ENTREPRENEURSHIP, INNOVATION & ECONOMIC GROWTH: AN EMPIRICAL STUDY OF DEVELOPED & DEVELOPING COUNTRIES

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Abstract

The purpose of this paper is to examine the relationship between entrepreneurship, innovation and economic growth. I use real GDP per capita, R&D investment per capita and new business density to measure growth, innovation and entrepreneurship respectively. The data consists of 125 countries including developed and developing countries for the period 2006 – 2016. Based on the work of Mankiw et al. (1992), I use a specification of the Cobb-Douglas production function to test the effect of entrepreneurship and innovation on growth of both groups of countries. I employ two estimation methods which are Static Panel Data Method and Generalized Method of Moments (GMM) to carry out the work. My results suggest that in short-term, the impact of innovation and entrepreneurship on growth is not significant or even have negative significance in developing countries. But the losses in short-term will be compensated in long-term since they show a positive and significant correlation in both groups of countries. The results also confirm the theory of spillage and the study of Mankiw et al. (1992).

Contents

1. Introduction

Entrepreneurship has been considered a vital factor in production, growth and development. Both theories and empirical evidences strongly demonstrate that fact. In particular, the theories of Joseph Schumpeter (1934) and Romer (1986) emphasize that entrepreneurship is a driving force of economic growth. Further to this, empirical evidence not only shows the positive impact of entrepreneurship on growth but also on economic development in the perspective of creating new jobs (Fritsch and Muller (2004), Van Stel and Storey (2004)), reducing unemployment (Fritsch and Wyrwich (2017), improving economic performance and progress of regions (McMillan and Woodruff (2002), Beugelsdijk and Noorderhaven (2004), Valliere and Peterson (2009)). For example, Fritsch & Wyrwich (2017) show that regional entrepreneurial culture exhibits a significant effect on employment and growth within German regions; Valliere & Peterson (2009) find that "entrepreneurship is a critically important dimension for predicting and explaining the economic performance of countries (developed and emerging)".

While innovation is not a new concept in economics, it has been understood in different terms and included in many economic concepts such as knowledge, capital accumulation, market behavior and mechanical advances. According to Adam Smith (1776), a way for firms to expand the markets for their products is to introduce innovations in the productive process to produce more competitive products. In the modern economic point of view, technological diffusion and the catch-up process (to be implied as innovation) are one of the main features of growth and development. For example, in the endogenous growth theory of Romer (1986, 1990), Lucas (1988), Aghion and Howitt (1992), they all agree that innovation is an prime driver of economic growth. Empirical evidence confirms the contribution of innovation to not only economic growth but also development (Nadiri (1993), Beugelsdijk (2007), Aghion et al (2009)).

Following the trending and countless successful cases of entrepreneurship over the last decades such as Google, Facebook, Amazon, etc., a lot of research has been undertaken to understand the relationship between entrepreneurship and growth on the one hand, and innovation and growth on the other hand. Likewise, more profound insights have also been gained as to how entrepreneurship, innovation and economic growth are interrelated. In spite of these discrete studies, a comprehensive understanding is still lacking concerning the interface of all those variables, although it is apprehended that there exists cause-and-effect relationship between the constructs. The link between the microeconomic origin of growth and the macroeconomic outcome is still too simply modelled in order to grasp the full picture of the complex interaction between entrepreneurship, innovation and growth; though, theoretical and empirical results have hinted toward a principal role of those variables to bridge micro and macro realms.

Limited studies empirically compare the impact of entrepreneurship and innovation on growth over time between developed and developing countries. Statistical evidence and common knowledge show that there are potential differences in various areas such as transportation, education, healthcare, jobs creation, and so on, for many reasons.

Taking into account all of the facts mentioned above, my paper attempts to shed light on the links between entrepreneurship, innovation and economic growth in both developing and developed countries. Then I compare the impact of entrepreneurship and innovation on growth in both groups of countries over the 2006 – 2016 period. Entrepreneurship and innovation are relatively hard to measure. Several studies measure entrepreneurship by self-employment, and innovation by ratio of patents to GDP (Wong et al., 2017; Li et al., 2012; Baksi, 2013); however, these may not adequately reflect the nuances of those factors in different regions or groups of countries. Freelancers or owners of small stores in remote regions are still considered self-employed but they are quite different from the normal definition of entrepreneur; moreover, patents usually take a very long time to show the wide effect on the economy due to the protection. Thus, I use research and development (R&D) investment per capita[1] and new business density[2] to measure innovation and entrepreneurship respectively. My dataset is collected from two reliable sources which are the World Bank and the United Nation Development Program.

The results of this study are the following: in the short-term, the impact of entrepreneurship on growth is negative for developing countries and is not significant for developed countries, while the impact of innovation on growth is not significant for both groups. But in the long-term, the impact of entrepreneurship on growth is positively significant in both groups. The impact of innovation on growth changes from insignificance in the short-term to positive significance in the

[1] Gloss domestic investment on research and development (R&D), expressed as a percent of GDP. They include both capital and current investment in the four main sectors: Business enterprise, Government, Higher education and Private non-profit. R&D covers basic research, applied research, and experimental development. R&D investment per capita is total R&D investment over total working labour force ages 15-64 (The World Bank).

[2] New businesses registered are the number of new limited liability corporations registered in the calendar year. New business density (new registrations per 1,000 people ages 15-64) varies by country (The World Bank).

long-term in developed countries. The collaboration of both entrepreneurship and innovation improve the results positively in both short and long-term.

Further to this, my findings also confirm the theory of spillage, a negative effect of short-term entrepreneurship, innovation or other factors on growth which may affect the technology and productivity level of the economy. I find that this spillage is offset in the long-term.

The remainder of this paper is organized as follows: in the next section a literature review will be carried out to exhibit the relationship between entrepreneurship, innovation and growth. In the third section, this paper provides the econometric strategy and specification considering the previous work of Mankiw (1992). Latter sections introduce the data collected for all developing and developed countries including sources and descriptions, then highlight the empirical results and economic interpretation. The last section provides the concluding remarks, together with suggestions for future research.

2. Literature Review

2.1. Setting the scene

When researchers or practitioners take innovation into account in economic analysis, they all carefully distinguish between innovation and invention. In technical term, invention is the first incidence of an idea for a new product or process, while innovation is the first try to carry it into practice. It seems both are closely linked, and it is hard to distinguish one from another. But in many circumstances, there is a considerable gap between those two activities: that is why it is necessary to define the term of innovation in this paper. According to Fargerber (2006), the main difference between invention and innovation is that invention may be carried out anywhere, while innovation occurs mainly in firms that need to combine several different kinds of capabilities, knowledge, resources and skills. In this sense, it is interesting to know the one, who is an innovator, who carries out all of these tasks. For that reason, it is essential to introduce the characterization of innovator, which is latter considered entrepreneur by economists.

Interest on entrepreneurship is not new. The term entrepreneurship was used for the first time in an economic context in 1755 and attributed to Richard Cantillon. But entrepreneurship is also widely used in various contexts such as psychology, sociology and anthropology. As a result, there is a complexity of definition on entrepreneurship. So it is important to introduce the meaning of entrepreneurship which is used in this paper. I combine the contributions and concepts of three economists: Joseph Schumpeter (1934), William Baumol (1968) and Knight (1921). For Schumpeter, entrepreneurship occurs when there is innovation in the introduction of a new product or a new organization; thus, when an entrepreneur ceases to innovate, he ceases to be an entrepreneur. Further to this, entrepreneurship and innovation of entrepreneur lead to a creative destruction process which is at the origin of long term growth and development. Taking the work of Schumpeter, Baumol claims that the entrepreneur is an innovator who is always engaged to do something that has never been done before. He also shows that while the total number of entrepreneurs differs among firms, their contribution to growth differs more along with their more or less productive allocation over time and the studied cultures (Baumol, 1990). While Knight distinguishes between risk and uncertainty; he claims that uncertainty is the important factor considered by entrepreneurs and introduces innovation. An entrepreneur has to take uncertainty into account and adopt decisions in an uncertain world. His profits are the reward for bearing this risk, and that contributes to wealth and prosperity.

