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Entrepreneurship, economic growth, and innovation: Are feedback effects at work?☆

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ABSTRACT

This study aims to analyze the relationships between entrepreneurship, innovation and economic growth, and to show the feedback effects in these relationships. A Schumpeterian approach considering three equations linking GDP, innovation, and entrepreneurship facilitates this analysis. This paper presents empirical analysis of entrepreneurial activity in 13 developed countries. Panel data with fixed effects methodology, for the period 2002 to 2007, provides the means to estimate the equations. The analysis shows that several factors have positive impacts on innovation and entrepreneurship, including monetary policy and social climate. Additionally, a feedback effect is at work: economic activity promotes entrepreneurship and innovation activities, and the latter enhances economic activity. Therefore, policymakers must consider this effect when designing economic policies.

1. Introduction

As an important part of the innovation process, economists traditionally consider knowledge diffusion as a key factor for encouraging economic growth. Several behaviors support this statement. First, innovation makes products more competitive, and allows firms to introduce products into more markets. In this sense, Adam Smith (1776) states that the division of labor, an essential element of the wealth of nations, depends on the extension of markets, which in turn depends heavily on innovation processes. Second, modern theoretical approaches stress the relevance of innovation processes by explicitly introducing factors that encourage innovation in firms. In this case, events in the real economy point out which qualitative variables to consider, in addition to the quantitative ones, because social behavior has the capacity to facilitate or discourage the innovation process. If economic agents reject or are unable to use innovations, the innovation processes would grind to a halt. As Schumpeter states, society must create a social climate that favors the innovation process.

This point is relevant because knowledge diffusion has important effects on economic agents, especially workers. Some traditional literature shows that such diffusion could have negative effects on the employment rate because of the resulting unemployment as technology takes the place of humans (Easterly, 2001; Mortensen & Pissarides, 1998; Vivarelli & Pianta, 2000, among others). An adequate social climate enables the reduction or mitigation of the negative consequences of such unemployment, allowing workers to improve their skills and access new job opportunities.

This paper aims to analyze the factors that promote knowledge diffusion as a component of the innovation process, and entrepreneurship activity as a key factor for introducing this knowledge into the production process, using a Schumpeterian approach to carry out the analysis. Section 2 considers the innovation process. Section 3 expands on the role of innovation in a Schumpeterian model, and Section 4 presents the results of the empirical analysis. Finally, Section 5 sets out the study's main conclusions.

2. The innovation process and economic growth

Innovation is far from being a recent phenomenon, and is inherent to human development. The emergence of innovations with the capacity to change people's behavior, labor methods, and work characterizes the history of humanity. This study, however, also analyzes the problems that innovation implementation can bring about.

Despite its pivotal role throughout human history, economists on occasions overlook innovation, often addressing the broad concepts of the subject with only indirect references to the process. For example, capital accumulation is a frequent and longstanding topic of academic discussion, in which classical economists concentrate on market

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performance and progress instead of mechanical innovation. Although some historical contributions do emphasize the role of innovation, as is the case with Schumpeter, this general neglect of innovation is now well and truly disappearing.

Fagerberg (2006, pp. 4–5) delineates an important distinction between innovation and invention, stating that, "Invention is the first occurrence of an idea for a new product or process, while innovation is the first attempt to carry it out into practice." As Faberger shows, the two have close ties, making distinguishing one from another very difficult. But in many cases, a considerable lag exists between the two. Crucially, however, a major difference between invention and innovation is that the former may occur anywhere, while innovation occurs mainly in firms that need to combine several different kinds of capabilities, knowledge, resources, and skills (Fagerberg, 2006, p. 5). In this sense, an innovator, or an entrepreneur in Schumpeterian terms, must carry out all of these tasks.

Schumpeter, along with other economists, stresses the prominent role of entrepreneurship and innovation in the economic growth process. In, "Theoretical Problems of Economic Growth", Schumpeter (1947) shows that scholars consider different factors that enhance economic growth: physical environment, social organization, institutions, technology, and so forth (Schumpeter, 1947, pp. 2–3). He goes on to explain, however, that all these factors are insufficient to explain the economic growth process because, "economic growth is not autonomous, being dependent upon factors outside of itself, and since these factors are many, no one-factor theory can ever be satisfactory" (p. 4). At the end of the paper, Schumpeter (1947, p. 8) concludes, "…since creative response means, in the economic sphere, simply the combination of existing productive resources in new ways or for new purposes, and since this function defines the economic type that we call the entrepreneur, we may reformulate the above suggestions by saying that we should recognize the importance of, and systematically inquire into, entrepreneurship as a factor of economic growth."

