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DO INNOVATION AND ENTREPRENEURSHIP HAVE DOMINANT ROLES IN ECONOMIC GROWTH? A NEW PERSPECTIVE OF DEVELOPED COUNTRIES

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Abstract

Purpose of the study: The purpose of this paper is to analyze the potential causal link between innovation, entrepreneurship activity, and economic growth in the case of nine developed countries over the time-span ranging between 2001 and 2014. The research goal is to examine if the findings of this paper support the endogenous growth theory.

Methodology: This paper has initially explored the stationary properties of the variables. Moreover, the causal links between the variables of interest have been investigated by estimating the panel VAR model (trivariate) employing the GMM framework. This paper also examines the potential causal linkage amid the variables of interest by employing the Granger causality test.

Main Findings: Empirical results suggest that economic growth is found to Granger cause innovation and entrepreneurship activity. These findings emphasize the necessity to take both innovation and entrepreneurship while analyzing the determinants of economic growth since these are found to be interconnected and may play a critical role in the growth of the economy. These findings also support the endogenous growth.

Applications of this study: Outcome of this paper is expected to provide significant insights for decision-makers to make a necessary effort not only to increase the start-up rates in developed countries but also to reduce the informal sector that is likely to occur as a result of start-ups in developing countries jeopardizing developed countries' competitiveness.

Novelty/Originality of this study: The first contribution of this study to the literature is the examination of cross-sectional dynamics of developed countries' innovation, entrepreneurship, and economic growth. Secondly, these results indicate that entrepreneurial activity is a proximate cause and should be modelled as the channel through which innovation contributes to economic growth. Thirdly, the data used in this study are more comprehensive.

Keywords: *Developed Countries, Economic Growth, Entrepreneurship Activity, Innovation, Panel VAR.*

INTRODUCTION

Since the pioneering work of Schumpeter (1934), innovation has been recognized as a key determinant of economic growth. Many authors have emphasized the crucial role of innovation in the growth process (Grossman, 2009; Fan, 2011; Rogers, 1995); competitiveness (Petrakis et al., 2015; Huang, 2011); employment (Kirchhoff, 1994); and financial development (Hanley et al., 2011; Corrado et al., 2013; Topaloglu, 2017). In this light, it is important to mention the externalities assigned to innovation that are recognized by financial economists. The most influential one is the technology spillover effect which is expected to contribute to the movement of the labor force (with a high level of human capital) to new firms, decrease the cost of rivals, and reduce the patterns that are not perfect (Cameron, 1998). Moreover, it will prevent firms from obtaining 100% of the social benefits connected with innovation. Finally, Cameron (1998) suggests that innovation will make the technologies that are currently used in the production process seem old-fashioned.

Taking into account the great importance of innovation in many segments of economic life, OECD (2007) listed the main factors influencing innovation, research, and development expenditure. It is first necessary to have in place policies with a proactive role in the development process of innovation; the inflow of foreign direct investment is important as well as the flow of information (Muslija, 2018); the economic climate should be stable to attract investors and provide lower interest rates for the companies engaged in innovation activities; the funding sources should be easily available, and research should be supported through tax stimulations. Apart from this, Galindo and Picazo (2013) emphasize that the innovation process is not new in the development of society. Its relevance is especially recognized in the modern theory of economic growth, indicating that the globalization process can increase the level of success and that innovation is recognized as the main platform for using the benefits assigned with the positive externalities. With regard to the link between entrepreneurship and economic growth, Feki and Mnif (2016) suggest that this activity is recognized as one of the most important determinants of economic growth. It also plays a very important role in the competitiveness process as well as in reducing the unemployment rate. The authors have also explained the three trends of thought with regard to entrepreneurship. Schumpeter (1934) is the first in chronological order and defines entrepreneurship as a platform for introducing innovation; the second important economist is Baumol (1968), who suggests that the stimulation of

innovation in production is the driving force of entrepreneurship; and the third suggests that the identification of opportunity is the key driving force of entrepreneurship (Kirzner, 1973). Moreover, entrepreneurship is expected to contribute to economic growth in the long run (Cipolla, 1981). This is possible since entrepreneurship enables the introduction of new techniques in the manufacturing sector, promotes participation in new markets, and increases competitiveness. For this reason, entrepreneurship has become a topic of interest to scholars treating the determinants of economic growth nowadays. However, Feki and Mnif (2016) have identified the measurement issue.