2.2. Innovation, Entrepreneurship and Economic Growth

Although theory as well as empirical evidence of innovation-led and/or entrepreneurship-led growth is vast (i.e., Glaeser et al, 1992; Verspagen, 1992; Drucker, 1998; Sahar Bahmani et al, 2010; Niels Bosma et al, 2018), the contexts that transforms entrepreneurship and innovation into economic growth and the mechanism applied remain under researched possibly due to difficulties in measuring these factors and the lack of relevant data. In this study, entrepreneurship and innovation are not seen as exogenous, but decisive factors that contribute to the growing process.

Recent research work has focused on the advance of empirical models to determine the relationship between entrepreneurship, innovation and growth that hint towards the overall economic development of a nation. Wong et al. (2005) use cross-sectional data on 37 countries participating in Global Entrepreneurship Monitor (GEM) 2002 to study the impact of technological innovation and new firm formation on growth. One inspiring area in their paper is that they utilize the GEM Total Entrepreneurial Activity (TEA) rates to measure different types of entrepreneurial activities and employ the ratio of patents to GDP over a 5-year period to measure innovation. They start from an augmented Cobb-Douglas function to show that entrepreneurship and innovation are key determinants of growth. Their finding is that the rapid growing new firms generates most of new job creation by small and medium enterprises in developed countries.

An extension of Wong et al. (2005) is carried out by Valliere and Peterson (2009), which reflects the differences in the economic effects of opportunity and necessity-based entrepreneurship in both developing and developed countries. They use data from 44 countries for the years 2004 and 2005, as collected by GEM and Global Competitiveness Report (GCR), to forecast GDP growth for developing and developed nations. The data from GEM is used to determine the effect of different types of entrepreneurship on GDP growth. The GCR data runs additional control variables proposed by three economic growth theories: geography, endogenous growth and innovation. Their finding shows that high-expectation entrepreneurs using national investments in knowledge creation and regulatory freedom can contribute significantly to economic growth rates in developed countries. But, that effect is absent in developing countries. It suggests that a threshold exists for entrepreneurs to gain access to the formal economy, below which entrepreneurial contributions act through informal mechanisms.

Likewise, Galindo & Mendez-Picazo (2013) investigate the relationship between innovation and economic growth, following the Schumpeterian approach, considering the entrepreneurship activity. They also use TEA, which is obtained from GEM (2009), as a measurement for entrepreneurship. Growth and innovation are measured by GDP and number of patents issued respectively, which are collected from the World Bank. They find that innovation plays a crucial role in economic growth and entrepreneurship lift-offs the innovation to improve firms' profit maximization. Their outcome also implies that other factors such as social climate, private investments and institutions are necessary to be considered in the growth and development processes. However, one limitation of their study is the limited number of observations. In particular, their empirical analysis is just developed for the case of ten developed countries, which are Denmark, Finland, France, Germany, Italy, Japan, Netherlands, Spain, Sweden and the USA, for the period 2001-2009.

In a different way, Feki & Mnif (2016) use a panel of 35 developing countries over 2004-2011 periods to analyze the link between entrepreneurship and economic growth. Instead of using the TEA index from GEM to measure entrepreneurship, they use two other indicators: the new business density and the number of patents filed by residents and non-residents. Their dataset is fully collected from the World Bank. In their study, they estimate a growth function using the method of static and dynamic panel data. Their results suggest that there is a significant and positive correlation between entrepreneurship and growth and the effect of technological innovations on economic growth is positive and significant only in the long term. In this sense, entrepreneurship is linked to innovation and it is considered a key instrument for improving competitiveness among nations, to promote economic growth and to increase employment opportunities.

In terms of national aspect, Li et al. (2012) study the impact entrepreneurship on the economic growth of China by using a panel dataset of 29 provinces over 20 years (1983-2003). They explain that employing data from one country can avoid inconsistency of variable definition which cross-country regressions are usually subject to since different countries have different statistical methods (Barro, 1991). They use two indicators to measure entrepreneurship which are private employment ratio and self-employment ratio. Besides, they also use staff and work ratio of state-owned enterprises and per capita sown land area as the instrumental variables in order to identify the causal relationship between entrepreneurship and growth. Their result suggests that entrepreneurship has a significant and positive effect on economic growth. The result is still robust even after they control for other demographic and institutional variables. Finally, they emphasize that their study not only highlights the important role of entrepreneurship in economic development in a transitional and developing country but also provides some evidence that can be a basis for evaluating the effect of China's policies on private business.

Another notable empirical study about the liaison between entrepreneurship, innovation and economic progress is Baksi (2013) for the case of India. He collects the data from GEM (2008) along with World Bank Enterprise Survey (2006) to explore the link between entrepreneurship, innovation and economic progress refer to Indian context. He explains that one of the important characteristics of GEM data is its consistency and comparability in measuring entrepreneurial activities, while the World Bank Enterprise Survey provides specific data pertaining to India's venture creation and its correspondence contribution to GDP of the nation. His study finds that entrepreneurship and technological innovation are significantly correlated to economic growth, and that confirms the significant proportion of GDP in India is made by the small and medium enterprises (SMEs) and high rate of technology adoption by India in the last decade.

From an economic globalization perspective, Coulibaly et al. (2018) attempt to analyze the impact of globalization and entrepreneurship on rapid economic growth and development in the case of BRICS emerging nations (Brazil, Russia, India, China, and South Africa). They use a comprehensive variable to proxy for economic globalization called the KOF Globalization Index which obtained from World Development Indicator (WDI) by World Bank for the period 2002-2013. While TEA, which is obtained from GEM for the same period, is used to measure the impact of entrepreneurship on economic development. Their study shows that entrepreneurship and economic globalization both have a significant and positive impact on economic development of BRICS, henceforth validating that BRICS countries are in a transition phase between an efficiency-driven development stage and an innovative-driven development stage.

Other relevant empirical studies demonstrate a strong linkage between entrepreneurship and economic development in the form of employment and growth. Fritsch and Wyrwich (2017) investigates the relationship among a regional culture of entrepreneurship, start-up activity and regional development for 70 planning regions of West Germany. They use the historical self-employment rate in the year 1925, which is collected from Statistik des Deutschen Reichs, as an indicator of a regional culture of entrepreneurship. They also take it as an instrument to analyze the effect of entrepreneurship on economic growth in recent periods. While data on new business formation, which is used to measure start-up activity, are obtained from the Establishment History File of the German Social Insurance Statistics. The result of their study reveals that German regions with a high level of entrepreneurship in the mid-1920s have higher start-up rates about 50 years later. Hence, a regional culture of entrepreneurship is an important factor for the persistence of entrepreneurship. Furthermore, they find that start-up activity has a significant impact on regional employment growth, which is one of the key elements of economic development, when using entrepreneurship culture as instrument for start-up activity.