In the first of the above quotations, Schumpeter states that an entrepreneur is a leader, who leads the means of production into new channels (Schumpeter, 1911, p. 89) and the entrepreneur is not necessarily, "a genius or benefactor to humanity" (p. 90ff). Entrepreneurs set profit forecasts as a precondition for innovation decisions. From Schumpeter's point of view, entrepreneurial profit "is a surplus over costs [that is] the difference between receipts and outlay in a business" (p. 128). In this context, an entrepreneur in a better situation would achieve higher profits; that is, an improvement of the product thanks to the innovation process creates a better position for the entrepreneur, who then has the opportunity to achieve higher profits. Innovation performs this function. Therefore, the innovation process is growth and profit enhancing.

The role of financial institutions is also relevant in this process. Entrepreneurs need financial resources to carry out their activity and to finance innovations. For this reason, an adequate policy whose design sets out to increase savings is necessary to facilitate the credit process. Additionally, the social climate is important in encouraging entrepreneurial activity and facilitating the introduction of innovations. A reduction in social stress would encourage entrepreneurs to carry out their activities. Measuring this factor is of primary importance, and income distribution is the most representative variable of this concept.

In this analysis, the feedback effect is also of interest. In this sense, better economic activity would create new opportunities for entrepreneurships and would stimulate innovation. Thus, economic growth would have a positive effect on this process. Conversely, as Drucker (1998) points out, innovation is a key process in entrepreneurship activity, promoting such business, thereby bringing to the fore another feedback effect: entrepreneurs innovate and their innovations stimulate other entrepreneurs to carry out their activity and to create more innovations.

3. Empirical estimation

To carry out analysis of the relationship between entrepreneurship, economic growth and innovation, this study develops a model on the basis of three equations that reflect both direct and indirect effects.

The three equations are:

$$\ln(y)_{it} = \beta_0 + \beta_1 \ln(In)_{it} + \beta_2(\Phi)_{it-2} + \beta_3 \ln(I)_{it} + \beta_4(KHU)_{it} + \varepsilon_{it} \quad (1)$$

$$\ln(In)_{it} = \beta_5 + \beta_6(ms)_{it-1} + \beta_7 \ln(\Phi)_{it-1} + \beta_8(y)_{it} + \varepsilon_{it} \quad (2)$$

$$\ln(\Phi)_{it} = \beta_9 + \beta_{10}(In)_{it} + \beta_{11} \ln(\lambda)_{it} + \beta_{12} \ln(ms)_{it} + \beta \ln(y)_{it} + \varepsilon_{it}. \quad (3)$$

Eq. (1) is the GDP equation, where y is Gross Domestic Product (GDP) in millions of United States dollars (USD), using data from the World Bank's World Database Indicators (WDI) database; *In* is innovation, which is measured via the proxy of patents, measured in number of patent issues; Φ is entrepreneurship; I is private investment in millions of USD; and *KHU* is human capital in millions of USD, again using the WDI as a source.

Φ is entrepreneurship whose measurement relies on the proxy, Total Entrepreneurship Activity (TEA), from the Global Entrepreneurship Monitor (GEM). Every year, the GEM carries out a research program that estimates the national entrepreneurial activity in each country that participates in the survey to construct the TEA index. In this case, the focus of the GEM study is on opportunity-driven entrepreneurs. In this group, the GEM includes entrepreneurs that embark on this activity primarily to pursue an opportunity; namely, they engage in entrepreneurship because of the prospect of opportunity. Furthermore, these individuals may desire greater independence in their professional lives, or be seeking to improve their income. Therefore, Φ is the percentage of individuals with involvement in TEA who: (i) claim to be driven by opportunity rather than a failure to find other work opportunities; and (ii) who indicate that the main driver for their involvement in this opportunity is the prospect of achieving independence or increasing their income, rather than just maintaining their earnings.

