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ICT and entrepreneurship: A comparative analysis of developing, emerging and developed countries

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ICT and entrepreneurship: A comparative analysis of developing, emerging and developed countries

Abstract

In this study, we investigate the impact of information and communication technologies (ICTs), represented by ICT capital services, on total entrepreneurial activity (TEA) in developing, emerging and developed countries with particular attention on countries' absorption capacities over the period 2006-2016. First, our results suggest a positive relationship between ICT capital services and entrepreneurship in the whole sample. Second, while the results concerning subsamples are larger in developing and emerging countries than in developed countries, the comparisons do not reveal statistically significant differences in the contribution of ICT capital services to entrepreneurship in these three groups of countries. Thus, regarding the benefits of ICTs in promoting entrepreneurship, developing and emerging countries are not earning more than the developed economies. This challenges the argument that these countries are 'leapfrogging' through ICT. Concerning the absorption capacity, we find that secondary school enrolment is the best channel of ICT entrepreneurial effect, not tertiary school enrolment, and innovation is a complement to ICT in promoting entrepreneurship only in emerging countries and developed countries, but not in developing countries.

JEL Classification: E22, L26, O47

Keywords: ICT, Entrepreneurship, Leapfrogging, Absorption capacities, Panel regressions

1. Introduction

The literature on entrepreneurship is marked by several academic conceptions, and therefore by several definitions (Carlsson et al., 2013; Jonsson, 2014). The theory of entrepreneurship was born with Cantillon (1755), who gave to the concept of entrepreneurship its economic meaning, and to the entrepreneur a role in economic theory (Cornelius et al., 2006). Entrepreneurs were considered to be risk bearers because of the uncertainty of future market prices (McMullen and Shepherd, 2006). Baudeau (1730–1792) then married the concepts of entrepreneur and innovator, arguing that the entrepreneur invents and applies new technologies to reduce costs and raise profits (Shane, 2000; Kirby, 2003). Hence the concept of innovation became dominant in Schumpeter's theorization of entrepreneurship as a bringer of economic change (Toms et al., 2020).

Since the 1930s, the rise of the managerial capitalist paradigm caused many to ignore traditional notions of entrepreneurship in favor of this newer, more formalized approach (Boutiller and Tiran, 2016). Li et al. (2009) summarize three theories of entrepreneurship definition: the “firm creation theory,” the “activity theory,” and the “opportunity theory.”

The firm creation theory conceives entrepreneurship as the creation of a new firm (Alvarez and Barney, 2007; Stephan and Pathak, 2016). This view diverges from a mainstream view in which the founders of a state-recognized entity have reached an advanced level of commitment to the pursuit of a particular business opportunity (Kim and Li, 2014).

The activity theory conceptualizes entrepreneurship as the practice of doing new things, but not as the creation of new firms. For this theory, entrepreneurship can happen both within a firm and in the absence of firm formation. Baker and Nelson (2005) corroborate the activity theory and suggest how entrepreneurs create value in exhausted and penurious environments.

The opportunity theory is represented by Mises (1951), Kirzner (1973), and Shane and Venkataraman (2000), who describe entrepreneurship as “how, by whom, and with what effects opportunities to create future goods and services are discovered, evaluated, and exploited” (Bartz and Winkler, 2016, pp. 196–197).

These three main theories can be grouped into three major schools of thought. First, the German school, represented by Schumpeter (1965) and Baumol (1968), emphasizes the process of “creative destruction” as carried out by entrepreneurs. Second, the neoclassical school, represented by Knight (1921) and Schultz (1980), focuses on the risks and uncertainties associated with entrepreneurial activity. Third, the Austrian school, represented by Mises (1951) and Kirzner (1973), emphasizes the ability of entrepreneurs to discern and utilize market opportunities.

However, the economic crisis that began in the 1970s led to the emergence of a new category of entrepreneurs, for whom creating a business was less the product of an ambitious and well thought-out project, and more of a solution for entering the labor market during a time of structural mass unemployment and job insecurity. This trend has developed in different parts of the world (Wong et al., 2005). As a result, the role of entrepreneurship in the economy has changed over the last fifty years (Stel et al., 2005).

In addition to the three aforementioned approaches for defining entrepreneurship, there are currently other schools of thought that have their own definitions. These include the great person school, the psychological characteristics school, the classical school, the management school, the leadership school, the intrapreneurship school, the rewarding school, the self-employment school, and the judgment school (see Cunningham and Lischeron, 1991; Fayolle 2002; Lu et al., 2020). Table 13A synthesizes these definitions. Each view is singular and important, and provides various insights on the basis of which entrepreneurship can be considered.

A wide range of determinants explains the level of entrepreneurship at the national level. According to Stel et al. (2005) and Djankov et al. (2002), these include administrative charges, entry rules, government support, and financial assistance. Entrepreneurship determinants can also be understood from the perspective of push-type factors (the demand side of entrepreneurship) and attraction-type factors (the supply side of entrepreneurship) (Gordon, 2015). One of the most important factors associated with the demand side of entrepreneurship is technological development, which has been the focus of a strategic plan pursued through investment in ICT. This paper aims to analyze the comparative effect of ICT on entrepreneurship in developing, emerging, and developed countries.

Dynamic and operational capability theory provides a solid framework to conceptualize the capabilities of ICTs to both make business activity more flexible and help make skills more effective for an entrepreneurial dynamic (Dvouletý, 2018). ICT can reduce transaction costs, improve organizational routines, and strengthen relationships with clients and suppliers. It is also the case that exploring and exploiting opportunities for penetration into a new market, forming an alliance, or completing a merger can all be strengthened in global and competitive environments through the emerging implementation of information technology (Alderete, 2017; Alderete, 2014). Finally, ICTs bring to experts, employees, and customers the ability to share knowledge and solve business problems. ICT not only promotes start-up businesses, it facilitates their development and growth (Giudice and Straub, 2011).

In order to measure the impact of ICT on entrepreneurship, most studies use ICT capital stock variables, such as the stock of information technology equipment, communication technology equipment, and software for ICT (Burnham, 2009; Giaoutzi and Vescoukis, 2006). From this perspective, Alderete (2017) finds that ICTs were the best conduits for boosting entrepreneurship in fifty-eight countries from 2007 to 2012. Other studies such as Niebel (2018) and Inklaar and Timmer (2013) used stock variables.

However, to the best of our knowledge, no research has been carried out using the flow variables (i.e., capital services). These flow variables are more appropriate than stock variables, as Inklaar and Timmer (2013) indicate. They find that measures of capital services represent short-lived ICT assets. At the single-asset level, capital service flows and capital stocks are assumed to be strictly proportional (Niebel, 2018). Schreyer (2001) claims that only measures of capital services take the heterogeneity of assets into account at the aggregate level. Another contribution lies in how the data set used is the first for this empirical work. These data come from the Conference Board Total Economy Database and from the Global Entrepreneurship Monitor (GEM). Our ICT asset capital services variable is from the Total Economy Database. The growth of ICT capital services is calculated as the growth rates of actual net stocks of individual assets (information technology equipment, communication technology equipment, and ICT software) weighted by their factor share in total ICT capital compensation. We consider the resource-based view (RBV) theoretical framework in order to understand the importance of ICT access for entrepreneurial activities. The advantage of this theory consists in how it provides a holistic view of the phenomenon, including theories of knowledge, networks, and social capital (Yli-Renko et al., 2002). As for the variable of entrepreneurship, we consider entrepreneurship under the definition of firm creation. More specifically, the number of new firms namely total entrepreneurial activity (TEA) is used as a proxy for depicting entrepreneurship because these are the data we have. However, this constrains our comprehension of why and how entrepreneurs conduct their entrepreneurial activities. We will attempt to respond to the following question: What are the comparative impacts of ICT on entrepreneurship in developing, emerging, and developed countries?

At first glance, there may be serious reasons why the effect of ICTs on entrepreneurship in developing and emerging countries may differ from those in developed countries. The former may lack absorptive capacities, such as an appropriate level of human capital, or other

complementarity factors, such as spending on research and development (R&D). They would thus earn less than ICT investments in developed countries. Second, ICTs may enable developing and emerging countries to “leapfrog” over traditional methods of increasing productivity, as Steinmueller (2001) points out. Additional productivity gains could be generated by “ICT-related spillovers or network effects” (Stiroh, 2002), as ICT can reduce transaction costs and speed up the knowledge-creation process (Pilat, 2004). These network effects may be more pronounced “when many firms in a region or sector use similar levels or types of ICTs” (Draca et al., 2007).