Van Stel and Suddle (2008) also give the similar result with Fritsch and Wyrwich (2017) which is that the impact of new start-up firms on overall employment is positive. They also indicate that immediate employment effects of new start-up firms are small in the Netherlands. The main objective of their research is to examine the relationship between new firm formation and regional employment change in the Netherlands. They also inspect whether the relationship differs by time period, by sector and by degree of urbanization. By using the regional dataset consists of 40 regions for period 1982-2002, which is obtained from Statistics Netherlands and Dutch Chambers of Commerce, they find that the maximum effect of new businesses on regional development is reached after about six years. Moreover, their result suggests that the linkage between new businesses and regional development is stable during the period and the employment impact of new firms is strongest in manufacturing industries and greater in areas with a higher degree of urbanization. One interesting area of their paper is that they use start-up rate, which is defined by as the number of new-firm start-ups divided by employment in full-time equivalents, to represent for entrepreneurship. The number of start-ups includes both new firms with employees and new firms without employees.

Last but not least, Kasseeah (2016) uses data on 125 countries to study whether entrepreneurship leads to economic development, which is measured in GDP, by considering several other factors including the level of financial development, the business environment and governance and the quality of institutions. She collects the dataset from World Bank Group Entrepreneurship Survey for the year 2011. The novelty of her study is that the data are augmented with indicators from the World Development Indicators and also various Doing Business Reports. Specifically, she uses the ranking given to economies in the Doing Business Reports as an indicator of the business environment. She uses two measures to quantify entrepreneurship which are business density defined as the number of newly registered corporations per 1,000 working-age people (those ages 15-64) and the number of new business registrations. Both measures are positively related to economic development and support the hypothesis that entrepreneurship positively supports economic development. Her finding implies that entrepreneurship is considered a development-promoting tool and recognized that countries, which encourage entrepreneurship, tend to have higher economic development regardless the level of development of any country or the region that it is located in, countries would gain from boosting entrepreneurship.

Taking into account all of empirical studies mentioned above, in this paper, I use a more recent and larger data sample (1375 observations), not only focused on a specific regional context but also provide comparison between groups of countries. I also use trend indicators to measure other related factors mentioned in Mankiw (1992) which may correlate to growth, innovation and entrepreneurship. In order to ensure the measurements of variables are accurate and consistent, I deploy the dataset which is obtained from World Bank and United Nations Development Program. The following sections are my empirical model and data.

3. Identification Strategy

The objective of this section is to empirically study the link between entrepreneurship, innovation and economic growth for a sample 36 developed countries and 89 developing countries using data over the 2006 – 2016 period.

There are two key questions about how the causal relationship of the three factors mentioned above will be investigated:

1. What is the effect of innovation and entrepreneurship on growth?

2. What is the difference of that effect on developed and on developing countries?

3.1. Econometric Model

In order to answer these two questions, this study adopts the framework introduced by Mankiw et al. (1992). Considering the following specification of Cobb-Douglas production function:

$$Y_t = K_t^{\alpha} H_t^{\beta} (A_t L_t)^{1-\alpha-\beta} \tag{1}$$

where Y is real output, K is the stock of physical capital, H is the stock of human capital, A is labour-augmenting factor reflecting the level of technology and productivity, L is raw labour in the economy and subscript t indicates time.

It is supposed that $\alpha + \beta < 1$, which implies decreasing returns to all capital. The A and L variables are assumed to grow as follows:

$$A_t = A_0 e^{gt+P\gamma} \tag{2}$$

$$L_t = L_0 e^{nt} \tag{3}$$

where g is the exogenous rate of technological progress, P is a parameter of entrepreneurship, innovation and other factors which may affect the technology and productivity level of the economy, and γ is a vector of coefficients related to these variables.

At the steady state, output per unit of labour grows at the constant rate g. This outcome can be achieved directly from the definition of output per effective unit of labour as follows:

$$\frac{Y_t}{A_t L_t} = (k_t)^{\alpha} (h_t)^{\beta}$$

$$\frac{Y_t}{L_t} = A_t(k_t)^{\alpha}(h_t)^{\beta} \quad (4)$$

Let $y_t^* = \left(\frac{Y_t}{L_t}\right)^*$ be the output per unit of labour at steady state. Taking logs of both sides of the equation (4) and dropping time subscript for simplicity, we get:

$$\ln\left(\frac{Y}{L}\right)^* = \ln A + \alpha \ln k^* + \beta \ln h^*$$

Utilizing equation (3), we have:

$$\ln\left(\frac{Y}{L}\right)^* = \ln A_0 + gt + \gamma \ln P + \frac{\alpha}{1-\alpha-\beta}\ln s^K + \frac{\beta}{1-\alpha-\beta}\ln s^H - \frac{\alpha+\beta}{1-\alpha-\beta}\ln(n+g+\delta) \quad (5)$$

Equation (5) defines the steady state productivity of labour, where a parameter of entrepreneurship and innovations proxies (P) exist. While s^H and s^K represent the fraction of income invested in human capital and physical capital respectively. Because of data limitation, this paper assumes that *gt* doesn't vary over time. So in Equation (6), lnA_0 and *gt* are considered as a sum of a constant a and ε is a country-specific shock. Then, the steady-state productivity of labour (y^*) grows according to the following equation:

$$\ln\left(\frac{Y}{L}\right)^* = a + \gamma \ln P + \frac{\alpha}{1-\alpha-\beta}\ln s^K + \frac{\beta}{1-\alpha-\beta}\ln s^H - \frac{\alpha+\beta}{1-\alpha-\beta}\ln(n+g+\delta) + \varepsilon \quad (6)$$

Re-arranging (6), we get:

$$\ln y^* = a + A_1 \ln ENT + A_2 \ln H + A_3 \ln K - A_4 \ln(n+g+\delta) + \varepsilon \quad (7)$$

and

$$\ln y^* = a + A_1 \ln INV + A_2 \ln H + A_3 \ln K - A_4 \ln(n+g+\delta) + \varepsilon \quad (8)$$

Where a is a constant term, A_1 to A_5 are the parameters to be estimated and ε is the error term which represents the effect of omitted variables that are particular to each country and period. y* is economic growth measured by Real Gross Domestic Product (GDP) per capita in current US dollars (USD). *INV* is innovation measured by R&D investment (as percentage of GDP) per capita. *ENT* is entrepreneurship measured by number of new business density. *H* is human capital measured by mean years of schooling. *K* is the capital stock measured by gross fixed capital formation in current U.S. Dollars.[3] $(n + g + \delta)$ includes: n the rate of labour force growth,[4] g is the rate of technological progress and δ is the rate of depreciation. Note that g and δ are assumed to be constant across countries and over time and their sum equals 0.05, following Mankiw et al. (1992).

Further to that, I also want to examine the collaboration of entrepreneurship and innovation on the growth rates, so equations (7) and (8) are extended to include a multiplicative interaction term as follows:

$$\ln y^* = a + A_1 \ln ENT + A_2 \ln INV + A_3 \ln H + A_4 \ln K - A_5 \ln(n + g + \delta) + \varepsilon \qquad (9)$$

Equations (7), (8) and (9) are the three equations which provide the basis for the empirical models that are estimated in this paper.

3.2. Estimation Approach

Because the study is the analysis of macro panels under a situation where N (number of countries, 125 countries) is large relative to T (period of time, 11 years) which implies several data problems such as endogeneity, heterogeneity, multi-collinearity and autocorrelation, I use two econometric estimation methods to deal with those problems.

Firstly, I apply the Static Panel Data method, which permits unobserved heterogeneity of the sample countries. The individual characteristics may be fixed or random, so a specification test of Hausman (1978) makes it possible to choose either of these specifications.