The effects of innovation on economic growth and the impact of entrepreneurship on economic growth have been widely studied to date but in isolation. Thus, the research problem in our study states: there is a lack of empirical evidence on the innovation, entrepreneurship, and economic growth nexus in developed countries while investigating the cross-sectional dynamics. The focus of this paper is to bring together these three economic terms of interest while investigating the cross-sectional dynamics. Thus, the first contribution of this study to the literature is the examination of cross-sectional dynamics of developed countries' innovation, entrepreneurship, and economic growth. Secondly, our results indicate that entrepreneurial activity is a proximate cause and should be modelled as the channel through which innovation contributes to economic growth. Thirdly, the data used in this study are more comprehensive and recent in comparison with studies to date. Additionally, it is explored whether entrepreneurship activity and innovation contribute to economic growth or occur just as a positive externality of the growth process. The most appealing challenge connected with entrepreneurship is the measurement process. In fact, entrepreneurship is a complicated economic term to measure, so there have been many attempts to provide an appropriate proxy; for instance, Hamilton (2004) suggests self-employment as an adequate proxy. However, Feki and Mnif (2016) have criticized this approach and suggested the GEM (Global Entrepreneurship Monitor) project. This group of specialists developed the Total Entrepreneurial Activity (TEA) index, summarizing individuals intending to start a business. This index is used in this paper, as well. Herein, the introduction of the TEA index in the innovation-growth nexus while treating the case of developed countries is an additional contribution of this paper to the literature.

Hereafter, this study aims to answer the two research questions: 1. whether or not entrepreneurship activity contributes to economic growth or is simply a consequence of the growth process; 2. whether or not innovation contributes to economic growth or is simply a consequence of the growth process. The structure of our paper is as follows: 1) Introduction; 2) Literature review; 3) Methodology; 4) Results; 5) Conclusions. After the brief introduction to the research problem, further steps in this paper include a detailed summary of the empirical research on the respective links between innovation, entrepreneurship, and economic growth. Furthermore, the methodology and variables will be presented. In addition to that, the results of the analysis will be summarized, and the findings will be discussed. The paper ends by presenting the concluding remarks.

LITERATURE REVIEW

Numerous studies have tackled the effect of innovation and entrepreneurship activity on economic growth. Here the main empirical work related to this study will be reviewed and discussed. Ulku (2004) finds evidence that innovation has a positive influence on the 20 OECD countries and ten non-OECD countries with regards to economic growth. He used a panel GMM model for the period 1981-1997. However, this paper does not observe the role of entrepreneurship activity. Wong et al. (2005) examined the relationship between technological innovation and economic growth using cross-sectional data on 37 countries around the world, which included both developed and emerging countries. They used four types of total entrepreneurial activity (TEA) and found a significant impact of high growth potential entrepreneurship on economic growth. However, in 2007, the OECD Council at the ministerial level decided to develop an innovation strategy to help these countries to boost the performance of innovation in order to enhance economic growth (OECD, 2007). The opposite result was obtained by Pessoa (2007), who did not find that innovation had a strong impact on economic growth in Sweden and Ireland. Contrary to our study, these papers do not take into account the cross-sectional dynamics of the countries of interest.

Despite the fact that the empirical part of our study does not take into account the technology frontier, it is of great importance to mention a few studies touching on it. In this light, it is important to summarize Minniti and Lévesque (2010) who indicated that most of the empirical evidence on economic growth pays attention to research and development expenditure since it tends to drive the change in technology. However, according to their evidence, these models do not take into account the unusual growth exhibited in emerging countries (i.e. China) where the share of research and development expenditure in GDP is literally close to zero compared to Japan that has a significantly higher share but a lack of growth. With regard to Minniti and Lévesque (2010), it is of prevailing importance to mention the idea of the technology frontier presented by Jones (2005). He suggests that innovation is derived from the distribution of possible production function that is not yet invented. Lafuente et al. (2019) suggested that innovations and entrepreneurship are connected to productivity growth. However, Abul (2019) suggested that investors in the markets are not necessarily always rational in their decisions.