The sources for the variables appear below each table.

Eq. (2) is the innovation equation, which incorporates the effect of monetary policy through the money supply term *ms* (sourcing its data from the WDI), as well as the effects of entrepreneurship and GDP. Therefore, this equation considers the feedback effect between innovation and GDP.

Finally, Eq. (3) is the entrepreneurship equation, where ϕ is entrepreneurship activity, λ is the Gini index (i.e., the income distribution of the population, according to WDI data), *ms* is the money supply, *In* is innovation, and y is GDP. In this case, the Gini index represents the Schumpeterian social climate and Drucker's (1998) statement that entrepreneurship activity exists when innovations exist.

3.1. Estimation method

Panel data with fixed effects methodology, for data from 13 countries (Belgium, Denmark, Finland, France, Germany, Iceland, Ireland, Italy, Netherlands, Norway, Sweden, United Kingdom and Spain), for the period 2002 to 2011, provides the means to estimate these hypotheses. The general specification of panel data with fixed effects is:

$$Y_{it} = \alpha_{it} + \sum_{k=1}^{K} \beta_{kit} X_{kit} + U_{it}$$

where i denotes the countries and t the time periods. α_{it} is a parameter that represents the specific effects of each cross-section; namely, each country. This parameter is constant over time. U_{it} gathers the effects of any absent variables that are specific to cross-section and period.

The panel data methodology combines cross-sections (information from several individuals at a given moment) for several points in time. Panel data has several advantages for econometric estimation. For example, panel data allow for controlling for individual or time

heterogeneity, which variables in the model are incapable of capturing. Furthermore, as Baltagi (2008, p. 7) asserts, panel data give, "informative more data, more variability, less collinearity among the variables, more degrees of freedom and more efficiency."

The above three-equation model uses balanced panel data with fixed effects. Fixed effects models often feature in the analysis of countries or regions, since the fixed effects allow a different intercept for each observation (Wooldridge, 2008, p. 452).

4. Findings

The Hausman specification test for the fixed effects estimator versus the random effects estimator for Eq. (1) yields a value of 88.4 ($p = 0.000$) with 4 degrees of freedom. Therefore, this result rejects the null hypothesis of an absence of correlation between the individual country effects and the explanatory variables, with the fixed effects model providing a more efficient estimate. The Hausman specification test for Eq. (2) yields a value of 6.7 ($p = 0.10$) with 3 degrees of freedom, likewise rejecting the null hypothesis of no correlation between the individual country effects and the explanatory variables. The Hausman specification test for Eq. (3) yields a value of 15.0 ($p = 0.0047$) with 3 degrees of freedom. Again, this result rejects the null hypothesis of no correlation. A noteworthy point is that Johnston and Di Nardo (1997, p. 403) recommend the use of fixed effects in small samples; a condition that holds in the case of the simple estimate.

Table 1 shows the Eq. (1) estimate. The estimate indicates that the signs of all variables are positive, and the table shows that they are both positive and significant. Therefore, both innovation and entrepreneurship have positive effects on economic growth. This result agrees with a substantial body of literature (see Acs, Audretsch, Braunerhjelm, & Carlson, 2004, 2005; Acs & Szerb, 2007; Audretsch, Bonte, & Keilbach, 2008; Audretsch & Keilbach, 2004a, 2004b, 2008; Audretsch, Keilbach, & Lehmann, 2006; Hamilton, 2007; Martinez, 2005; Mueller, 2007; Noseleit, 2013; Roper, 2007; Spencer, Kirchhoff, & White, 2008; Stel, Carree, & Thurik, 2005; Thurik, 1999, 2009; Wennekers & Thurik, 1999; West, Bamford, & Marsden, 2008, among others). Thus, according to the results of the analysis, all the activities that encourage the innovation process also encourage economic growth.

Table 2 shows the estimates from Eq. (2). The entrepreneurship and economic activity signs are positive, so they have a positive effect on innovation. Higher levels of economic activity creates new business opportunities, which means that entrepreneurs may have an interest in accessing new markets and business opportunities by supplying products with a higher degree of competitiveness. Innovation facilitates this possibility, thereby increasing entrepreneurs' interest in introducing new technological processes. The results show a positive relationship between the two variables, demonstrating one feedback effect.

The role of central banks is the other factor that this equation incorporates. In this case, the sign is negative, meaning that if central banks decrease the money supply, interest rates would increase, encouraging people to save. In this case, entrepreneurs would have greater chances of obtaining the funds necessary to carry out their innovation processes.

Finally, Table 3 shows the estimates from Eq. (3). Innovation's positive sign implies that Drucker's (1998) statement holds. Therefore, this equation shows a second feedback effect, indicating the positive effects of innovations on economic growth and entrepreneurship, and implying

Table 1
Eq. (1) estimates.

Dependent variable: Log(y)				
Method: Panel EGLS (cross-section weights)				
Variable	Coefficient	Std. error	t-Statistic	Prob.
C	6.22	0.29	21.42	0.00
Log(I)	0.19	0.01	10.60	0.00
Log(In)	0.24	0.03	6.36	0.00
Log($\Phi(-2)$)	0.01	0.00	1.96	0.05
Log(KHU)	0.42	0.05	8.30	0.00
Effects specification				
Cross-section fixed (dummy variables)				
_BEL				−0.03
_DNK				−0.29
_FIN				−0.29
_FRA				0.21
_GER				0.31
_ISL				−0.71
_IRL				0.01
_ITA				0.41
_NLD				0.09
_NOR				−0.08
_SWE				−0.22
_GBR				0.30
_SPA				0.29
Weighted statistics				
R-squared	0.99	Mean dependent var		44.17
Adjusted R-squared	0.99	S.D. dependent var		36.56
S.E. of regression	0.02	Sum squared resid		0.05
F-statistic	38830.03	Durbin–Watson stat		2.05
Prob (F-statistic)	0.00			
Unweighted Statistics				
R-squared	0.99	Mean dependent var		27.06
Sum squared resid	0.06	Durbin–Watson stat		1.71

Sources: GEM and the World Bank. GDP current US $—Source: WDI and GDF, 2010; patent issues, residents—Source: WDI and GDF, 2010; Gross Fixed Capital formation—Source: WDI and GDF, 2010; public expenditure on education, total—Source: WDI and GDF, 2010.

Table 2
Eq. (2) estimates.

Dependent variable: Log(In)				
Method: Panel EGLS (cross-section weights)				
Variable	Coefficient	Std. error	t-Statistic	Prob.
C	6.09	0.94	6.42	0.00
Log($M2(-1)$)	−0.57	0.09	−6.41	0.00
Log($\Phi(-1)$)	0.00	0.01	0.15	0.87
Log(y)	0.17	0.04	3.92	0.00
Effects specification				
Cross-section fixed (dummy variables)				
_BEL				−1.55
_DNK				−0.82
_FIN				−0.57
_FRA				1.32
_GER				2.79
_ISL				−2.29
_IRL				−0.94
_ITA				0.68
_NLD				−0.06
_NOR				0.08
_SWE				−0.36
_UK				1.81
_SPA				−0.08
Weighted statistics				
R-squared	0.99	Mean dependent var		37.82
Adjusted R-squared	0.99	S.D. dependent var		45.56
S.E. of regression	0.21	Sum squared resid		3.48
F-statistic	8336.04	Durbin–Watson stat		1.20
Prob (F-statistic)	0.00			
Unweighted statistics				
R-squared	0.97	Mean dependent var		8.21
Sum squared resid	5.20	Durbin–Watson stat		0.47

Sources: GEM and the World Bank; GDP current US $—Source: WDI and GDF, 2010; money and quasi money growth—Source: WDI and GDF, 2010.

Table 3
Eq. (3) estimates.

Dependent variable: Log(Φ)				
Method: Panel EGLS (cross-section weights)				
Variable	Coefficient	Std. error	t-Statistic	Prob.
C	−4.28	3.30	−1.29	0.19
Log(*In*)	0.05	0.07	0.83	0.40
Log(λ)	0.20	0.43	0.47	0.63
Log(*ms*)	−0.36	0.16	−2.17	0.03
Log(*y*)	0.23	0.11	1.93	0.05
Effects specification				
Cross-section fixed (dummy variables)				
_BEL				−0.19
_DNK				−0.00
_FIN				0.12
_FRA				−0.78
_DEU				−0.73
_ISL				1.60
_IRL				0.75
_ITA				−0.78
_NLD				0.20
_NOR				0.30
_SWE				−0.11
_UK				−0.31
_SPA				−0.07
Weighted statistics				
R-squared	0.72	Mean dependent var		1.61
Adjusted R-squared	0.68	S.D. dependent var		0.73
S.E. of regression	0.27	Sum squared resid		8.48
F-statistic	18.77	Durbin–Watson stat		1.75
Prob(F-statistic)	0.00			
Unweighted statistics				
R-squared	0.63	Mean dependent var		1.39
Sum squared resid	8.74	Durbin–Watson stat		1.77

Sources: GEM and the World Bank; Patent issues, residents—Source: WDI and GDF, 2010; Gini Index—Source: WDI and GDF, 2010; money and quasi money growth—Source: WDI and GDF, 2010; GDP current US $—Source: WDI and GDF, 2010.

that the latter would also encourage innovation activity, in turn causing a positive effect on economic activity. The absence of hindrances for this virtuous circle would create benefits for the nation in the form of higher levels of employment and welfare. The positive GDP sign also shows that economic stimulation would encourage entrepreneurs to carry out their activity, thereby reflecting the second feedback effect. As the above discussion shows, greater economic activity creates new opportunities for entrepreneurs and increases interest in taking advantage of these opportunities.

Table 3 reveals other noteworthy results. As per the above discussion, central bank activity plays an important role in the process, because central banks' policies have the potential to provide more financial resources for entrepreneurs to expand their businesses or to create new ones. In Eq. (3), *ms* represents this behavior, and its sign is negative. Therefore, if central banks decrease the money supply, interest rates increase, promoting savings, and creating a greater supply of financial resources. Thus, entrepreneurs would have more opportunities to obtain funding to finance innovative activities. Programs encouraging entrepreneurs to innovate, therefore, would be more likely to succeed. The only down side to this situation is the increase in interest rates, which would result in a negative effect because a very significant increase could discourage entrepreneurs from investing and innovating. On the other hand, higher interest rates would reduce prices and may increase the competitiveness of the goods and services of the firms.

Income distribution is a proxy for social climate. In general terms, better income distribution would lessen social stress, would probably reduce social opposition to the innovation process, and would improve entrepreneurs' expectations.

Eq. (3) uses the Gini index to measure income distribution, with data from the WDI. The hypotheses posit its sign to be negative because a fall in this index implies less inequality. Despite this assumption, Table 3 shows that the sign is in fact positive, meaning that inequality would have a positive effect on entrepreneurship activity. This result may tie in with the sign for money supply.

As per the above discussion, entrepreneurship and innovation activities are dependent on obtaining the necessary resources. Savings play an important role here, and economic agents with a higher income have a greater propensity to save. The acquisition of more resources for savings makes more funds available to innovators and entrepreneurs, which would encourage economic activity, positively impacting future employment.

This kind of policy, however, must adjust these measures upon achieving economic growth targets. If the policymaker allows these measures to continue, problems may arise, such as social strains that would have negative effects on economic activity, which could bring an end to the positive process.

5. Conclusions

The above sections analyze the feedback effect among innovations, economic growth, and entrepreneurship, and consider certain factors that could drive these three elements of the economy.

A Schumpeterian model organizes and estimates such effects, and the analysis shows that innovations and entrepreneurship share positive relationships with economic growth, prompting a circular effect whereby all three variables would exert positive effects on each other. Greater entrepreneurship activity and innovation would enhance economic activity, and the latter would in turn have positive effects on innovation and entrepreneurship activities. In addition, the analysis shows that a tighter money supply positively and significantly encourages innovation and entrepreneurship activities.

Despite these findings, scholars looking to make inferences from the conclusion that savings positively influence innovations must exercise caution. If policymakers try to increase savings, changing the income distribution would be necessary, shifting income from the poor to the rich, and thus creating social tensions that could have negative impacts on entrepreneurship activity, thereby adversely affecting small and medium-sized enterprises' behavior. Therefore, upon achieving some suitable economic growth level, central banks should temper or adjust policies that promote unequal income distributions (to raise savings) in order to improve income distribution in society (reduce inequality), and thus avoid any tensions that could otherwise arise.

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