Thus, the three equations to be estimated, (7), (8) and (9), are re-defined as follows.

$$\ln y_{it}^* = a + A_1 \ln ENT_{it} + A_2 \ln H_{it} + A_3 \ln K_{it} - A_4 \ln (n + g + \delta)_{it} + \varepsilon_{it} \qquad \text{(I)}$$

$$\ln y_{it}^* = a + A_1 \ln INV_{it} + A_2 \ln H_{it} + A_3 \ln K_{it} - A_4 \ln (n + g + \delta)_{it} + \varepsilon_{it} \qquad \text{(II)}$$

[3] Gross fixed capital formation includes land improvements (fences, ditches, drains, and so on); plant, machinery, and equipment purchases; and the construction of roads, railways, and the like, including schools, offices, hospitals, private residential dwellings, and commercial and industrial buildings.

[4] Labour force comprises people ages 15 and older who supply labour for the production of goods and services during a specified period.

$$\ln y_{it}^{*} = a + A_1 \ln ENT_{it} + A_2 \ln INV_{it} + A_3 \ln H_{it} + A_4 \ln K_{it} - A_5 \ln (n+g+\delta)_{it} + \varepsilon_{it} \qquad \text{(III)}$$

where *t* is the time trend variable and subscript *i* refers to the i^{th} country.

Secondly, since lag occupies a central role in economics and is clearly reflected in the short-run-long-run methodology of economics (Gujarati, 2003), and getting valid (external) instruments both from theoretical and empirical point of view is very difficult, I decided to use the Generalized Method of Moments (GMM), which permits one or more lags of the dependent variables are included as explanatory variables, in order to display the effect of entrepreneurship and innovation on growth adjusting over time towards the long-run equilibrium. Moreover, this method helps us solve the problems of endogeneity, simultaneity bias, reverse causality and omitted variables that may weaken the results from static panel data method. There are two GMM approaches: the first is the difference GMM (DIF-GMM) and the second is system GMM (SYS-GMM). The SYS-GMM combines equations of the first differences instrumented by lagged levels with an additional set of equations in levels instrumented by lagged first-differences (Arellano and Bover, 1995; Bulndell and Bond, 1998); therefore, it is superior and suitable for my empirical test.

From the three equations above, I add the lag of growth as an explanatory variable. Thus, the three equations to be estimated are modified as follows:

$$\ln y_{it}^{*} = a + A_1 \ln y_{it-1}^{*} + A_2 \ln ENT_{it} + A_3 \ln H_{it} + A_4 \ln K_{it} - A_5 \ln (n+g+\delta)_{it} + A_6\, DC_{it} + \varepsilon_{it} \qquad \text{(IV)}$$

$$\ln y_{it}^{*} = a + A_1 \ln y_{it-1}^{*} + A_2 \ln INV_{it} + A_3 \ln H_{it} + A_4 \ln K_{it} - A_5 \ln (n+g+\delta)_{it} + A_6\, DC_{it} + \varepsilon_{it} \qquad \text{(V)}$$

$$\ln y_{it}^{*} = a + A_1 \ln y_{it-1}^{*} + A_2 \ln ENT_{it} + A_3 \ln INV_{it} + A_4 \ln H_{it} + A_5 \ln K_{it} - A_6 \ln (n+g+\delta)_{it} + A_7\, DC_{it} + \varepsilon_{it} \qquad \text{(VI)}$$

4. Data Description

4.1. Presentation of Variables

4.1.3. The Dependent Variable

Growth

Economic growth is the dependent variable in my study in order to test its relationship with innovation and entrepreneurship. Since economic growth implies an increase in the value of income and goods produced in the economy, I use real GDP per capita (in USD) as the measure to quantify growth. I collect the data over the 2006 – 2016 period from the World Bank. The real GDP per capita is a popular measure for growth and used in a wide range of empirical studies since it is especially helpful when comparing one country, group of countries or regions to another.

4.1.2. The Explanatory Variables of Interest

Innovation

In this study, I use R&D investment per capita over the 2006 – 2015 period in order to measure the level of innovation in a country. This data is collected from the World Bank. The reason I use R&D investment per capita to measure innovation is because R&D investment plays a crucial role in innovation and economic performance. R&D investment aims to foster innovation in both private and public sectors by allowing researchers, scientists and inventors to develop new ideas, knowledge, techniques and technologies. With the change of technology, labour can produce more with either the same or fewer resources, thus increasing productivity in the economy. The empirical evidence also supports the effectiveness of R&D in encouraging innovation, development and growth (Levin et al, 1987; Stokey, 1995; Jones & Williams, 2000). In fact, major economies in the world such as the U.S, China or Japan invest a huge amount of money on R&D in order to improve the economic performance and achieve the long-term growth. Particularly, the U.S spends the most on R&D worldwide, estimated at $465 billion in 2014 (from private and public), China comes in second at $284 billion, and Japan comes in third with $165 billion. The dataset about R&D investment in this study is not completely full for all 125 countries, but it is still considered good enough for an empirical study at country groups level.

Entrepreneurship

Another key variable is entrepreneurship, measured as the number of new business density over the 2006 – 2016 period. The new business density, which is the number of newly registered limited liability corporations per calendar year, normalized by working age population. This is a valuable indicator which quantifies the impact of regulatory, political, and macroeconomic institutional changes on new business registration, a vital component of a dynamic entrepreneurship. This data is also collected from the World Bank's database. Although some empirical studies use self-employment rates to measure entrepreneurship, it seems not very precise and aligned with a modern definition about entrepreneurship as a person who organizes and operates a business or businesses, taking on greater than normal financial uncertainty in order to do so, contributing to wealth and prosperity in the economy. While the definition of self-employment is often identified as freelancer or owner of a very small or micro-business rather than an employer or company. Recent empirical research also uses new business density, or total entrepreneurship activity (TEA), to measure the entrepreneurship level instead of using self-employment rate (Galindo & Mendez-Picazo, 2013; Feki & Mnif, 2016). But the dataset of TEA index is limited only for 60 countries over the 2005-2015 period. So in this study, I choose new business density as a better proxy for entrepreneurship. Once again, the data of new business density is not completely full for all countries in this study.

4.1.3. Control Variables

To study the relationship between the three key variables mentioned above, it is necessary to control for factors that can influence them. In other words, it is to find out how the interaction between the three variables is affected by the diverse characteristics. Therefore, the factors that possibly relate to the dependent variable are used as explanatory variables. In this section, additional explanatory variables are included: human capital, capital stock and growth rate term, $(n+g+\delta)$. These variables are also used in the study of Mankiw (1992).

i) Human capital

The first control variable that I use is human capital. I use mean years of schooling to measure human capital. I collect the data from United Nations Development Program. In this study, I restrict my focus to education – thus ignoring investment in health, among other things. High mean years of schooling (education) is associated with higher labour earnings and implied growth (Brahim, 2008; Lucas, 1988). Besides, higher mean years of schooling indicates a better education and knowledge by people or the labour force which support generating innovation and entrepreneurship. I expect a statistically significant and positive relationship of human capital on economic growth.

ii) Capital stock

The second explanatory variable is the capital stock which is measured by gross fixed capital formation in USD. This data is obtained from the World Bank. This variable is a key variable in many studies about economic growth, including Mankiw (1992), since it is one of the main factors that drive long-run economic growth. Measuring the capital stock is hard and still vague. In this study, I focus on capital stock in the form of fixed assets by using the gross fixed capital formation indicator. In principle, statistical measures of gross fixed capital formation are supposed to refer to the net additions of newly produced fixed assets, which enlarge the total stock of fixed capital in the economy. This indicator is also guided by the OECD as one of the methods to measure capital.[5] A positive correlation between the capital stock and growth is expected.

iii) Composite variable of population growth, technological progress and depreciation

The third set of explanatory variable is the term $(n+g+\delta)$, where n is the rate of labour force growth,[6] g is the rate of technological progress and δ is the rate of depreciation. As Mankiw et al (1992), I also assume that $g+\delta$ is equal to 0.05. So I collect the data of labour force from World Bank to quantify the growth rate of labour force, which is n. The labour force in this study represents total working-age population, where working age is defined as 15 to 64. To compute the growth rate of labour force, I take the natural logarithm of the total labour force in the dataset. Since $g+\delta$ is constant for all countries, countries with a higher labour force growth implies a higher potential economic growth since the labour force is the main source of income generation for economy. Moreover, based on the findings of Mankiw et al. (1992) and the three equations

[5] OECD Statistics Manual 2001, Measuring Capital: Measurement of capital stocks, consumption of fixed capital and capital services

[6] Labour force comprises people ages 15 and older who supply labour for the production of goods and services during a specified period.

mentioned above, I expect the sign of *(n+g+δ)* to be negative which means it has positive correlation with growth.