Since the industrial revolution, technology has become a crucial factor regarding welfare and economic growth in most countries. Braunerhjelm (2008), Carlsson et al. (2009), and Urbano and Aparicio (2016) worked together on three different papers, and their results revealed that changes in entrepreneurship have a positive influence on economic growth. However, Urbano and Aparicio (2016) examined the effect of different types of entrepreneurship capital on

economic growth in OECD suggesting that entrepreneurial activity is an important driver of economic growth. They argue that investment in R&D is insufficient to sustain economic growth and that it needs to be accompanied by knowledge and investment to produce new products. Several types of research revealed the role of entrepreneurs in the economy; for example, Baumol (1968) and Antonelli (2009) state that entrepreneurs are a dynamic component in the growth of productivity. Antonelli (2009) argues that a lot of empirical work confirms the importance of the entrepreneurial role in economic growth. Lucas (2009) argues that the industrial revolution created a large number of educated people who had new ideas that lead to more innovation and more affect the growth of the economy positively. Our paper differs from these findings in the sense that it brings together innovation, entrepreneurship, and economic growth. Galindo and Picazo (2013) examine the relationship between innovation and economic growth for selected developed countries including Denmark, Finland, France, Germany, Italy, the Netherlands, Spain, Sweden, and the USA for the period 2001-2009. Following Schumpeter's approach (1934, 1939), they concluded that innovation plays a crucial role in economic growth. Entrepreneurship was found to be an engine for producing new technology to enhance the firm's capability to generate more profit. They argued that other factors might support the process of innovation in economic growth, such as the monetary policy and social climate, which should be less stressful. These studies provide evidence on the nexus of interest in the case of developed countries but do not take into account the cross-sectional dynamics. Toma et al. (2014) constructed a theoretical model that links economic development with entrepreneurship. They argue that the relationship between entrepreneurship and economic growth is strong and that education is an engine of entrepreneurship.

Petrariu et al. (2013) investigated the influence of innovation on economic growth in 15 central and eastern European countries (CEE), included Estonia, Latvia, Lithuania, Poland, Germany, the Czech Republic, Slovakia, Hungary, Moldova, Bulgaria, Croatia, Macedonia, and Serbia, for the period 1996-2010. They did not find evidence of any positive impact of innovation on economic growth. They argued that, although these countries have high GDP growth, it is not linked to innovation. Hajek et al. (2013) used a self-organizing map to investigate regional innovation in the European region. They revealed a positive influence of knowledge on economic growth in the European countries. The innovation and entrepreneurial activity in these countries is associated with economic integration between them. Feki and Mnif (2016) conducted a study on the role of both entrepreneurship and innovation in economic growth for a panel of 35 developing countries for the period 2004-2011. They reported a positive long-run relationship between innovation and economic growth. Vila (2019) explained the micro-macro interfaces that combine education, invention, and innovation into a single system that influences economic growth; however, factors such as internal invention and innovation combined with local factors such as graduate students from higher education institutions all work together to influence the growth of the economy. Maradana et al. (2019), meanwhile, examined the long-run relationship between innovation and per capita economic growth in 19 European countries for the period 1989-2014 by applying co-integration. They revealed a long-run relationship between innovation and economic growth for most of the selected countries. Mixed results were obtained, for example, for some countries, where they reported that the per capita economic growth leads innovation while, in other countries, innovation has a positive impact on the per capita growth. They argued that the level of innovation plays a crucial role in stimulating economic growth.

From the previous literature review, it can be concluded that most of the researchers who investigated the relationship of interest found that innovation, R&D, entrepreneurship, and technology have positive impacts and produce sustainable effects on the economy of the majority of the investigated countries. These include developed countries, such as OECD, non-OECD (for example, Freeman, 1987), Eastern Europe (for example, Sener and Tunali, 2017), and developing countries (for example, Pele, 2014). Our paper differs from the aforementioned studies in the sense that it analyses the trivariate link of interest in the panel of nine developed countries and gives strong support to the endogenous growth theory while performing the panel VAR model. Moreover, special effort is given to find the appropriate proxy of the entrepreneurship activity while using the most recent data. Most of the aforementioned studies focused on developed countries, as most researchers believe that innovation is a key engine of growth for these economies. However, these studies do not investigate the cross-sectional dynamics of developed countries while treating the nexus of interest, which is the major difference between our paper and recent studies.

METHODOLOGY

Innovation has been recognized as the key factor in developing an economy based on knowledge. Consequently, it is expected to contribute significantly to economic growth. Porter and Stern (1999) argue that innovation involves several processes and is not only about technology and science. The private sector can serve as the engine for innovation. However, in the most fundamental sense, the economic output can be increased only by enlarging the inputs used in the process of production or by finding innovative ways to increase the output with the given inputs. In this light, it is important to emphasize that innovation is defined as the utilization of the new products in process or ones that are significantly upgraded (OECD and EUROSTAT, 2005). It can also include better marketing, relations with the stakeholders, or business practice. With regards to economies based on knowledge, their important characteristic is the generation, distribution, and implementation of innovation and knowledge. Moreover, economic growth and employment opportunities can be stimulated significantly in the case that innovations have been successfully created and distributed. For this reason, innovation tends to drive the competitiveness of an economy as well as the standard of living. Moreover, innovation needs an efficient regulatory framework and public support, which enables more

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productive activities. In this light, this paper employs panel data methodology to explore the potential linkage amid innovation, entrepreneurship activity, and economic growth.

Starting with the 1980s, VAR (vector autoregressive) models have been given a very important role among macroeconomists. One important feature of the panel models is the high probability to have heterogeneity between and within the units of interest. Taking into account the fact that panel VAR models control for this heterogeneity, these are used intensively in modern research (Abrigo and Love, 2016). Moreover, it is important to emphasize that these models enable us to control for potential dynamics while reducing the set of restrictions. In addition, one should be very careful while interpreting the results of the panel VAR model. This is due to the fact that variables are interdependent in the model (Satrovic and Muslija, 2019). Thereby, the estimated coefficients provide very limited information on the reaction to the innovations or shock. To formalize the panel VAR model, we follow the framework explained by Abrigo and Love (2016). The model can be summarized as (Eq. 1):

$$Y_{it} = Y_{it-1}A_1 + Y_{it-2}A_2 + \cdots + Y_{it-p+1}A_{p-1} + Y_{it-p}A_p + X_{it}B + u_{it} + \varepsilon_{it} \quad (1)$$

where the vector of dependent variables are presented by Y_{it} and has the dimension of $(1 \times k)$; the variables to be assumed endogenous are denoted by X_{it} and this vector has the dimension of $(1 \times l)$; the fixed effect is denoted by u_{it} with the dimension $(1 \times k)$. The period of interest is denoted by t, whereas the units of interest are denoted by i. It is also important to emphasize the assumptions for shocks (innovations): $E[e_{it}] = 0, E[e'_{it}e_{it}] = \Sigma$and $[e'_{it}e_{is}] = 0$. Moreover, s is assumed to be lower than t. A fixed-effects estimator may be used to estimate the Eq. 1. However, it may result in potential bias. For this purpose, GMM estimation is assumed to provide more efficient results and to deal with this potential issue. Hence, this paper uses the GMM framework to estimate the model. This paper analyses the potential link between the three variables of interest, namely: economic growth, innovation, and entrepreneurship. The formalization of the model is given in Eq. 2:

$$\boldsymbol{PAN_{it}} = \sigma + \sum_{\boldsymbol{i=1}}^{\boldsymbol{k}} \boldsymbol{\beta_i}\, \boldsymbol{PAN_{t-1}} + \sum_{j=1}^{k} \theta_j\, TEA_{t-j} + \sum_{m=1}^{k} \varphi_m\, GDP_{t-m} + u_{1t}$$

$$\boldsymbol{TEA_{it}} = \alpha + \sum_{i=1}^{k} \beta_i\, PAN_{t-1} + \sum_{\boldsymbol{j=1}}^{\boldsymbol{k}} \boldsymbol{\theta_j}\, \boldsymbol{TEA_{t-j}} + \sum_{m=1}^{k} \varphi_m\, GDP_{t-m} + u_{2t}$$

$$\boldsymbol{GDP_{it}} = d + \sum_{i=1}^{k} \beta_i\, PAN_{t-1} + \sum_{j=1}^{k} \theta_j\, TEA_{t-j} + \sum_{\boldsymbol{m=1}}^{\boldsymbol{k}} \boldsymbol{\varphi_m}\, \boldsymbol{GDP_{t-m}} + u_{3t}. \quad (2)$$

GMM framework is used to estimate Eq. 2. Abrigo and Love (2016) summarized the number of estimators based on the GMM framework that can be used to estimate Eq. 1. Moreover, Holtz-Eakin et al. (1988) indicated the fact that equation-by-equation GMM estimation tends to provide consistent estimates of panel VAR where efficiency is obtained through the model consisting of the system of equations. To formalize the aforementioned model, this paper follows the detailed description presented by Abrigo and Love (2016). With regard to panel VARs, it is important to emphasize that they follow the logic of the standard models. As indicated above, these control the heterogeneity and can deal with the interdependencies that do (not) change within the time dimension.

RESULTS/FINDINGS

To present the findings of empirical research, it is first necessary to display the main measures of summary statistics for the case of the nine developed countries considered in this research (Table 1). The country selection follows Galindo and Picazo (2013). Italy is not included due to the data availability issue. To proceed to the panel VAR model estimation, there is a need to check whether or not the mean and variances are constant over time. For this purpose, we have utilized the unit root tests summarized in Table 2.

Table 1: Summary statistics

Variable	Measure	Germany	Denmark	Spain	Finland	France	Japan	Netherl.	Sweden	United States	Total
PAN	Mean	12,714	178	281	174	2,504	57,384	423	414	216,675	32,301
	Sd	2,139	29	80	51	665	3,003	132	153	50,580	69,724
	Max	17,811	229	467	270	3,605	62,793	633	703	293,706	293,706
	Min	10,486	131	196	102	1,593	53,281	240	148	148,958	102
TEA	mean	4.85	5.15	5.85	5.60	4.72	3.37	6.50	4.92	11.06	5.78
	sd	0.71	1.00	1.00	1.29	1.29	1.17	2.12	1.44	1.82	2.44

	max	6.28	7.23	7.62	8.16	6.03	5.42	10.31	8.25	13.81	13.81
	min	3.77	3.64	4.31	3.14	1.63	1.48	3.60	3.45	7.59	1.48
GDP	mean	41,231.43	58,435.14	30,509.07	45,502.93	40,501.07	44,347.86	49,295.5	50,628.93	48,367.79	45,424.41
	sd	2,491.631	1,677.846	1,120.747	2,380.78	949.31	1,434.429	1,919.807	2,861.225	1,767.595	7,609.094
	max	45,023	61,175	32,460	49,364	41,630	46,484	52,118	53,562	50,872	61,175
	min	38,218	56,109	29,008	41,400	38,928	42,191	46,422	45,271	45,047	29,008

Source: Computed by Authors

Table 2: Stationarity properties of the variables

Trend included in the model	**lnPAN**		**D.lnPAN**		**lnTEA**		**D.lnTEA**		**lnGDP**		**D.lnGDP**	
Method	Stat.	p-value	Stat.	p-value	Stat.	p-value	Stat.	p-value	Stat.	p-value	Stat.	p-value
Levin–Lin–Chu (LLC) t* test	-3.24	0.001	5.97	0.000	1.57	0.941	-31.19	0.000	-3.91	0.000	-5.58	0.000
Im–Pesaran–Shin test	-0.44	0.328	-2.50	0.006	-2.18	0.015	-16.49	0.000	-0.11	0.457	-2.31	0.011
ADF – Fisher inverse chisquare	23.42	0.175	47.51	0.000	34.85	0.010	67.49	0.000	22.17	0.224	33.23	0.016

Source: Computed by Authors

The natural logarithm of all variables is calculated to ease the comparison and interpretation. Thus, the first step in the unit root tests covers the application of all three tests, including trends to check for the stationary properties of the log levels of all of the variables. The log levels are found to contain a unit root. Taking these findings into account, the unit root in the first difference has also been tested. All of the tests agree on the stationary properties of the variables of interest for a 5% level of significance which is a necessary precondition to run the panel VAR model. Moreover, there was a need to determine the order of the model. The minimum value of the selection criteria is displayed for the first order panel VAR (Table 3). Thereby, the procedure to follow will estimate the first-order panel VAR.

Table 3: MBIC, MAIC and MQIC criteria

Order	**CD**	**J**	**J p-value**	**MBIC**	**MAIC**	**MQIC**
1	0.6289021	32.11191	.2279649	-83.35807	-21.88809	-46.35947
2	0.867306	20.95737	.281569	-56.02262	-15.04263	-31.35688
3	0.2559824	10.53074	.3092495	-27.95926	-7.469264	-15.62639

Source: Computed by Authors

The empirical section further proceeds to the estimation and interpretation of the panel VAR model that considers three variables. The findings are presented in Table 4. To improve efficiency, the trivariate panel VAR model has been estimated by using the GMM framework.

Table 4: Panel VAR model

Independent variables	**Dependent variables**		
	D.lnGDP	**D.lnPAN**	**D.lnTEA**
$D.GDP_{t-1}$	0.786 (0.124)***	3.092 (0.591)***	3.290 (0.620)***
$D.lnPAN_{t-1}$	0.037 (0.019)**	0.072 (0.134)	-0.033 (0.112)
$D.lnTEA_{t-1}$	-0.004 (0.003)	-0.014 (0.014)	0.011 (0.045)

Note: ***, **, * significant at 1%, 5% and 10% respectively.

Source: Computed by Authors

Table 4 outlines a significant positive response of the proxy of economic growth to the lagged value of GDP. Moreover, innovation and entrepreneurship activity are found to respond positively to economic growth. With regard to innovations, developing countries tend to be very competitive due to the cheap labor force. Economic growth is found to react positively to innovation activity, implying the necessity to develop and apply for patents in order to stimulate economic activity in the selected economies. To provide more informative results, there is a need to present the findings of the Granger causality test (Table 5).

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Table 5: Causal relationships

Equation	Excluded		
	D.lnPAN	**D.lnTEA**	**All**
D.lnGDP	3.887 (0.049)*	1.971 (0.160)	5.134 (0.000)
	D.lnGDP	D.lnTEA	All
D.lnPAN	27.383 (0.000)	1.046 (0.307)	30.841 (0.000)
	D.lnGDP	D.lnPAN	All
D.lnTEA	28.166 (0.000)	0.089 (0.765)	28.960 (0.000)

Note: * p-value

Source: Computed by Authors

Table 5 implies that innovation Granger causes GDP, whereas entrepreneurship activity is not found to have a causal link with economic growth. In addition to these findings, it is of great importance to mention that the joint causal impact of innovation and entrepreneurship activity on economic growth is significant. Besides these, it is also important to emphasize that economic growth is found to have a unidirectional Granger causal link with innovation, whereas the coefficient with entrepreneurship is not found to be significant. Moreover, the joint impact of economic growth and entrepreneurship is found to be significant. GDP is also found to have a unidirectional causal link with entrepreneurship. To conclude the empirical section, we have calculated the forecast-error variance decomposition (FEVD). With regard to economic growth, innovations and entrepreneurship are found to explain less than 5% of the variability of economic growth. This suggests the necessity to be very careful while selecting the determinants of economic growth since it is a very complex macroeconomic variable.

CONCLUSION AND SUGGESTIONS

The above analysis outlines the various findings. The panel VAR model displays a significant positive response of the proxy of economic growth to the lagged value of GDP. Moreover, innovation and entrepreneurship activity are found to respond positively to economic growth. With regard to innovation, it is important to emphasize that economic growth is found to react positively to innovation activity, implying the necessity to develop and apply for patents in order to stimulate economic activity in the selected economies. Our results on the Granger causal nexus suggest that innovation Granger causes GDP, whereas entrepreneurship activity is not found to have a causal link with economic growth. Moreover, the link between innovation and economic growth is found to be bidirectional; the link between economic growth and entrepreneurship is unidirectional while there is no evidence on the causal link between innovation and entrepreneurship. These findings are in line with Schumpeter (1934); Grossman (2009); Fan (2011); Rogers (1995) and Baumol (1968). Therefore, in terms of developed countries, innovation is recognized as one of the most important determinants of competitiveness.

As contrary to the studies presented in the literature review section, this study accounts for the cross-sectional dynamics of developed countries while using more recent and comprehensive data and paying special attention to the proxy variable of entrepreneurship activity. However, there are some limitations of this study which are particularly linked to the proxy of innovation since this is a very complex economy. Therefore, using only patents in the model to identify the relationship between innovation and economic growth is the first limitation of this study. The second limitation is data availability; this is why we have analyzed the case of nine developed countries.

Having an insignificant coefficient with entrepreneurship is very appealing. It suggests that the higher average proportion of individuals included in the start-up process is not a guarantee for improvements in the growth process. Wong et al. (2005) emphasize that only definite tasks and roles of entrepreneurs can drive the economic growth at the micro-level. Taking into account the fact that we observe the macro level, these roles of entrepreneurs cannot be distinguished and present insight for future research. Moreover, the insignificant coefficient with entrepreneurship outlines the fact that not all entrepreneurial tasks contribute to the growth process. Thus, entrepreneurial activity should be supported by innovation to drive the growth process. In this light, positive attitudes towards entrepreneurship and innovation in an economy are of fundamental importance.

Apart from the paragraphs above, it is important to emphasize that the findings of this paper are not supported by Feki and Mnif (2016) suggesting the positive link between entrepreneurship and economic growth. Hereafter, the empirical evidence suggests that entrepreneurs that have high expectations are responsible for a significant rise in economic activity. This is especially true in developed countries since these countries direct significant funds towards knowledge and pay special attention to create favourable laws regulating entrepreneurship. These findings are in line with Valliere and Peterson (2010). More-developed countries stimulate start-ups; thereby, the response of entrepreneurship activity on economic growth is expected to be positive. With regard to innovations, developing countries tend to be very competitive due to the cheap labor force. As a consequence, developed countries need to find a way to increase their competitiveness. Innovations are recognized as a good way to increase competitiveness, especially those in terms of

technology. Feki and Mnif (2016) have also displayed a positive link between innovation and economic activity. It is worthwhile noticing that the joint impact of innovation and entrepreneurship on economic growth is found to be significant, which is in accordance with Baumol (1968), suggesting that the stimulation of innovations in production is the driving force of entrepreneurship and these both have dominant roles within economic growth.

The first contribution of this study to the literature is the examination of cross-sectional dynamics of developed countries' innovation, entrepreneurship, and economic growth. This gives the ability to control the heterogeneity across developed countries while analyzing the nexus of interest. Secondly, these results indicate that entrepreneurial activity is a proximate cause and should be modelled as the channel through which innovation contributes to economic growth. Thirdly, the data used in this study are more comprehensive and recent in comparison with studies to date. Hereafter, the results of this paper support the endogenous growth theory, suggesting a causal link running from innovation to economic growth and provide an answer to the research questions. Herein, the nexus of interest is investigated while the proxy measures of entrepreneurship activity are critically observed.

The findings of this paper are in line with Audretsch and Thurik (2001) who suggest the transition from a "managed economy" towards an "entrepreneurial economy". The first model is driven by capital and low-skilled labor, whereas the second model is driven by knowledge. This study, accordingly, emphasizes that the activity of entrepreneurs is of key importance to take in knowledge spillovers. Moreover, high start-up rates are more prevalent in developing compared to developed countries. For this purpose, policymakers need to make a necessary effort not only to increase the start-up rates in developed countries but also to reduce the informal sector that is likely to occur as a result of start-ups in developing countries jeopardizing developed country's competitiveness (Van Stel et al., 2005). Moreover, key decision-makers in developed countries should drive technological knowledge and innovation principally for financial gain. Hereafter, it is of key importance to support the entrance of new firms since these can play an important role in innovations that are not technological. This is especially true in the software industry.

Special attention should be given to the development of social climate since the reduction of stress in a society tends to drive entrepreneurship. Furthermore, policymakers need to take into account the feedback process since our findings indicate the bidirectional relationship between innovation and economic growth. No doubt, many of the countries globally have recognized the importance of innovation and entrepreneurship in economic growth. Thus, the empirical findings on the matter may be very useful for decision-makers to focus their policies towards attitudes and quality of entrepreneurs instead of quantity. In this sense, there is a need to create a positive climate for entrepreneurship and innovation through education. Finally, policymakers should create a favourable bankruptcy law that will mitigate the potential negative outcome of entrepreneurial activity.

LIMITATION AND STUDY FORWARD

There are some limitations of this study which are particularly linked to the proxy of innovation since this is a very complex economic term. Therefore, using only patents in the model to identify the relationship between innovation and economic growth is the first limitation of this study. The second limitation is data availability; this is why we have analyzed the case of nine developed countries. The recommendation for future research is to wait for the longer time-series that will be available and by that to provide the confirmation to the findings obtained in this paper. Moreover, the proxy of financial development may be introduced. It will also be interesting to take into account the role of the competitiveness index. Institutions tend to have a decisive impact on the prevalence and nature of entrepreneurship. Thus it would be of great importance to analyze the role of institutions. Last but not least, complex phenomena as innovation should be approximated using more appropriate proxy variables.

CO-AUTHORS CONTRIBUTION

The first co-author was planning and supervising the work. She was also responsible for the empirical part of the study. The second co-author's duty was the interpretation of the results and concluding remarks. The third co-author was responsible for the theoretical part of the study.

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