The sample comprises fifty-nine developing, emerging, and developed countries between 2006 and 2016. Thus, it covers more countries and years than previous studies. Section 4 presents the results, including a comparison of the estimated coefficients for the contribution of ICT capital services to entrepreneurship, for both the full sample and for the three subgroups of countries. The results for the full sample of countries confirm the positive contribution of ICT to entrepreneurship. Estimations of the three subsamples reveal only small differences between developing, emerging, and developed countries. However, the results do not reveal statistically significant differences in the contribution of ICT capital to entrepreneurship among these three groups of countries. Hence the “leapfrogging” effect of ICTs on entrepreneurship seems to be unconfirmed in developing and emerging countries, compared to developed countries. Concerning absorption capacity, secondary school enrollment is a better conduit of the ICT entrepreneurship effect than tertiary school enrollment. Innovation acts as a complement to ICT in emerging and developed countries, boosting entrepreneurship. But this does not occur in developing countries. Finally, section 5 provides the conclusions of our study.

The organization of the paper is as follows. After presenting in section 2 the current literature review of the impact of ICT on entrepreneurship, section 3 describes the data set used for the empirical work. We then provide in section 4 the empirical results of the impact of ICT on entrepreneurship in developing, emerging, and developed countries. Section 5 ends the paper with concluding remarks.

2. Related Literature and Theoretical Framework

The concept of entrepreneurship is widely used in the academic literature, even though the definition of this conceptual framework lacks consensus (Shane and Venkataraman, 2000). Many studies have focused on entrepreneurship in different fields and use a variety of methodological approaches (Acs and Audretsch, 2003; Acs and Szerb, 2007; Karatas-Ozkan et al., 2014; McDonald et al., 2015; Shane and Venkataraman, 2000; Wennekers and Thurik, 1999; Zahra, 2007). It is therefore very difficult to give a single definition of entrepreneurship (Friis et al., 2006; Spencer et al., 2008).

In summary, several theories underpin the broader theory of entrepreneurship, including the firm creation, activity, and opportunity theories, all of which we established earlier. According to the firm creation theory, entrepreneurship is “risk taking and responsibility in the design and implementation of a business strategy or the creation of a business” (Schumpeter, 1912). As for opportunity theory, entrepreneurship helps to generate lucrative opportunities; according to Shane and Venkataraman (2000), it defines entrepreneurship as the scientific examination of how opportunities to create goods and services are identified, evaluated, and exploited, and with which effects. For Schumpeter (1935), the entrepreneur is the economic agent who realizes “new combinations of factors of production,” which are all investment opportunities: manufacture of new goods; introduction of a new production method from one industry to another; opening new outlets; the conquest of a new source of raw material or semi-finished products; and creation of a new organization (e.g., formation of a monopoly). The activity

theory understands entrepreneurship to consist in doing new things within firms or without firm creation.

Research shows that such factors as culture, economic conditions, institutions, technological advances and educational attainment impact entrepreneurship (Bettignies and Brander, 2007; Gentry and Hubbard, 2000; Harper, 1998; McMillan and Woodruff, 2002; Shane, 1996.). For instance, Kaufmann et al. (2006), Nyström (2008), Acs et al. (2005), Audretsch and Thurik (2001), Furman et al (2002), and Thurow (2003) show that good institutions, a high level of economic development and technological progress are positively related to national entrepreneurship rates. Several other studies show that these same factors have a negative relationship (Naudé, 2011; Wong et al., 2005), a U-shaped relationship (Wennekers et al., 2005) or even no relationship at all (Stel et al., 2007). According to Cowling and Bygrave, 2003), when unemployment rates are high, entrepreneurs' rates will be high (Cowling and Bygrave, 2003) because the population does not find alternative sources of employment (Llisterri et al., 2006). With regard to innovation, the process of transforming new ideas and knowledge into new products and services (Schumpeter 1934) means that business opportunities are more likely to emerge in sectors where innovations are being developed (Schumpeter, 1939). Moreover, according to human capital theory, higher-quality human capital should have a superior ability to exploit opportunities successfully (Davidsson and Honig, 2003). Concerning institutional factors, the rules governing the economic activity within the environment guide entrepreneurial activity (Bowen and Clerq, 2005).

ICTs, on the other hand, include a broad range of product and service technologies, including computer hardware, software and services. ICTs include wired and wireless products and services, as well as satellite-based products (Schreyer, 2001). The rapid spread of ICTs has led to significant changes in the way goods and services are produced, in the nature of the goods and services produced, and in the means by which goods and services are brought to the market and distributed to customers. Over the last decade, the growth of the digital economy has been the key driver of structural change and economic growth at the national and regional levels in developed and industrialized economies.

However, there are substantial differences between countries and regions regarding their roles in ICT development and their propensity to adopt and apply ICT in various sectors and activities (Huang, 2011). 'Technology leapfrogging' refers to the adoption of advanced technology in an application area where the immediately prior technology has not been adopted. Discussions of ICT leapfrogging have largely focused on developing countries, which generally lag in technology adoption. Unlike the developed countries, they are not inhibited by entrenched intermediate technology. Advanced technology provides developing countries with the opportunity to accelerate economic development (Hanna et al., 1995). It has also been suggested that developing countries do not have any alternative in adopting technology except to leapfrog to advanced technologies (Davidson et al., 2000). The concept of technology leapfrogging for ICTs first emerged in the early 1990s (Mody and Dahlman, 1992).

However, research in this area is still limited, hindered by a lack of clear empirical data from developing countries, measurement difficulties, the relatively short period of newly emerged and advanced ICTs, and the long time needed to gather reliable data to understand technology leapfrogging in developing countries (Alzouma, 2005). As a result, technology leapfrogging remains a controversial concept. For example, in Africa, Chisenga (2000) believes that implementing this concept would facilitate global integration of businesses and provide a better learning environment for African children, besides benefiting the economy. However,

Chisenga (2000) also believes that investments in ICT compete with providing necessities for the poor. One argument against leapfrogging has been that it might be an expensive trajectory in the short run for developing countries, which tend to carry large debt burdens (Chen et al., 2004).

Hence, the availability of ICT is associated with the production of accessible digital resources (Alderete, 2017). ICT could contribute to a vast amount of information processing transformation, storage, and exchange. Accordingly, with the rapid diffusion of ICT, a large volume of valuable market information, including multimedia data, could be easily and quickly accessed by entrepreneurs. Additional productivity gains could be triggered by ICT spillovers, including network effects, reduced transaction costs, promotion of better decisions, faster innovation, and increased competitiveness (Niebel, 2018). Many policies have been developed to support entrepreneurship, both in general and in specific sectors related to ICTs (McQuaid, 2002).

Therefore, ICT plays a pivotal role in cultivating the emergence of business ideas or opportunities. Previous studies have shown a strong correlation between ICT diffusion and the development of new businesses (Giudice and Straub, 2011). The availability of ICT shows how important the opportunities to gain information and knowledge are in an economy. Extensive support for ICT infrastructure would create many opportunities for entrepreneurs to conduct business and stimulate new entrepreneurial activities. Along with the rise of the Internet, smartphones and cellular networks, more and more people have done business online. According to a report from China (<https://www.business.hsbc.com/china-growth>), the number of small businesses relying on online transaction platforms exceeded 10 million in 2015, and the total revenue of these businesses reached over 180 billion RMB (Chinese currency – Renminbi Yuan). That was expected to double in 2016. Because of ‘social influence’ in an entrepreneur’s interactions with others, the entrepreneur can be motivated to learn and adopt ICTs that other peer entrepreneurs have used in their own business activities. By examining a sample of 282 Argentinian entrepreneurs, Fornoni et al. (2012) recognize that social capital can facilitate access to financing for businesses.

For the development of entrepreneurial activity, we highlight the advantages of the ICT through the social and commercial interactions that it could generate with its users. Thus, the entrepreneur can develop powerful incentives and knowledge to adopt the same technologies (Wang et al., 2009). As a result, in a country with greater access to ICT, entrepreneurs are more likely to adopt ICT tools and use them more. They are more likely to exploit market information and commercial opportunities available on ICT infrastructure (Giudice and Straub, 2011). Moreover, ICTs allow entrepreneurs to gain real-time market insight and improve their responsiveness (Luo et al., 2012; Chen et al., 2015; Nazir and Pinsonneault, 2012). ICT use can enhance business opportunities (Reuber and Fischer, 2011) and reduce transaction and communication costs (Niebel, 2018). Thus, the availability of ICT can extend the market scope and enable international entrepreneurship (Reuber and Fischer, 2011). ICT infrastructure provides a ubiquitous platform for customers, suppliers, and other business partners to connect with one another so that the efficiency and effectiveness of information exchange, communications, and collaborations could be improved (Agarwal et al., 2009). Effective communication and information exchange enable entrepreneurs to coordinate with various participants in entrepreneurial activities, reduce entrepreneurial uncertainties, and enhance the possibility of entrepreneurial success (Chen et al., 2015). Carrillo and Gaimon (2004) point out that firm resources and capabilities, efficiency, and effectiveness require coordination and management of ICT systems.

However, studies of the impact of ICT on entrepreneurship are still rare (Alderete 2017). Burnham (2009) analyses the causal links between economic growth, the climate for innovation and entrepreneurship, and the deployment of technology, with specific reference to telecommunications. Giaoutzi and Vescoukis (2006) examine the role of ICT in building entrepreneurial capacity. Those authors recognise that ICT and entrepreneurship are tied together. Recently, Alderete (2017) examines whether mobile broadband can be viewed as an enabling technology for entrepreneurship in developing and developed countries. She finds that mobile broadband ensures better reach and lower costs, and it ultimately brings ICT benefits to entrepreneurs.

Much of the studies on the effects of ICT have been based on Schumpeterian neo-classical theories with the effects of incremental innovation induced by ICT (Laursen and Meliciani, 2010), or theories of knowledge (Pieri et al., 2018), or network theory for dealing with social capital (Bratkovic et al. 2009). Those studies independently analyse the effects of innovation, knowledge and social capital generated by ICT. So, they can take a holistic view of the phenomenon. A theory based on resources encompasses three aspects: the knowledge-based view (Spender and Grant, 1996), dynamic capabilities (Teece et al., 1997) and innovation theory based on information (Johannessen et al., 1999). Thus, in this article, we argue that the importance of access to ICT for entrepreneurial activity is better explained and understood from theoretical perspectives, namely RBV (Wade and Hulland, 2004; Rivard et al., 2006). Drawing upon the logic of RBV, Barney (1991) and Zhang and Greve (2018), prior studies have identified and examined ICT as a crucial source of valuable and heterogeneous resources, which may help a firm gain the advantages of ICTs. ICTs are technologies for improving entrepreneurship (Alderete, 2014; Shane, 2003; Ardichvili et al., 2003; Kotelnicov, 2007). ICT not only facilitates start-up businesses but it also improves their development and growth (Giudice and Straub, 2011). We consider entrepreneurship to be a process of building new firms and recognising opportunities to create value in newly firms (Alderete, 2017). This concept will define an entrepreneurial economy, which requires the availability of economic resources, such as human and technological capital (Alderete, 2017). Hence, ICT increases entrepreneurial activity, so a positive relationship between ICT capital services and entrepreneurial activity is expected. Hence, we formulate the following hypothesis:

H1: The higher the amount of ICT capital services, the higher the TEA.

Niebel (2018) argues that in developing countries, gains in economic growth because of ICT investments are lower because of the lack of absorptive capacities, such as an appropriate level of human capital or complementary factors such as R&D expenditures (Keller, 2004), health status and infrastructure. In contrast, in high-income countries, richer complementary inputs to ICT and fairer environments could boost venture creation, (Caroli and Van Reenen, 2001). Hence, the economic development of a country tends to facilitate the emergence of new industries and technologies. This creates opportunities for small businesses. A higher level of development for a country can encourage and strengthen entrepreneurial activity (Acs and Varga (2005). Hence, we formulate the following hypothesis:

H2: ICT capital services affect entrepreneurial activity differently, according to a country's level of economic development.

3. Data, Variables, Descriptive Statistics, and Empirical Method

3a. Data

We use TEA from the Global Entrepreneurship Monitor (GEM) database, following Alderete (2017). This comprises the number of adults 18–64 years old per 100 involved in nascent and/or young firms (in the case of both types of firm, it is still counted as one active person). There is another database that measure entrepreneurship, the World Bank Group Entrepreneurship Survey (WBGES). This article uses the GEM database because of the comparison of the two by Acs et al. (2008). GEM data consider the informality of entrepreneurship, especially in developing countries, many of which host large informal sectors. Informality means starting a business without necessarily registering it. GEM data consider a wide range of entrepreneurial activities. They include from companies that operate in the formal sector but with a legal status different from being a limited liability company (LLC), businesses that are part of the informal economy, and entrepreneurial initiatives at a very early stage that might grow to operate in the formal sector.

The ICT variables are ICT capital services (*ICTc*) and non-ICT capital services (*Non ICTc*) and (Niebel, 2018; Colombo et al., 2013) from the November 2017 update to the Conference Board Total Economy Database (<https://www.conference-board.org/data/economydatabase/index.cfm?id=30565>) (The Conference Board, 2018). This database was developed by the Groningen Growth and Development Centre (<http://www.rug.nl/ggdc/overview-databases/ted>), and it has been maintained by the Conference Board since 2007.

ICTc and *Non-ICTc* are calculated as growth rates of actual net stocks of individual assets (information technology equipment, communication technology equipment and ICT software) weighted by their factor share in total ICT capital compensation (non-ICT). Our data were collected in 59 countries from 2006 to 2016.

3b. Control variables

Several control variables may influence the entrepreneurship that we account for in our analysis. They are similar to those of Alderete (2017), namely:

i. Economic Development: the growth rate of the real GDP ratio on the total population's per capita GDP in constant 2011 \$US (Audretsch and Thurik 2001; Stel et al. 2007). These data are from the World Bank (2018). Gross domestic product is included to control for differences in economic development in the various countries.

ii. Unemployment (Carree and Thurik, 2003; Thurik et al., 2008): rate of unemployment as a percentage of the total labour force. Unemployment refers to the share of the labour force which is not working but is seeking employment. When unemployment rates are high, there will be a high number of 'necessity entrepreneurs' (Cowling and Bygrave, 2003). It is expected, *ceteris paribus*, that higher unemployment rates will lead to higher rates of firm formation (Listerri, 2006). This contrasts with the so-called prosperity-pull hypothesis, which could have a negative relation to unemployment.

iii. Trademarks: these reflect innovation from entrepreneurial activity (Thurik et al., 2008; Acs and Audretsch, 1989; Shane, 2003). A trademark is a distinctive sign which identifies certain goods or services as those produced or provided by a specific person or enterprise. They

are filed with a national and regional Intellectual Property (IP) Office. The number of trademarks is not corrected for the size of the country or the economy, making the measure incomparable across countries. As a result, the measure is highly skewed as can be seen from the tables of descriptive statistics. Therefore, we use a logarithmic scale for trademark data (WIPO, 2018).

iv. The secondary gross enrolment ratio: the total enrolment in secondary education, regardless of age, expressed as a percentage of the eligible official school-age population. It corresponds with secondary education in a school year. This measure of human capital (Bishop and Brand, 2014; Davidsson and Honig, 2003; Audretsch's, 1995; Audretsch and Lehmann, 2005; Acs and Armington, 2006; Shane and Venkataraman, 2000) is one of the ICT skill indicators published by ITU.

v. DaysDB: the number of days for starting a business, from the World Bank's Doing Business reports 2018. It purports to measure the time spent starting a business in a country (Alderete, 2017). This indicator examines the regulations that enhance business activity and those that constrain it. It can be compared across 183 economies and over time (The World Bank Doing Business Reports, 2018). A high number of days is less conducive to starting and operating a local firm.

3c. Descriptive Statistics

Tables A1, A2, A3 and A4 report descriptive statistics for the full sample and the three subgroup of countries for the sample period from 2006 to 2016. The average TEA is 0.753114 in developing countries. It had the minimum value of 0.024221 (for Pakistan in 2009) and a maximum value of 3.888000 (for Peru in 2012). For the emerging countries, this average is 2.918111 ranging from 0.040000 to 21.30900. The highest average of TEA was 5.315511 for the developed countries.

ICT capital services, the main variable of interest, show a similar average growth rate of 80.44% and 44.31% in developing and developed countries, respectively. This number is lower in emerging countries at 19.00%. It should be noted that in the sample from Niebel (2018), from 1995 to 2010, the average growth rates of ICT capital services are 18 and 17% in developing and emerging countries, and 11% in developed countries. Therefore, developed countries have improved since 2010, and emerging countries have seen a decline in ICT capital services.

3d. Empirical method

To explore the relationship between TEA and its predictors, with a special interest in ICT capital services, the baseline specifications are fixed effect (FE), random effects (RE), and S-GMM, as given in the following formulas:

$$\begin{aligned} TEA_{it} &= \beta_0 + \beta_1 ICT_{it} + \beta_2 X_{it} + \mu_t + \delta_i + \varepsilon_{it} \\ TEA_{it} &= \beta_0 + \beta_1 TEA_{it-1} + \beta_2 ICT_{it} + \beta_3 X_{it} + \mu_t + \delta_i + \varepsilon_{it} \end{aligned} \quad (1)$$

where i refers to the country and t refers to the time from 2006 to 2016. μ_t is a time-specific effect, δ_i is unobserved country-specific fixed effect, and ε_{it} is the error term. Note that X_{it} is the matrix of the control variables previously listed. As a reminder, the variable of entrepreneurship is TEA; the two variables of ICTs are ICT capital services (ICT_c) and Non-

ICT capital services (*Non_ICTc*). The time dummy variables control for common shocks affecting (almost) all countries, such as the global financial crisis of 2007–2008, and they are integrated fixed effect and random effect.

We used FE, RE and GMM regressions for the sake of robustness. This is because FE considers individual, unobservable characteristics, known as ‘unobserved heterogeneity’. The RE model takes the covariance problem fully into account. This specification assumes that group effects follow a certain distribution (in general, it is a normal distribution) over all the groups. We therefore simply estimate the variance of these groups.

Besides FE and RE, we use GMM estimates for robustness. This approach was chosen because it answers some questions specific to our data and model, particularly the issues of lagged dependent variables, unobserved fixed effects and independent endogenous regressors. It also reflects heteroscedasticity and autocorrelation between and within individuals or countries (Roodman, 2009).¹ Arellano and Bover (1995) and Blundell and Bond (1998) developed the GMM system by including a level equation. The different equations use the lagged levels of the regressors as instruments and the level equation uses the lagged differences of the regressors as instruments. Efficiency is achieved by using additional instruments, and GMM assumes that the different variables used as instruments are not correlated with country-fixed effects. We use a robust two-stage estimation that adjusts standard errors for autocorrelation and heteroscedasticity.² The first is the Sargan/Hansen test for the over-identification of restrictions. The second examines the hypothesis that there is no second-order serial correlation in the first-order lagged residuals. To avoid the problem of instrument proliferation (Roodman, 2009), the instrument matrix is reduced, and the number of delays is set at a level that ensures that the number of instruments is less than the number of cross-sections.

The econometric analysis is carried out for the full sample, as well as for the subsamples. The classification of countries according to their income levels in Table 12A is based on the classification developed by the World Bank (<https://databank.banquemondiale.org/source/world-development-indicators>).

4. Empirical Results, Discussion, and Implications

Before presenting the results of our estimates, our primary concern is to test for multicollinearity between the different predictor variables. We perform the variance inflation factor (VIF) test after the regression for the whole sample in a fixed-effects model to check for multicollinearity. The results are presented in Table 11A. These results show that the VIF statistics are all less than 3 (Kennedy, 2008). This allows us to conclude that there is no multicollinearity and autocorrelation problem between our predictors.

Table 1 presents the results for the equation (1) estimation of the full sample for the period 2006-2016 using FE, RE and S-GMM methods. Our findings show that TEA is positively related to ICT capital services, regardless of the estimation method used. These results support hypothesis H1, which states that the higher ICT capital services, the higher the TEA. For example, for the FE estimation (column 1), the coefficient is 0.629 at the 1% level of

¹ See also Harris et al. (2008) for an overview of different dynamic panel models.

² Note that country-fixed effects are not explicitly included in GMM estimations. The system includes equations in levels and differences. They are purged in the differenced equations, and they are not introduced in the level equations since they would introduce bias (Roodman, 2009).

significance. Hence, ICTs have the potential to drive entrepreneurship by promoting the formation of TEA. This result is consistent with Alderete (2014) and Leitao and Baptista (2011), who find a positive relationship between entrepreneurship and ICT.

Insert table 1

Comparing the contribution of ICT to entrepreneurship in developing, emerging, and developed countries is the primary goal of this paper. Therefore, in the next step, equation (1) is estimated for each subgroup of countries individually.

Tables 2, 3 and 4 present the results for the subsample regressions for the three subgroups of countries – developing, emerging, and developed countries – for the period from 2006 to 2016. The results confirm hypothesis H2. Hence, the coefficients for ICT capital services show modest differences between the subgroups of countries. Table 2 shows that developing countries have higher levels of the ICT effect on TEA than emerging countries (table 3) and developed countries (table 4). For example, in FE the coefficients are 0.653 for developing countries, 0.432 for emerging countries and 0.403 for developed countries, in tables 2, 3, and 4, respectively. For the other estimates (RE and S-GMM), the results suggest that the effect of ICT capital services on entrepreneurial activity is overall greater in developing countries than in emerging and developed countries. ICT capital services enhance more entrepreneurial activity in developing countries than in developed and emerging countries (Alderete, 2014). Mobile subscriptions have doubled in the last two years and now exceed mobile subscriptions in developed countries. Hence, mobile technologies are playing a growing role, and thus affect entrepreneurship. ICT capital services enable, for example, people who do not have access to the Internet to develop the skills needed to compete in the 21st century and thus create new economic opportunities (Alderete, 2017). Using mobile phones has also helped many entrepreneurs reduce costs and improve their processes (Essegbey and Frempong, 2011). In many developing countries, for example, farmers are using mobile phones to find the best prices for their products (Kotelnicov, 2007). In many developing countries, micro-credits used to purchase mobile phones have led to significant entrepreneurial activity. In recent times, the growing penetration of smartphones and tablets has led to the growing role of mobile applications, which are becoming the key drivers of the mobile industry. One of the best-known ICT applications is mobile banking. This tool helps banking systems reduce transaction costs. It allows small business owners to save time and money while providing more complete and up-to-date information for business decision-making (Wright and Ralston, 2002).

Moreover, the coefficient of the effect of ICTs on entrepreneurship between the three subsamples could be explained by the concept of leapfrogging. In industrial organization, Dimelis and Papaioannou (2011) and Fudenberg et al. (1983) mainly have developed that concept. They analyze the conditions under which a new entrant can skip an established business. The main idea is that minor and incremental innovations could lead a dominant company to stay ahead. However, radical innovations sometimes allow new businesses to overtake the old and dominant businesses. Hence, developing countries, with their incremental innovations of ICT use, could lead to more entrepreneurial activity than occurs in emerging and developed countries.

Insert table 2

Insert table 3

Insert table 4

Thus, we would like to test whether the differences between the coefficients of the three subgroups are due to hazard or whether they are significantly robust.

We test whether to keep the FE model or the RE model. To do so, we perform the Hausman test for the whole sample, for developed countries, emerging countries and developing countries. The results are presented in Table 10A. All the results show that the probabilities of the test each time are lower than 1%. Therefore, FE models are preferable to RE models. So, for the rest of the estimations, we use FE models, (Arellano, 1993).

The steps to perform an equality FE test to compare ICT coefficients in the three subgroups of countries (that is, a Chow-type test on the differences in ICT coefficients between subgroups of countries) are as follows: (1) estimate the OLS FE regression with the country; (2) estimate a regression apparently uncorrelated to the using of the Stata *suest* command; and (3) test if the difference between the country pair coefficients is zero (Niebel, 2018). We use only FE models because the Chow test is not available for a GMM model. All tests of the country pairs do not reject the differences between the ICT coefficients being zero. Thus, although the ICT coefficient of 0.653 in FE is larger in developing than in developed (0.403), and emerging countries (0.432), the differences are not statistically significant (table 9A). For example, regarding the Chow-type test on the differences in ICT coefficients between subgroups of countries on benefits of ICTs in promoting entrepreneurship, developing and emerging countries do not earn more than developed economies. This calls into question the argument that these countries are ‘leapfrogging’ through ICTs.

Whatever the results for each subgroup, a positive effect occurs for ICT capital services on entrepreneurial activity. This has important implications for theory, managerial practice and policy that are addressed in the following paragraphs.

ICTs are a field of research that require further investigation. Governments must strive to invest in innovation, including education and training and R&D. Economic policies must ensure the ICT the right conditions for expanding business start-ups, on the one hand, and they should support ICT universalization, on the other. This means promoting entrepreneurship at the micro and macro levels. Governments and regulatory organizations can exploit new technologies by promoting e-government and endorsing applications to transform public services. In doing so, entrepreneurs can access government information, saving time and reducing transaction costs through mobile applications.

In addition, the desire to promote entrepreneurship highlights the additional benefits of ICT capital services, and it adds new reasons to reduce the digital divide. This political involvement is particularly useful in developing countries, emerging countries and, eventually, developed countries, which also need to implement initiatives for ICT capital services, especially in rural areas. The better the technological ICT capital services, the greater the entrepreneurial opportunities to exploit. Among other policies, governments can promote competition in the ICT capital services sector by reducing barriers to acquiring new technologies. This policy is needed to reduce tariffs and expand the ICT infrastructure.

Moreover, the model controls for variables such as GDP per capita. The results in table 1 show an overall positive relationship between TEA and GDP. This finding is similar to those from Thurow (2003), who found a significant relationship between the level of development of a country and the entrepreneurship rate. Concerning the other explanatory variables of entrepreneurship, unemployment does not significantly increase TEA, regardless of the model

and the sample considered. The rest of the independent variables (such as Trademarks, Secondary, and Ndays) significantly and positively affected entrepreneurial activity in all the developing, emerging and developed countries.

It is often pointed out that in developing countries and emerging countries, the level of human capital and complementary factors such as R&D expenditures do not favor the positive effect that ICTs should have. Thus, in the following sections, we explore whether absorptive capacities, i.e. human capital and R&D, are complementary to ICT.

In addition, for the rest of our study, we keep the estimates obtained from the FE method because the Hausman test shows a favorable result for this model. The FE model is also preferred in our case: Using country FE, i.e., capturing country specificities that are fixed through time, is very useful to control for unobservable characteristics, such as cultural, institutional and policy drivers.

4a. Controlling for the effect of education

As mentioned with regard to the Chow test, developing countries do not benefit more from ICTs to boost entrepreneurship compared to developed and emerging countries. This result questions the fundamental differences between the countries and the relevance of the concept of 'leapfrogging' through ICTs. One difference between the high and middle-income countries and the low-income countries stems from the technical skills of the employees. Therefore, it would be interesting to investigate the role of education or the quality of human resources in enhancing the effect of ICTs on entrepreneurship.

Another interesting question is to explore the potential interdependence of education levels and ICTs in fostering entrepreneurship in each subsample. In other words, are there some indirect or cumulative effects of ICTs and the levels of education on entrepreneurship in these different subsample countries? To check this hypothesis, we introduce into the baseline model an interaction variable for ICTs and those for the quality of education (secondary and tertiary school enrolment: ICT* secondary; ICT* tertiary). We then test their significance.

Insert table 5

Insert table 6

The results are reported in tables 5 and 6. They suggest that education enhances ICT effects and thus boosts TEA. Through education (i.e. schooling), individuals gain fundamental skills (Ardichvili et al., 2003; Shane, 2000), develop learning and organization skills to become familiar with markets and technology, and recognize the opportunities offered by the environment (Shane, 2000). They exploit these opportunities (Grant, 1996) to create entrepreneurial activities (Alvarez and Barney, 2007). Moreover, education helps to exploit opportunities by acquiring financial resources for starting businesses (Bruns et al., 2008; Dimov, 2010). Education contributes to the accumulation of new knowledge, and it generates benefits for TEA (Bradley et al., 2012; Corbett et al., 2007).

It should be noted that, regardless of the countries considered, more new businesses are created when enrolment rates in secondary education increase. Secondary education qualifications lead to better evaluation and exploitation of business opportunities. However, the enrolment rates in tertiary education do not have a significant effect on the creation of new businesses. This result is consistent with those of Jimenez et al. (2017). Those with more

education look for paid work opportunities, while those with less education are more inclined to entrepreneurial opportunities.

4.b Controlling for the effect of innovation

R&D also has been considered as absorptive capacity. This refers to the ability of companies to benefit from the new knowledge created in neighboring firms or industries (Griffith et al., 2004; O'Mahony and Vecchi, 2009). Thus, discussions of the relationship between ICT, R&D, and entrepreneurship suggest complementarities between the two innovative assets: ICT and R&D (Polder et al., 2010; Corrado et al., 2017).

In this section, we contribute to these new developments by investigating whether ICT and R&D act as complementary factors that boost TEA. To address this question, we include the specification of an interaction term in the efficiency component of model 1. Although there are several traditional indicators of innovation, such as R&D, there are a lot of missing data on R&D expenditures in the database of World Bank development indicators (WDI). This renders the expenditure data in R&D unusable over our study period. So, instead of R&D, we use another proxy of innovation, namely 'patent applications', because patent application data for our study period are more available. We use the logarithmic form of patent applications so this metric has the same order of magnitude as the other variables. We also use trademarks as another proxy of innovation because those data also are more available than R&D data.

The results are reported in tables 7 and 8. They show that the interaction between ICT and R&D is positive and statistically significant. This indicates complementarities between the two assets for increasing technical efficiency and boosting TEA.

These findings suggest that ICT may complement R&D in the reorganization of production during the innovation process, consistent with Polder et al. (2010) and consequently foster entrepreneurship (Corrado et al., 2017). Our results also support the evidence from Chen et al. (2016), who found that industries with more intense ICT usage enjoy larger returns on R&D and other organizational investments.

Furthermore, we note that the coefficients of interaction are larger in emerging and developed countries than in developing countries. This would suggest that absorption capacities are more important in emerging and developed countries than in developing countries. Developing countries should be encouraged to make more investments in innovation for 'leapfrogging' through ICT.

Insert table 7

Insert table 8

5. Conclusion

In this study, we analyze whether ICTs affect entrepreneurship with a particular focus on the role of countries' income levels and capacity for absorption. Given that very few studies have focused on ICT capital services, this paper investigates their importance for entrepreneurial activity based on a sample of 59 countries over the period from 2006 to 2016.

The regression of the full sample of countries reveals that ICT-Capital services enable the increase of entrepreneurship. First, this article is one of the first attempts to validate empirically the positive impact of ICT capital services on entrepreneurship.

Second, the fundamental question is whether the gains from ICT capital services differ in developing, emerging, and developed countries. This question is answered by performing several independent regressions for subsamples of developing, emerging and developed countries and then testing the equality of estimated coefficients across subgroups of countries. Regressions for the three country subsamples reveal fairly small differences in the contribution of ICT capital services to entrepreneurship in developing, emerging, and developed countries. Although the coefficients are slightly larger for developing and emerging countries, there is no clear statistical indication that developing and emerging countries benefit more from ICT capital services than developed economies.

In developing and emerging countries, the effect of ICT on entrepreneurial activity is greater than in developed countries. However, this difference is not statistically significant. Therefore, developing and emerging countries should be encouraged to adopt ICTs to take advantage of this effect. This could be realized through capacity absorption and enhancement of ICT infrastructure.

In developed countries, one of the most important measures for governments to consider is to continue to promote entrepreneurship in the Fourth Industrial Revolution by facilitating administrative procedures for business creation. States must also reduce the tax barriers to the formation of new business by transforming and digitizing all public services to facilitate access. This will allow more open communication for entrepreneurs in the administrative process. One development track may also be framing and facilitating the granting of credit to these new organizations. Entrepreneurs need a boost to start in the promising sector of ICT.

In our testing for absorption capacity, the results show that secondary school is the best channel for boosting the ICT entrepreneurial effect, rather than tertiary school. Moreover, innovation fosters the entrepreneurial effect in emerging and developed countries, but not in developing countries. Hence, public authorities in developing countries must reinforce the importance of continuous training, particularly towards entrepreneurship. This will help their people capture and sustain the productivity they need to increase entrepreneurship (Díaz-Chao et al., 2015).

Insert Appendix

Table 1A

Table 2A

Table 3A

Table 4A

Table 5A

Table 6A

Table 7A
Table 8A
Table 9A
Table 10A
Table 11A
Table 12A
Table 13A

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Table1. Dependent variable: Total Entrepreneurial Activity (TEA),full sample over 2006-2016

Variables	FE	RE	S-GMM
TEA(-1)			0.205** (0.038)
ICTcapserv	0.629*** (0.008)	0.716*** (0.011)	0.629*** (0.195)
N.ICTcapserv	0.028* (0.010)	0.053** (0.031)	0.045** (0.018)
GDPgpercapita	0.081** (0.003)	0.036** (0.014)	0.512 (0.081)
Trademarks	0.181** (0.005)	0.089* (0.001)	0.235*** (0.040)
Secondary	0.004** (0.001)	0.217** (0.012)	0.226*** (0.016)
Ndays	-0.407* (0.083)	-0.107 (0.003)	-0.230 (0.016)
Unemployment	0.017 (0.012)	0.105 (0.028)	0.321 (0.109)
Constant	2.038*** (0.077)	3.083 (0.094)	1.851*** (0.726)
Year Dummies	Yes	Yes	
R ²	0.524	0.435	
Observations	649	649	602
p-value AR(1)			0.001
p-value AR(2)			0.760
p-value (Sargan test)			0.000
P-value (Hansen test)			0.980

Clustered standard errors in parentheses, *p < .10, **p < .05, ***p < .01.

Table2. Dependent variable: Total Entrepreneurial Activity (TEA), developing countries over 2006-2016

Variables	FE	RE	S-GMM
TEA(-1)			0.313* (0.048)
ICTcapserv	0.653** (0.002)	0.661** (0.097)	0.357*** (0.012)
N.ICTcapserv	0.053 (0.004)	0.414** (0.032)	0.501 (0.106)
GDPgpercapita	0.208*** (0.051)	0.621*** (0.093)	0.108*** (0.084)
Trademarks	0.072*** (0.021)	0.054*** (0.009)	0.671*** (0.451)
Secondary	0.103* (0.048)	0.808* (0.060)	0.455* (0.099)
Ndays	-0.129*** (0.015)	-0.151*** (0.052)	-0.075*** (0.006)
Unemployment	0.507 (0.146)	0.087 (0.005)	0.615 (0.145)
Constant	2.094 (0.183)	3.011*** (0.168)	1.037** (0.140)
Year Dummies	Yes	Yes	
R ²	0.485	0.493	
Observations	165	165	148
p-value AR(1)			0.001
p-value AR(2)			0.758
p-value (Sargan test)			0.000
P-value (Hansen test)			0.860

Clustered standard errors in parentheses, *p < .10, **p < .05, ***p < .01.

Table3. Dependent variable: Total Entrepreneurial Activity (TEA), emerging countries over 2006-2016

Variables	FE	RE	S-GMM
TEA(-1)			0.713* (0.005)
ICTcapserv	0.432** (0.041)	0.418*** (0.078)	0.451*** (0.098)
N.ICTcapserv	0.558** (0.061)	0.504* (0.042)	0.874** (0.181)
GDPgpercapita	0.601 (0.034)	0.908** (0.137)	0.714** (0.051)
Trademarks	0.506* (0.097)	0.682*** (0.128)	0.505** (0.162)
Secondary	0.508* (0.036)	0.308* (0.004)	0.409* (0.111)
Ndays	0.105 (0.063)	0.605 (0.039)	0.305 (0.182)
Unemployment	0.217 (0.005)	0.215 (0.065)	0.316 (0.143)
Constant	4.037*** (0.045)	3.149 (0.902)	4.870*** (0.937)
Year Dummies	Yes	Yes	
R ²	0.379	0.243	
Observations	231	231	215
p-value AR(1)			0.001
p-value AR(2)			0.785
p-value (Sargan test)			0.000
P-value (Hansen test)			0.942

Clustered standard errors in parentheses, *p < .10, **p < .05, ***p < .01.

Table 4. Dependent variable: Total Entrepreneurial Activity (TEA), developed countries over 2006-2016

Variables	FE	RE	S-GMM
TEA(-1)			0.791* (0.016)
ICTcapserv	0.403*** (0.087)	0.417*** (0.096)	0.421* (0.001)
N.ICTcapserv	0.627*** (0.098)	0.836* (0.159)	0.232** (0.062)
GDPgpercapita	0.306 (0.003)	0.810*** (0.041)	0.709*** (0.016)
Trademarks	0.203* (0.047)	0.307* (0.031)	0.505* (0.065)
Secondary	0.602* (0.099)	0.453* (0.126)	0.535** (0.158)
Ndays	-0.821** (0.163)	-0.721*** (0.184)	-0.411* (0.105)
Unemployment	0.511 (0.021)	0.362 (0.061)	0.461 (0.098)
Constant	2.511** (0.517)	3.912** (0.175)	2.761* (0.546)
Year Dummies	Yes	Yes	
R ²	0.514	0.483	
Observations	253	253	239
p-value AR(1)			0.001
p-value AR(2)			0.736
p-value (Sargan test)			0.000
P-value (Hansen test)			1.000

Clustered standard errors in parentheses, *p < .10, **p < .05, ***p < .01.

Table 5. Controlling for education effect, dependent variable: Total Entrepreneurial Activity (TEA), FE, GMM in Full and developing countries over 2006-2016

Variables	Full sample				Developing countries			
	FE		GMM		FE		GMM	
TEA(-1)			0.003*	0.004*			0.004**	0.021**
			(0.015)	(0.015)			(0.015)	(0.013)
ICTcapserv* Secondary	0.6917***		0.033**		0.6756**		0.014**	
	(0.0659)		(0.016)		(0.0661)		(0.013)	
ICTcapserv* Tertiary		0.5193**		(0.002)		0.4027**		0.024***
		(0.0088)		0.603**		(0.0022)		(.009)
N.ICTcapserv	0.0037	0.0023	0.057**	0.019	0.8887**	0.0007	0.042*	0.028**
	(0.0025)	(0.0022)	(0.005)	(0.029)	(0.2545)	(0.0016)	0.014	(0.014)
GDPgpercapita	0.9886***	0.9853***	0.677*	0.014**	0.1171	0.8861***	0.002	2.180
	(0.0034)	(.0043)	(0.041)	(0.013)	(0.0898)	(0.2546)	(0.012)	(2.098)
Trademarks	0.2005***	0.2545***	0.604*	0.012	0.4210*	0.5212*	0.004**	0.037***
	(0.0001)	(0.0001)	(0.004)	(0.006)	(.0139)	(.0191)	(0.015)	(0.003)
Secondary	0.9173***		0.606**		0.8916**		0.004***	
	(0.2503)		(.430)		(0.2522)		(0.001)	
Tertiary		0.453		(0.017)		0.307		0.013
		(0.398)		(0.002)		(0.231)		(0.111)
Ndays	-0.1644*	-0.1057	-0.004	-0.452**	-	-0.0173	-0.018***	-0.020***
	(0.0913)	(0.0897)	(0.013)	(0.381)	0.1101**	(0.0715)	(0.007)	(0.007)
Unemployment	0.1202***	0.1056**	-0.015***	0.008	0.9180**	0.0568***	0.666	0.027
	(0.0502)	(0.0497)	(0.006)	(0.011)	(0.3615)	(0.3220)	(0.548)	(0.037)
Constant	-	-	-0.025***	-0.056**	2.0056**	2.9184***	0.004***	0.096*
	1.0694***	1.0388***	(0.006)	(0.013)	(0.0797)	(0.0034)	(0.001)	(0.639)
Year Dummies	Yes	Yes			Yes	Yes		
R ²	0.421	0.438			0.485	0.493		
Observations	649	659	602	602	165	165	148	148
p-value AR(1)			0.001	0.000			0.001	0.000
p-value AR(2)			0.785	0.636			0.567	0.569
p-value (Sargan test)			0.000	0.000			0.000	0.000
P-value (Hansen test)			0.942	0.863			0.783	0.732

Clustered standard errors in parentheses, *p < .10, **p < .05, ***p < .01.

Table 6. Controlling for education effect, dependent variable: Total Entrepreneurial Activity (TEA), FE, GMM in emerging and developed countries over 2006-2016

Variables	Emerging countries				Developed countries			
	FE		GMM		FE		GMM	
TEA(-1)			0.016*	0.017*			0.024*	0.031*
			(0.025)	(0.025)			(0.025)	(0.017)
ICTcapserv*	0.6756***		0.034		0.6994***		0.062*	
Secondary	(0.0661)		(0.037)		(0.0714)		(0.037)	
ICTcapserv* Tertiary		0.3159**		0.711		0.3051*		0.008*
		(0.0083)		(0.652)		(0.0031)		(0.006)
N.ICTcapserv	0.0027	0.0027	0.699*	0.188**	0.0022	0.0025	0.073*	0.805***
	(0.0023)	(0.0022)	(0.622)	(0.021)	(0.0023)	(0.0019)	(0.033)	(0.096)
GDPgpercapita	0.8887***	0.0007	0.036**	0.047	1.4652***	0.2867***	0.032*	0.147*
	(0.2545)	(0.0016)	(0.001)	(0.036)	(0.3496)	(0.0848)	(0.025)	(0.018)
Trademarks	0.4171*	0.5861***	0.024*	0.711	0.3762***	0.4095**	0.069*	0.928*
	(0.0898)	(0.2546)	(0.025)	(0.652)	(.0021)	(.0084)	(0.036)	(0.537)
Secondary	0.4210**		0.062*		0.6974***		0.316**	
	(.0139)		(0.037)		(0.0633)		(0.625)	
Tertiary		0.1212		0.188**		0.6815***		0.013**
		(.0891)		(0.021)		(0.0689)		(0.015)
Ndays	-0.0052***	-0.0203	-0.016**	-0.119**	-0.020***	-0.016**	-0.018***	-0.011**
	(.0018)	(.0139)	(0.006)	(0.051)	(0.007)	(0.006)	(0.007)	(0.008)
Unemployment	0.1101**	0.0173	0.073*		0.0330	-0.6992**	0.052*	-0.016**
	(0.0502)	(0.0715)	(0.033)		(0.1457)	(0.3432)	(0.031)	(0.006)
Constant	-2.9180***	2.0568***	6.946*	6.575*	-1.6992**	-2.6147*	6.508*	9.320**
	(0.3615)	(0.3220)	(3.932)	(3.648)	(0.3432)	(0.3475)	(3.713)	(3.794)
Year Dummies	Yes	Yes			Yes	Yes		
R ²	0.485	0.493			0.379	0.343		
Observations	231	231	215	215	253	253	218	218
p-value AR(1)			0.000	0.000			0.001	0.000
p-value AR(2)			0.543	0.645			0.765	0.654
p-value (Sargan test)			0.000	0.000			0.000	0.000
P-value (Hansen test)			0.823	0.759			0.784	0.731

Clustered standard errors in parentheses, *p < .10, **p < .05, ***p < .01.

Table 7. Controlling for innovation effect, dependent variable: Total Entrepreneurial Activity (TEA), FE, GMM Full and developing countries over 2006-2016

Variables	Full sample				Developing countries			
	FE		GMM		FE		GMM	
TEA(-1)			0.031*	0.036**			0.008	0.019
			(0.017)	(0.016)			(0.0263)	(0.034)
ICTcapserv*	0.635**		0.052*		0.038**		0.021**	
Trademark	(0.044)		(0.031)		(0.009)		(0.011)	
ICTcapserv* Patents		0.564***		0.104**		0.318***		0.106*
		(0.180)		(0.005)		(0.010)		(0.015)
N.ICTcapserv	0.421*	0.218*	0.805***	0.994***	0.121*	0.218*	0.352***	0.886***
	(0.023)	(0.029)	(0.096)	(0.258)	(0.023)	(0.029)	(0.056)	(0.080)
GDPgpercapita	1.093***	1.099***	0.147*	0.329*	1.994***	1.165***	0.012*	0.024
	(0.290)	(0.289)	(0.018)	(0.012)	(0.290)	(0.289)	(0.020)	(0.030)
Trademarks	0.316*		0.928*		0.328**		0.618**	
	(0.163)		(0.537)		(0.157)		(0.413)	
Patents		0.518**		0.038**		0.412**	0.014	0.263***
		(0.028)		(0.016)		(0.118)	(0.015)	(0.072)
Secondary	0.409**	0.443**	-0.478**	-0.014*	0.436**	0.025	0.012	0.640
	(0.179)	(0.181)	(0.014)	(0.001)	(0.175)	(0.030)	(0.030)	(0.537)
Ndays	-0.021	-0.017	-0.011**	-0.025*	-0.604**	-0.149**	-0.189***	-0.011**
	(0.023)	(0.029)	(0.008)	(0.016)	(0.001)	(0.063)	(0.241)	(0.095)
Unemployment	0.793***	0.899***	-0.016**	-0.013	0.796***	0.505	0.542	0.852
	(0.291)	(0.289)	(0.006)	(0.412)	(0.212)	(0.119)	(0.525)	(0.646)
Constant	1.653***	5.403***	11.963***	-0.003**	6.589***	2.338***	0.664	
	(0.550)	(0.627)	(3.527)	(0.017)	(0.549)	(0.625)	(0.786)	
Year Dummies	Yes	Yes		-0.065	Yes	Yes		
R ²	0.485	0.521		(0.002)	0.587	0.573		
Observations	649	649	602	602	165	165	148	148
p-value AR(1)			0.000	0.000			0.001	0.000
p-value AR(2)			0.544	0.676			0.764	0.656
p-value (Sargan test)			0.000	0.000			0.000	0.000
P-value (Hansen test)			0.854	0.765			0.776	0.722

Clustered standard errors in parentheses, *p < .10, **p < .05, ***p < .01.

Table 8. Controlling for innovation effect, dependent variable: Total Entrepreneurial Activity (TEA), FE, GMM in emerging and developed countries over 2006-2016

Variables	Emerging countries				Developed countries			
	FE		GMM		FE		GMM	
TEA(-1)			0.830** (0.609)	0.078*** (0.030)			0.163*** (0.009)	0.071** (0.030)
ICTcapserv* Trademark	0.619** (0.044)		0.423** (0.026)		0.794** (0.049)		1.204*** (0.195)	1.173*** (0.183)
ICTcapserv* Patents		0.771** (0.049)		0.796*** (0.212)		0.871*** (0.176)		
N.ICTcapserv	0.504*** (0.095)	0.605*** (0.195)	0.731*** (0.198)	0.730*** (0.198)	0.525** (0.030)	0.473*** (0.184)	0.734*** (0.199)	1.173*** (0.183)
GDPgpercapita	0.019 (0.024)	0.019 (0.024)	0.117** (0.054)	0.340** (0.156)	0.730*** (0.198)	0.024 (0.030)	0.007 (0.024)	0.052** (0.023)
Trademarks	0.800*** (0.212)		0.102*** (0.027)		0.608** (0.010)		0.734*** (0.199)	
Patents		0.618** (0.128)		0.796*** (0.212)		0.712** (0.118)		0.997* (0.570)
Secondary	0.257** (0.072)	0.174* (0.100)	0.671 (0.634)	0.070 (0.674)	0.106* (0.018)	0.108* (0.010)	1.204*** (0.195)	1.205*** (0.195)
Ndays	-0.140 (0.360)	-0.115 (0.123)	-0.800*** (0.212)	-0.192 (0.645)	-0.505 (0.789)	-0.124 (0.395)	-0.020* (0.018)	-0.340** (0.156)
Unemployment	0.810*** (0.202)	0.705*** (0.012)	0.034* (0.027)	0.030 (0.037)	0.008 (0.012)	0.764*** (0.179)	0.067 (0.043)	0.072* (0.098)
Constant	2.036*** (0.996)	1.269*** (0.721)	0.020 (0.026)	0.005* (0.016)	1.959*** (0.994)	1.188*** (0.719)	0.001** (0.107)	0.005* (.049)
Year Dummies	Yes	Yes			Yes	Yes		
R ²	0.482	0.522			0.482	0.522		
Observations	213	231	215	215	253	253	218	218
p-value AR(1)			0.000	0.000			0.001	0.000
p-value AR(2)			0.544	0.672			0.764	0.652
p-value (Sargan test)			0.000	0.000			0.000	0.000
P-value (Hansen test)			0.862	0.760			0.772	0.764

Clustered standard errors in parentheses, *p < .10, **p < .05, ***p < .01.

Appendix

Table 1A. Summary statistics, full sample

Variable	Mean	Median	Std. Dev.	Min	Max
TEA	3.215452	2.178060	3.514332	0.024221	21.30974
ICTcapserv	0.446806	0.267308	2.458996	-3.822664	54.80456
N.ICTcapserv	1.910055	1.435263	2.715128	-3.651998	50.28701
GDPgpercapita	2.326605	2.159227	3.254532	-11.87718	30.35658
Unemployment	7.607200	6.850000	4.427519	0.490000	27.18000
Secondary	91.33829	98.43256	17.97114	14.78620	126.0540
Trademarks	55689.32	20743.00	148911.2	1.000000	2104409
Ndays	26.71405	17.00000	27.44805	0.500000	230.0000

Table 2A. Summary statistics, developing countries

Variable	Mean	Median	Std. Dev.	Min	Max
TEA	0.753114	0.423865	0.90226	0.024221	3.888169
ICTcapserv	0.804399	2.829810	4.61269	-3.822664	54.80456
N.ICTcapserv	3.344462	0.221875	4.51685	-1.002215	50.28701
GDP	3.585194	3.482475	3.138657	-4.160107	30.35658
Unemployment	6.610074	4.550000	3.900740	0.650000	18.33000
Secondary	59.35896	60.32957	16.61191	14.78620	85.42012
Trademarks	83892.94	12771.00	268449.4	1621.000	2104409
Ndays	30.48438	28.25000	19.26023	6.000000	104.5000

Table 3A. Summary statistics, emerging countries

Variable	Mean	Median	Std. Dev.	Min	Max
TEA	2.918111	2.231831	2.505233	0.1279074	10.88841
ICTcapserv	.1899666	.1511251	0.210672	-0.409107	1.014099
N.ICTcapserv	1.701801	1.512219	1.235654	-3.651998	5.856638
GDPgpercapita	2.469657	2.669194	3.480593	-11.87718	16.22569
Unemployment	9.006339	8.225000	5.156601	0.490000	27.18000
Secondary	80.96729	81.09656	10.46613	49.83054	98.80054
Trademarks	38345.95	22147.00	40921.43	1118.000	182998.0
Ndays	35.49236	26.00000	34.66587	3.000000	230.0000

Table 4A. Summary statistics, developed countries

Variable	Mean	Median	Std. Dev.	Min	Max
TEA	5.315511	3.976661	4.303480	0.040294	21.30974
ICTcapserv	0.443067	0.390949	0.202107	0.067732	1.082028
N.ICTcapserv	0.943270	0.794896	0.708933	-0.153016	4.919196
GDPgpercapita	0.969623	1.206826	2.497539	-8.706689	24.37653
Unemployment	6.931789	6.11000	3.481940	2.490000	26.09000
Secondary	102.3844	101.7366	3.574121	95.64809	122.9388
Trademarks	52800.76	33846.00	67777.68	1.000000	393210.0
Ndays	13.49431	10.00000	15.97843	0.500000	138.0000

Table 5A. Correlation Matrix, Full sample

	ICTcapserv	N.ICTcapserv	TEA	Ndays	GDPperpc	Unemployment	Secondary	Trademarks
ICTcapserv	1							
N.ICTcapserv	-0.0125	1						
TEA	0.2365	-0.1752	1					
Ndays	-0.1484	0.3739	-0.3270	1				
GDPpercapita	0.0427	0.4152	-0.0978	0.2476	1			
Unemployment	-0.2765	-0.2382	0.0357	0.0609	-0.1288	1		
Secondary	0.1039	-0.5401	0.3249	-0.2932	-0.2120	0.1549	1	
Trademarks	0.0345	0.0511	-0.1544	-0.0120	0.0394	-0.1025	0.1115	1

Table 6A. Correlation Matrix, Developing countries

	ICTcapserv	N.ICTcapserv	TEA	Ndays	GDPperpc	Unemployment	Secondary	Trademarks
ICTcapserv	1							
N.ICTcapserv	-0.1304	1						
TEA	-0.0120	0.4473	1					
Ndays	-0.2522	0.1721	-0.0896	1				
GDPpercapita	0.0380	0.3601	0.1080	0.3709	1			
Unemployment	0.2645	-0.5181	0.0885	-0.4554	-0.3811	1		
Secondary	-0.4536	0.1854	0.3902	0.3701	0.1677	-0.3171	1	
Trademarks	0.2234	-0.0305	0.0272	0.0539	0.1713	-0.2324	0.0098	1

Table 7A. Correlation Matrix, Emerging countries

	ICTcapserv	N.ICTcapserv	TEA	Ndays	GDPperpc	Unemployment	Secondary	Trademarks
ICTcapserv	1							
N.ICTcapserv	0.4645	1						
TEA	-0.2427	-0.0651	1					
Ndays	0.1812	0.1973	0.0464	1				
GDPpercapita	0.3070	0.4082	-0.1035	0.2051	1			
Unemployment	-0.3238	-0.1378	0.4564	0.1180	-0.1428	1		
Secondary	-0.3161	-0.2560	0.0993	-0.0534	-0.0884	0.0622	1	
Trademarks	0.2082	0.2875	0.3688	0.0073	0.0805	-0.2984	-0.0512	1

Table 8A. Correlation Matrix, Developed countries

	ICTcapserv	N.ICTcapserv	TEA	Ndays	GDPperpc	Unemployment	Secondary	Trademarks
ICTcapserv	1							
N.ICTcapserv	0.3061	1						
TEA	0.1778	0.2516	1					
Ndays	0.0313	-0.0098	-0.3858	1				
GDPpercapita	0.2107	0.2023	0.1194	-0.0814	1			
Unemployment	-0.3309	-0.2389	0.2794	0.3176	-0.0629	1		
Secondary	-0.1593	0.0244	0.0132	0.0901	-0.0278	0.2282	1	
Trademarks	-0.1710	-0.1573	0.0987	0.0406	-0.0137	0.1654	0.3266	1

Table 9A. Chow test

	Developing vs Emerging	Developing vs Developed	Emerging vs Developed
Probability	Prob > chi2 = 0.3338	Prob > chi2 = 0.2090	Prob > chi2 = 0.5021
Conclusion	coefficients do not vary between groups	coefficients do not vary between groups	coefficients do not vary between groups

Table 10A. Hausman test

Statistics	All countries	Developed countries	Emerging countries	Developing countries
Chi2(7)	37,07	50,38	40,27	38,23
Prob(Chi2)	0,00	0,00	0,00	0,00

Table 11A. Variance Inflation Factor (VIF) test

Variables	VIF	1/VIF
ICTcapserv	1,457	0,686
N.ICTcapserv	1,674	0,597
GDPgpercapita	1,321	0,757
Trademarks	1,879	0,532
Secondary	1,564	0,639
Ndays	1,657	0,604
Unemployment	1,213	0,824

Table 12A. List of countries by group

Developing countries	Emerging countries	Developed countries
1. Bangladesh	1. Brazil	1. Australia
2. Bolivia	2. Bulgaria	2. Austria
3. Cameroon	3. Colombia	3. Belgium
4. Ecuador	4. Costa Rica	4. Canada
5. Jordan	5. China	5. Denmark
6. Kenya	6. Egypt	6. Finland
7. Nigeria	7. India	7. France
8. Pakistan	8. Indonesia	8. Germany
9. Peru	9. Iran	9. Hungary
10. Philippines	10. Jamaica	10. Ireland
11. Senegal	11. Malaysia	11. Italy
12. