.524	17.911	0.000	3.847	0.278
United States	1.041	0.791	2.490	0.477	119.709	0.000	5.313	0.150	3.259	0.353	12.833	0.005
Panel	35.940	0.016	22.716	0.303	180.086	0.000	14.411	0.809	36.377	0.014	39.590	0.006

– a unilateral causality from higher-level entrepreneurial education to the early-stage entrepreneurship in Chile, Croatia, Slovenia, Spain, the United Kingdom and the United States,
– a unilateral causality from educational attainment to the early-stage entrepreneurship in the United Kingdom, and
– a bilateral causality between educational attainment and early-stage entrepreneurship in Spain.

The results of Emirmahmutoglu and Kose's (2011) causality analysis revealed that basic-level entrepreneurial education also had a significant impact on early-stage entrepreneurship unlike the results of Dumitrescu and Hurlin's (2012) causality analysis. Furthermore, country-level causality analysis indicated that especially higher-level entrepreneurial education had a significant impact on the early-stage entrepreneurship in the sample.

Lastly, the country level causality between education indicators and early-stage entrepreneurship was performed by Toda and Yamamoto (1995) causality test and the test findings were depicted in Table 10:

– a significant unilateral causality from basic-level entrepreneurial education to early-stage entrepreneurship in Croatia,
– a unilateral causality from higher-level entrepreneurial education to the early-stage entrepreneurship in Chile, Croatia, Ireland, and the United Kingdom,
– a unilateral causality from educational attainment and the early-stage entrepreneurship in Chile, Italy, Slovenia, the United Kingdom, and the United States.
– a bilateral causality between educational attainment and the early-stage entrepreneurship in Spain.

The findings of Toda and Yamamoto (1995) causality test were generally in line with the findings of Emirmahmutoglu and Kose (2011) causality test. The test indicated that especially higher-level entrepreneurial education and educational attainment were significant determinants of early-stage entrepreneurship in the short run.

Table 10. Toda and Yamamoto (1995) causality test results

Country	Null hypothesis	Chi-Sq	Prob
Chile	BSE ↛ TEA	0.537485	0.4635
	TEA ↛ BSE	1.467950	0.2257
	HELE ↛ TEA	4.674514	0.0217
	TEA ↛ HELE	0.522345	0.4698
	EDU ↛ TEA	3.802167	0.0512
	TEA ↛ EDU	0.081305	0.7755
Croatia	BSE ↛ TEA	5.602944	0.0179
	TEA ↛ BSE	0.121730	0.7272
	HELE ↛ TEA	9.344712	0.0022
	TEA ↛ HELE	0.012313	0.9116
	EDU ↛ TEA	0.138665	0.7096
	TEA v EDU	0.904105	0.3417

Continued Table 10

Country	Null hypothesis	Chi-Sq	Prob
Germany	BSE ↛ TEA	0.229447	0.6319
	TEA ↛ BSE	0.007038	0.9331
	HELE ↛ TEA	0.753808	0.3853
	TEA ↛ HELE	0.006528	0.9356
	EDU ↛ TEA	0.756516	0.3844
	TEA ↛ EDU	0.079998	0.7773
Greece	BSE ↛ TEA	0.143190	0.7051
	TEA ↛ BSE	0.046835	0.8287
	HELE ↛ TEA	0.831923	0.3617
	TEA ↛ HELE	0.084283	0.7716
	EDU ↛ TEA	0.489871	0.4840
	TEA ↛ EDU	1.492592	0.2218
Ireland	BSE ↛ TEA	0.000423	0.9836
	TEA ↛ BSE	0.652115	0.4194
	HELE ↛ TEA	5.119610	0.0237
	TEA ↛ HELE	0.945274	0.3309
	EDU ↛ TEA	0.844017	0.3583
	TEA ↛ EDU	0.001204	0.9723
Italy	BSE ↛ TEA	1.423667	0.2328
	TEA ↛ BSE	0.901279	0.3424
	HELE ↛ TEA	0.079296	0.7783
	TEA ↛ HELE	0.375022	0.5403
	EDU ↛ TEA	4.674346	0.0306
	TEA ↛ EDU	0.382063	0.5365
Slovenia	BSE ↛ TEA	0.355222	0.5512
	TEA ↛ BSE	0.039774	0.8419
	HELE ↛ TEA	1.414356	0.2343
	TEA ↛ HELE	0.008487	0.9266
	EDU ↛ TEA	13.05545	0.0003
	TEA ↛ EDU	0.601800	0.4379
Spain	BSE ↛ TEA	0.786325	0.3752
	TEA ↛ BSE	0.039208	0.8430
	HELE ↛ TEA	0.973533	0.3238
	TEA ↛ HELE	0.067112	0.7956
	EDU ↛ TEA	3.365591	0.0606
	TEA ↛ EDU	10.11085	0.0015

End of Table 10

Country	Null hypothesis	Chi-Sq	Prob
United Kingdom	BSE ↛ TEA	1.459566	0.2270
	TEA ↛ BSE	0.286787	0.5923
	HELE ↛ TEA	5.049679	0.0246
	TEA ↛ HELE	1.922504	0.1656
	EDU ↛ TEA	3.280112	0.0701
	TEA ↛ EDU	1.289010	0.2562
United States	BSE ↛ TEA	0.247439	0.6189
	TEA ↛ BSE	0.196649	0.6574
	HELE ↛ TEA	0.352064	0.5529
	TEA ↛ HELE	0.015635	0.9005
	EDU ↛ TEA	3.089852	0.0788
	TEA ↛ EDU	2.172794	0.1405

The main findings of the study are presented in Table 11. Panel level causality findings indicated that educational attainment and entrepreneurial education during basic and higher education levels were significant factors underlying early-stage entrepreneurial activity. On the other hand, the findings of country-level causality revealed that educational attainment and entrepreneurial education during higher education especially were effective on entrepreneurial activity in the short run. However, the cointegration analysis pointed out that both entrepreneurial education during primary and higher education levels and educational attainment had a positive effect on early-stage entrepreneurial activity in the long run at panel and country levels.

Table 11. Summary of empirical analyses

Test	Main findings
Dumitrescu and Hurlin (2012) causality test	– bilateral causality between higher level entrepreneurial education and early-stage entrepreneurial activity. – a unilateral causality from educational attainment to early-stage entrepreneurial activity.
Emirmahmutoglu and Kose (2011) causality test	– a unilateral causality from basic-level entrepreneurial education to early-stage entrepreneurial activity. – higher-level entrepreneurial education to early-stage entrepreneurial activity. – a bilateral causality between educational attainment and early-stage entrepreneurial activity.
Cointegration analysis	– entrepreneurial education at basic and at higher education levels had a positive impact on early-stage entrepreneurial activity. – educational attainment had a positive impact on early-stage entrepreneurial activity.

Conclusions

Using data for 10 high-income economies, we investigated the effect of entrepreneurship-oriented education and general education on the early-stage entrepreneurial activity at country level through causality and cointegration analyses.

The causality analysis revealed that entrepreneurship-oriented education at higher education level and general education had a significant impact on the early-stage entrepreneurial activity in the short run. On the other side, the cointegration analysis discovered that entrepreneurship-oriented education at basic and higher education levels together with general education level positively affect the early-stage entrepreneurial activity in the long run.

The results have both practical and theoretical implications. For researchers concerned to contribute to the entrepreneurship literature, this study can encourage them to analyze more deeply the role of entrepreneurship education at different levels of entrepreneurial activity based on a sample of developing countries, to compare the results and to indicate solutions to stimulate teaching entrepreneurship if results are not satisfactory. For practitioners, the importance of entrepreneurship education on entrepreneurial activities can be the impulse necessary to revise the national curriculum, to establish entrepreneurial education as a priority in educational policy.

The example of developed economies must be followed by developing and least developed countries that can boost entrepreneurial activity through designing and implementing entrepreneurship focused education at all education levels.

Given that entrepreneurship education is among the most practical fields of education, being strongly anchored in the business reality and linked to the business environment perhaps, some of the implications and applications of this research can be associated with experience-based learning approaches and processes. Dynamism is a feature of this area and the involvement of guest speakers, combined with the development of case studies enhance the educational process, further contributing to the development of the business environment by encouraging entrepreneurial initiatives. Students are encouraged to develop mindsets that eventually transform them in low-risk-aversion business persons who are innovation-oriented and willing to initiate new ventures. Entrepreneurial education provides them the needed knowledge, an increased capacity of critical thinking and the skills and tools necessary for business creation and management. Education also contributes by providing them the chance of properly managing and balancing their emotions and perceptions relative to their entrepreneurial initiatives.

Considering entrepreneurship's importance, it is vital for countries to improve their national curriculum and those responsible for developing and implementing national educational policies must incorporate entrepreneurship education into the school curriculum.

Education institutions must be stimulated to develop entrepreneurship programs, to redesigning the curriculum, and to providing training for school staff to face the challenges of entrepreneurship education. Integrating into the educational system, teachers that can combine entrepreneurial experience with relevant professional qualifications can improve learning outcomes. Since most professors do not have entrepreneurial experience, it is recommended to participate in different entrepreneurship training programs to gain and improve skills associated with entrepreneurship.

Bringing together practitioners, academics, and policymakers to work on developing a new curriculum that will incorporate entrepreneurial education at different education levels, defining entrepreneurship course objectives and learning outcomes, and finding new teaching strategies that can efficiently improve learning abilities can have a positive impact on entrepreneurship education.

Our study has some limitations that need to be pointed out: firstly, a sample of 10 high-income economies has been analyzed therefore future research should include in their sample countries with different stages of economic development, secondly the Total early-stage Entrepreneurial Activity (TEA) index was employed to measure entrepreneurial activity but future studies can include measures to proxy entrepreneurship such as Kauffman Index of Entrepreneurial Activity, self-employment rates, business start-ups, etc. Since our analyses focused on 2003–2018 period, future analyses should involve medium or long-time data.

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Author contributions

All authors have contributed significantly to this research in all phases and sections.

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