4.2. Sample and Sources

I select 125 countries, including developed and developing groups which are basically classified by their level of development as measured by fuel export-import and per capita gross national income (GNI) by United Nation Department of Economics and Social Affairs (UN/DESA) 2018.[7] There are 36 developed countries and 89 developing countries.[8]

The time length of the dataset is a limitation for this empirical analysis because one of three key variables, entrepreneurship, which is measured by new business density, covers just 11 years (2006 – 2016). As a result, I have to pick the data during the 2006 – 2016 period for all variables.

Table 1: Summary statistics

Variable	Measure	N	Mean	S.D.
All Countries				
Real GDP per capita	Real GDP per capita in current USD	1,365	16,173	21,010
Innovation	R&D investment per capita in percentage of real GDP	696	0.194	0.246
Entrepreneurship	Number of new business density	1,020	3.935	5.296
Human Capital	Mean years of schooling	1,375	8.318	3.116
Labour force	Total labour force (ages 15-64)	1,364	2.360e+07	8.334e+07
Physical Capital	Gross fixed capital formation in current USD	1,272	1.353e+11	4.558e+11
Developed Countries				
Real GDP per capita	Real GDP per capita in current USD	396	37,720	22,879

[7] World Economic Situation and Prospect Report 2018, United Nations
[8] The starting dataset consisted of 112 developed countries, but I dropped 23 countries due to large missing data over the sample span

Variable	Measure	N	Mean	S.D.
Innovation	R&D investment per capita in percentage of real GDP	337	0.299	0.259
Entrepreneurship	Number of new business density	365	6.434	5.511
Human Capital	Mean years of schooling	396	11.735	1.160
Labour force	Total labour force (ages 15-64)	396	1.41e+07	2.81e+07
Physical Capital	Gross fixed capital formation in current USD	396	2.47e+11	5.52e+11
Developing Countries				
Real GDP per capita	Real GDP per capita in current USD	969	7,367	11,868
Innovation	R&D investment per capita in percentage of real GDP	359	0.096	0.187
Entrepreneurship	Number of new business density	655	2.541	4.622
Human Capital	Mean years of schooling	979	6.936	2.540
Labour force	Total labour force (ages 15-64)	968	2.75e+07	9.70e+07
Physical Capital	Gross fixed capital formation in current USD	876	8.49e+10	3.95e+11

Table 1 shows the summary statistics of variables to be used. For all countries, the average real GDP per capita among the whole dataset is 16,173. The measure of innovation is on average 0.194 (with standard deviation of 0.246) and the measure of entrepreneurship is 3.935 in average (with standard deviation of 5.296).

One may easily observe a big gap in the mean and standard deviation of variables listed in the table between developed and developing countries. The mean and deviation of real GDP per capita in developed countries are 37,720 and 22,879 respectively; they are just 7,367 and 11,828 in developed countries. The measure of innovation is on average 0.299 (with standard deviation of 0.259) in developed countries; it is just 0.096 (with standard deviation of 0.187) in developing countries. In developed countries, the measure entrepreneurship is on average 6.434 (with standard deviation of 5.511); in developing countries, the measure of entrepreneurship is on average 2.541 (with standard deviation of 4.622).

5. Empirical Result

5.1. Short-term Effect

Using the static panel data method for 125 countries in the sample over 2006 – 2016 periods, I obtain the results presented in Table 2.

For a short reminder about the models to be used in Table 2, I use Model (I) to examine the impact of entrepreneurship on growth, Model (II) to investigate the effect of innovation on growth and Model (III) to explore the influence of both entrepreneurship and innovation on growth.

The p-value of Hausman test for both developed and developing countries in all three models is of 0.000. Therefore, I reject the null hypothesis of random effect is appropriate. So a fixed effect is applied in all three models below.

The R-square value for both developed and developing countries in all three models is considered high (on an average of 0.700). The average of R-square value in previous papers such as Wong et al. (2005), Valliere and Peterson (2009) or Feki and Mnif (2016) is around 0.500.

Table 2: Effect of entrepreneurship and innovation on economic growth in developed and developing countries, 2006 – 2016. (Static Panel)

Dependent variable: ln y_{it} (Growth)	**Model (I)**		**Model (II)**		**Model (III)**	
	Developed	Developing	Developed	Developing	Developed	Developing
ln *ENT* (Entrepreneurship)	0.0270	-0.0466***			0.0428**	-0.0327
	(0.0170)	(0.0147)			(0.0183)	(0.0290)
ln *INV* (Innovation)			0.00100	-0.000461	0.00314	0.00146
			(0.00205)	(0.00282)	(0.00258)	(0.00271)
ln *H* (Human Capital)	1.116***	0.627***	1.243***	1.243***	1.169***	1.088***
	(0.131)	(0.110)	(0.145)	(0.184)	(0.146)	(0.177)
ln *K* (Physical Capital)	0.453***	0.523***	0.454***	0.569***	0.437***	0.630***
	(0.0225)	(0.0194)	(0.0224)	(0.0258)	(0.0248)	(0.0292)
ln $(n+g+\delta)$	-5.155***	-3.174***	-4.067**	-6.814***	-4.058**	-10.59***
	(1.683)	(1.175)	(1.950)	(2.442)	(1.926)	(2.620)
Constant	10.39**	3.617	7.110	11.30*	7.661	20.72***
	(4.336)	(3.013)	(5.099)	(6.374)	(5.030)	(6.750)
Observations	365	596	337	346	309	261
R-squared	0.598	0.750	0.597	0.802	0.586	0.835
Hausman Test	0.0000	0.0000	0.0000	0.0000	0.0000	0.0055

Standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Model (I): As mentioned above, I use this model to examine the impact of entrepreneurship on growth. The R-squared for developed countries is around 0.6, which means that 60% of the variation in dependent variable is explained by the independent variables present in the model, indicating an acceptable specification in the case of panel data. The R-squared for developing countries is 0.75, which is better and may be considered as having good explanatory power. As we can see in the table, entrepreneurship has a significant and negative impact on growth in developing countries. But its impact on growth in developed countries is not significant. The control variables have the expected signs and are very significant in all countries.

Discussion: This is an interesting result since most of empirical studies find that entrepreneurship should has a positive impact on the growth of countries, especially developing countries. The result could be explained by the fact that entrepreneurship has a positive effect in the long-term, and negative effect in the short-term. In the initial phase of starting new businesses, there is a direct employment effect from new jobs created which implies a positive effect on income. After the initial phase, there is a stagnation phase or even a downturn as new businesses gain market share from existing businesses. But they are unable to compete with the existing ones and so some of them fail. In general, the failure rate of the first five-year of starting a business is around 40-50%.[9] Following this interim phase of potential failure and displacement of existing firms, the increased competitiveness of suppliers leads to a positive gain in growth once again. Previous studies also show that even though a large percentage of new businesses do not survive, the surviving new businesses can create and retain up to 80% of the net jobs that are lost by the new businesses that do not survive.[10] One can explain the impact of entrepreneurship in developed countries is insignificant in short-term by the type of entrepreneurs in these countries are considered high-expectation or innovation-based entrepreneurs who recognize and exploit high-growth opportunities.[11] Even in the downturn phase, the number of surviving new businesses may be higher than the general failure rate. That offset may lead to insignificant result. In conclusion, we can expect a positive impact of entrepreneurship on growth when we carry out the test for the long-term effect in the next sub-section.

Model (II): The purpose of this model is to investigate the effect of innovation on growth. So instead of using entrepreneurship as the proxy of technology and productivity, I use innovation measured by R&D investment per capita. The R-squared for developed countries is around 0.6 and for developing countries it is 0.8, which means the specification is very good. The signs and statistical significance of control variables are as expected. But the effect of innovation on growth is insignificant in both developed and developing countries.

Discussion: Time is always one of the most interesting innovation barriers. The impact of innovation measured by R&D investment per capita on growth usually takes a long time to be

[9] Helmers, C., and M. Rogers (2010). Innovation and the survival of new firms in the UK. *Review of Industrial Organization*, 36: pp. 227–248 [9].
[10] Birch, D. (1987). Job creation in America: How our smallest companies put the most people to work. *New York: The Free Press*
[11] Global Entrepreneurship Monitor defines high-expectation entrepreneurs as individuals who run start-ups and newly formed businesses (less than 42 months old) which expect to employ at least 20 employees in 5 years. They represent for a mere roundly 10% of the world's entrepreneurs expect to create almost 75% of the jobs generated by new business ventures

effective. Indeed, R&D is time consuming and expensive. For examples, the Carbon Trust in the UK, which initiated a $30 million program, is projecting a ten-year effort; the average cost per drug developed and approved by a single-drug company is $350 million and takes over a decade.[12] The success rate is also a major factor to take into account. In the time period of 2006 to 2015, the success rate of developing a new drug is just 9.6 %.[13] In fact, ten years is a short time for innovating any new technology, but a very long-term for a return on investment and business cycle in macroeconomics, which is around five years.[14] Moreover, for the full benefits of a new technology to be realised, it is necessary to take time for it to spread across the economy and equally benefit firms in different sectors and of different sizes. This process is called the diffusion of innovation. So in the short-term, we cannot see any significant impact of innovation measured by R&D investment per capita on the economic growth of countries. As economic theory, innovation is the main driver of long-term growth. So we can expect to see a positive effect of innovation on growth when we carry out the test for long-term effect in the next sub-section.

Model (III): To better understand the influence of both entrepreneurship and innovation on growth, I add both entrepreneurship and innovation into this model. The R-squared for developed countries is around 0.60 and for developing countries is up to 0.84, which means the explanatory power is very good for developing countries. The signs and statistical significance of control variables are as expected. The impact of innovation on growth is still insignificant in all countries. The impact of entrepreneurship on growth changes from negative and significant to insignificant in developing countries and from insignificant to positive and significant (at 0.05) in developed countries. In other words, the presence of both entrepreneurship and innovation in this model improves the effect of each factor on growth.

Discussion: The influence of both entrepreneurship and innovation on growth significantly changes the result from their individual impact on growth in both groups of countries. Particularly, the impact of entrepreneurship on growth changes from insignificant to positive and significant in developed countries and from negative and significant to insignificant in developing countries. It

[12] Herper, Matthew (11 August 2013). "The Cost of Creating a New Drug Now $5 Billion, Pushing Big Pharma to Change". *Forbes, Pharma & Healthcare*. Retrieved 17 July 2016

[13] "Clinical Development Success Rates 2006-2015". *BIO Industry Analysis*. June 2016

[14] The time from one economic peak to the next, or one recessive trough to the next, is considered a business cycle. From the year 1945 to the year 2009, the NBER defined eleven cycles, with the average cycle lasting a bit over 5-1/2 years

is interesting to analyze the insignificant effect of the entrepreneurship on growth in developing countries. One may say that the effect of both entrepreneurship and innovation is positively associated with growth in developed countries since the entrepreneurs in these countries are considered high-expectation or innovation-based entrepreneurs who recognize and exploit high-growth opportunities, effectively harnessing the knowledge development infrastructure of the nation, benefiting from decreased governmental regulations, and generating wealth and jobs; while in developing countries, entrepreneurs are usually considered the opportunity-based entrepreneurs who do not have high-growth expectations, due either to constraints in their environments and markets, or to more modest motivations and growth objectives for their firms.[15] That argument may be debatable, but it somehow helps us explain the insignificant effect of the collaboration between entrepreneurship and innovation on growth in developing countries in the short-term.

5.2. Long-term Effect

There are two diagnostic tests associated with the dynamic panel GMM: the over-identification test Sargan/Hansen, which can test the validity of the lagged variables as instruments, and the Arellano and Bond (1991) test for autocorrelation where the null hypothesis is the absence of autocorrelation of the first order errors in the level equation. In all three Model (IV), (V) and (VI), the results of both tests in Table 3 are as expected. The statistics fail to reject both H_0 of validity of the lagged variables as instruments and no autocorrelation of the second order provides a justification for the model specification.

[15] Global Entrepreneurship Monitor defines opportunity-based entrepreneurs as individuals who perceive a business opportunity and start a business as one of several possible career options. These individuals expect to achieve much lower growth rates, either due to perceived environmental constraints or to limited objectives or motivations on the part of the entrepreneurs

Table 3: Effect of entrepreneurship and innovation on economic growth in developed and developing countries, 2006 – 2016. (Dynamic Panel)

Dependent variable: ln $\boldsymbol{y}_{it}$ (Growth)	**Model (IV)**		**Model (V)**		**Model (VI)**	
	Developed	Developing	Developed	Developing	Developed	Developing
ln y_{it-1} (Lag 1 of Growth)	0.850***	0.857***	0.814***	0.784***	0.802***	0.749***
	(0.0212)	(0.0144)	(0.0184)	(0.0169)	(0.0304)	(0.0277)
ln *ENT* (Entrepreneurship)	0.0062***	0.0112***			0.00902***	0.00693**
	(0.00130)	(0.00338)			(0.00180)	(0.00296)
ln *INV* (Innovation)			0.00297***	-0.000406	0.00236***	-0.000459
			(0.000425)	(0.000355)	(0.000597)	(0.000551)
ln *H* (Human Capital)	0.0931**	0.0848***	0.0622**	0.163***	0.0884**	0.157***
	(0.0406)	(0.0133)	(0.0255)	(0.0242)	(0.0412)	(0.0196)
ln *K* (Physical Capital)	0.140***	0.103***	0.174***	0.163***	0.188***	0.202***
	(0.0201)	(0.00983)	(0.0169)	(0.0132)	(0.0292)	(0.0243)
ln $(n+g+\delta)$	-2.129***	-1.430***	-2.604***	-2.635***	-2.723***	-3.124***
	(0.309)	(0.136)	(0.265)	(0.228)	(0.441)	(0.371)
Constant	3.552***	2.693***	0	0	0	0
	(0.546)	(0.249)	(0)	(0)	(0)	(0)
Observations	332	540	303	315	278	239
AR(1)	0.007	0.002	0.001	0.000	0.014	0.002
AR(2)	0.133	0.370	0.302	0.042	0.405	0.203
Sargan/Hansen Test	0.998	0.307	0.839	0.594	0.922	0.851
Standard errors in parentheses *** p<0.01, ** p<0.05, * p<0.1						

Model (IV): After adding the one-year lag of growth into the regression, the results change as expected. The impact of entrepreneurship on growth in both developed and developing countries are positive and significant. The sign and significance of control variables are as expected.

Discussion: The result of entrepreneurship in Table 3 exhibits my explanation in Model (I). In other words, the impact of entrepreneurship on growth is negative in short-term, but it is positive in the long-term. The gains in long-term is even more significant than the temporary losses in short-term. Moreover, combining the result from Model (IV) and Model (I), one can see that the impact of entrepreneurship on growth in developing countries is stronger than developed countries in terms of statistical significance. In the developing group, it changes from negative and significant at 0.01 to positive and significant at 0.01. That is a significant change. One may explain this by two reasons. First, due to economic convergence, the growth of developing countries is higher and faster than developed countries so we obtain a significant change between short and long-term. Second, the contributions to growth of developed countries are from many traditional sectors, major industries, mainly from existing firms. In terms of income contribution to GDP, new businesses are incomparable to existing firms. It is opposite with the situation in developing countries where there is a lack of many big existing firms and the large gap in income between employed and unemployed worker. So the role of business organizations even big or small, new or existing are considered significant for growth in developing countries.

Model (V): After adding the one-year lag of growth into the regression and using innovation as a proxy of technology and productivity instead of entrepreneurship, the impact of innovation on growth in developed countries is positive and significant. But it is still insignificant in developing countries. The sign and significance of control variables are as expected.

Discussion: Once again the result of innovation on growth in the long-term verifies my explanation in Model (II). One can explain the reason why the impact of innovation on growth in developed countries is significant even in the long-term but not in developing countries by considering that there is a lower successful rate of R&D in developing countries. Moreover, as I discussed above, R&D investment takes a long time to be effective and widely used and some R&D outcomes just go to no where since they are just a very tiny update from the previous ones. Another reason may be taking into account is that the law of innovation protection in developing countries is not strict. As a result, researchers, scientists or inventors lose motivation to develop absolutely new technology since the pressure of return on investment for R&D is high. They usually just re-invent the previous or existing patents since the investment to a new technology is very costly and time consuming. In brief, the innovation measured by R&D investment per capita has a significant and positive impact on growth of developed countries in long-term, but it doesn’t show a significant impact on growth in developing countries due to possible reasons mentioned above.

Model (VI): After adding the lag one-year of growth and innovation and entrepreneurship into the regression, the impact of both entrepreneurship and innovation on growth is still significant and positive as two previous models. The signs and statistical significance of control variables are as expected.

Discussion: The result of adding both entrepreneurship and innovation into a regression on growth does not change the sign and significance of each individual factor which is carried out in model (IV) and (V). Combining with results of model (III), one can see that both entrepreneurship and innovation shows a positive and significant impact in countries in long-term. The negative or vague effect in short-term will positively repay in long-term. The effect of both entrepreneurship and innovation on growth in developed countries show a stronger evidence than developing countries. This finding is also consistent with the theory of spillage and compensation where the long-term entrepreneurship, innovation or other factors which may affect the technology and productivity level of the economy, through the existence of economic forces, can compensate short-term growth losses.

6. Conclusion

In the context of this study, I examine the impact of entrepreneurship, innovation and their collaboration on economic growth in developed and developing countries (125 countries in total) over the period 2005-2016.

My findings suggest that:

- In the short-term, entrepreneurship has negative impact on growth for developing countries and is not significant for developed countries. The impact of innovation on growth is not significant for both developed and developing countries. When entrepreneurship interacts with innovation, the impact of each factor on growth changes positively which implies a positive supporting between those two factors.
- But in the long-term, the impact of entrepreneurship on growth is positively significant in both groups of countries. The impact of innovation on growth changes from insignificance in the short-term to positive significance in the long-term in developed countries. While its impact is still not significant in developing countries due to possible reasons such as lenient patent protection law, inefficiency in R&D, time consuming or low speed of technology diffusion. The collaboration of both entrepreneurship and innovation does not change the result of each factor on economic growth.

Further to this, my findings also confirm the theory of spillage which is a negative effect of short-term entrepreneurship, innovation or other factors which may affect the technology and productivity level of the economy is offset in the long-term.

In this sense, entrepreneurship and innovation measured by new business density and R&D investment per capita are considered two key instruments for promoting economic growth in both developed and developing countries. Governments need to be patient, because the impact of entrepreneurship and innovation requires a period of adjustment. The long-term benefits will significantly compensate short-term losses. In other words, the time period under consideration matters a lot. In order to achieve the best result, governments should promote both entrepreneurship and innovation at the same time. Especially, developing countries should pay more attention on innovation such as tightening patent protection law, enhancing R&D efficiency, etc., in order to maximize the its benefits.

Limitations

This study is subject to a number of limitations that may have influenced the results or may limit their generalizability. Primarily these arise from limitations of the sample. The dataset of only 11 years may prevent the observation of lag effects that occur only on longer time scales. A larger set of panel data, especially regards to time observations, may be more powerful to investigate and explain the relationship between entrepreneurship, innovation and growth.

In addition to limitations from the time dimension, there exist limitations in the group of countries included in the data. Owing to constraints in the availability of the United Nations and World Bank’s data, the sample just includes a certain subset of developed and developing countries, but the lack countries in transition such as Russia, Ukraine and Azerbaijan is especially unfortunate, as this group of countries may provide useful information in shedding a light on the generalizability of the results in both regional and worldwide perspectives.

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APPENDIX 1A: List of developed countries

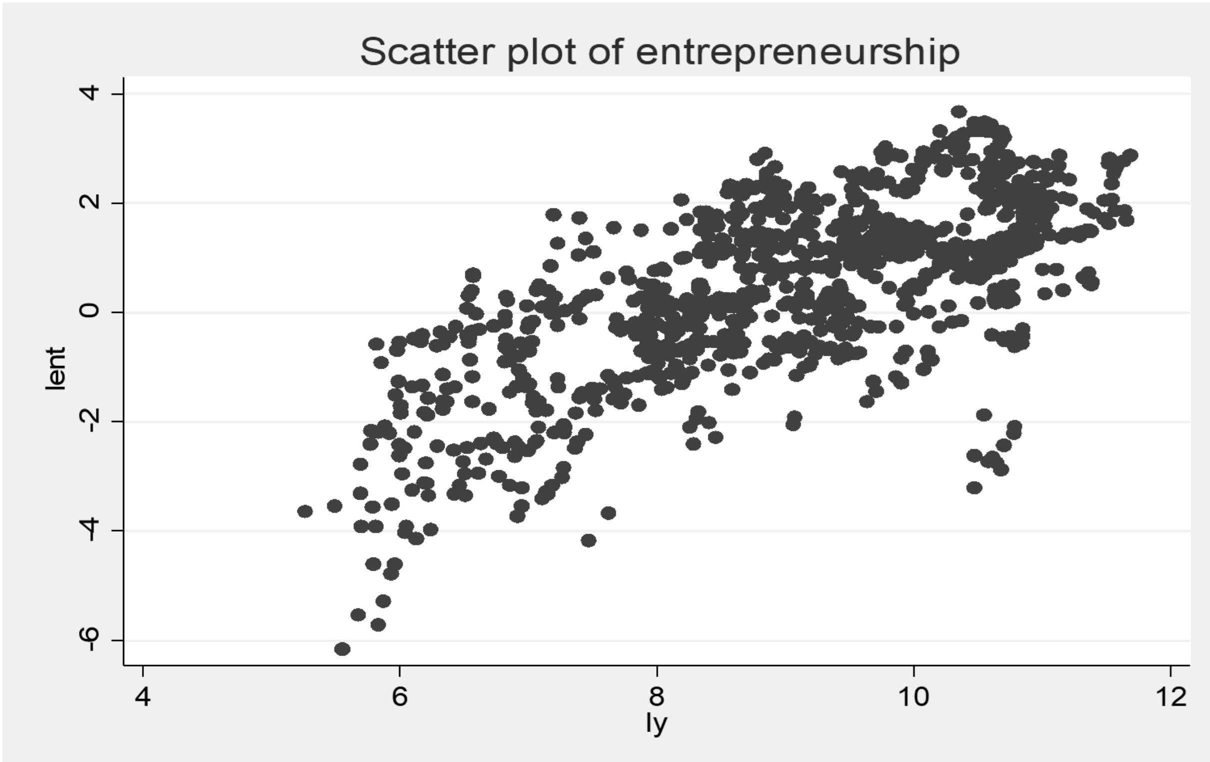
No.	Name of country	No.	Name of country
1	Australia	19	Japan
2	Austria	20	Latvia
3	Belgium	21	Lithuania
4	Bulgaria	21	Luxembourg
5	Canada	23	Malta
6	Croatia	24	Netherlands
7	Cyprus	25	New Zealand
8	Czech Republic	26	Norway
9	Denmark	27	Poland
10	Estonia	28	Portugal
11	Finland	29	Romania
12	France	30	Slovakia
13	Germany	31	Slovenia
14	Greece	32	Spain
15	Hungary	33	Sweden
16	Iceland	34	Switzerland
17	Ireland	35	United Kingdom
18	Italy	36	United States

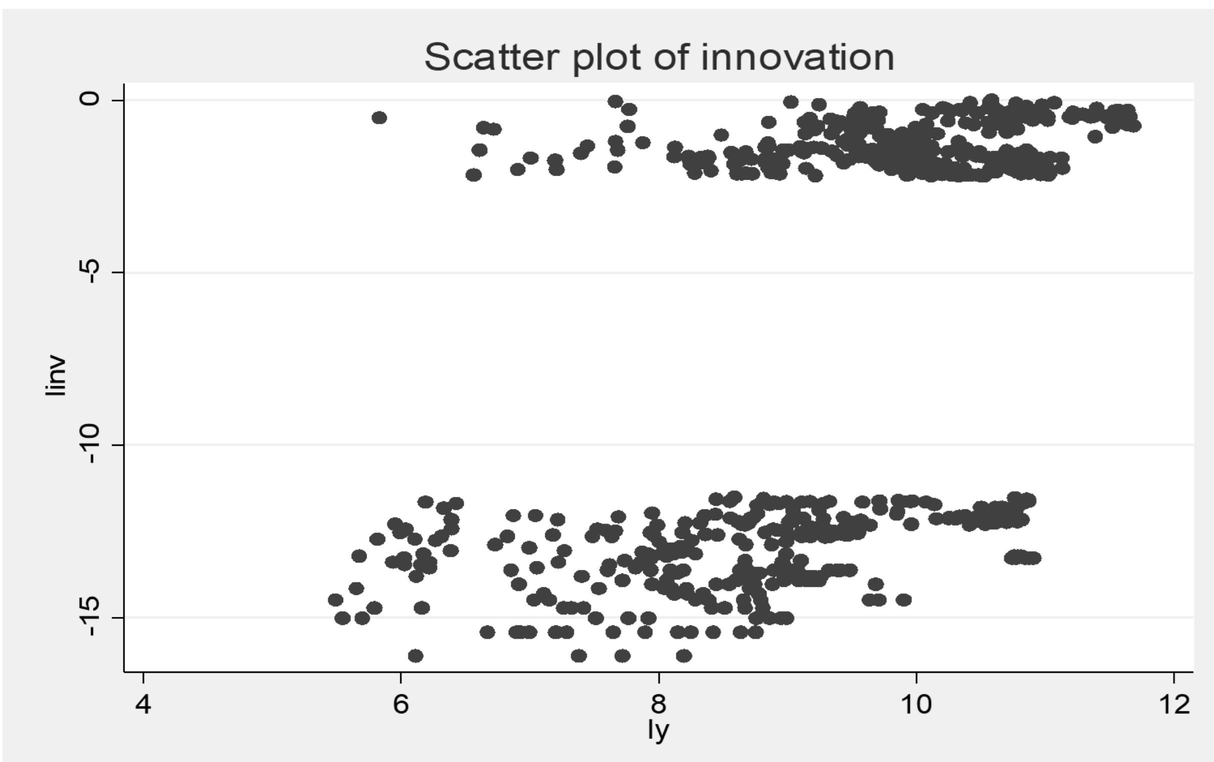
APPENDIX 1B: List of developing countries

No.	Name of country	No.	Name of country
1	Algeria	46	Mauritius
2	Argentina	47	Mexico
3	Bangladesh	48	Mongolia
4	Belize	49	Morocco
5	Botswana	50	Mozambique
6	Brazil	51	Myanmar
7	Brunei Darussalam	52	Namibia
8	Cambodia	53	Nepal
9	Chile	54	Nicaragua
10	China	55	Niger
11	Colombia	56	Nigeria
12	Congo (Democratic Republic of the)	57	Oman
13	Costa Rica	58	Pakistan
14	Cuba	59	Panama
15	Côte d’Ivoire	60	Papua New Guinea
16	Dominica	61	Paraguay
17	Dominican Republic	62	Peru
18	Ecuador	63	Philippines
19	Egypt	64	Qatar
20	El Salvador	65	Rwanda
21	Ethiopia	66	Samoa
22	Gabon	67	Sao Tome and Principe
23	Ghana	68	Saudi Arabia
24	Guatemala	69	Senegal
25	Haiti	70	Sierra Leone
26	Honduras	71	Singapore
27	Hong Kong	72	South Africa
28	India	73	Sri Lanka
29	Indonesia	74	Sudan

No.	Name of country	No.	Name of country
30	Iran (Islamic Republic of)	75	Suriname
31	Iraq	76	Syrian Arab Republic
32	Israel	77	Thailand
33	Jamaica	78	Timor-Leste
34	Jordan	79	Togo
35	Kenya	80	Trinidad and Tobago
36	Korea (Republic of)	81	Tunisia
37	Laos	82	Turkey
38	Lebanon	83	Uganda
39	Lesotho	84	United Arab Emirates
40	Madagascar	85	Uruguay
41	Malawi	86	Vanuatu
42	Malaysia	87	Viet Nam
43	Maldives	88	Yemen
44	Mali	89	Zambia
45	Mauritania		

APPENDIX 2: Scatter plot of entrepreneurship and innovation against growth





APPENDIX 3: Correlations

	ln y	ln ENT	ln INV	ln H	ln K	ln $(n+g+\delta)$
All countries						
ln y	1.0000					
ln ENT	0.5513	1.0000				
ln INV	0.5101	0.5881	1.0000			
ln H	0.8004	0.5689	0.5235	1.0000		
ln K	0.4319	-0.1435	-0.2888	0.2673	1.0000	
ln $(n+g+\delta)$	-0.2424	-0.5460	-0.6810	-0.2726	0.7562	1.0000
Developed countries						
ln y	1.0000					
ln ENT	0.0120	1.0000				
ln INV	0.0943	0.4187	1.0000			
ln H	0.2335	0.0595	0.1499	1.0000		
ln K	0.3856	-0.5565	-0.6017	0.0443	1.0000	
ln $(n+g+\delta)$	0.0111	-0.5926	-0.6716	-0.0295	0.9185	1.0000
Developing countries						
ln y	1.0000					
ln ENT	0.6087	1.0000				
ln INV	0.4780	0.5495	1.0000			
ln H	0.7844	0.5683	0.4509	1.0000		
ln K	0.5062	0.0504	-0.2075	0.3415	1.0000	
ln $(n+g+\delta)$	-0.1777	-0.4150	-0.6425	-0.2012	0.7369	1.0000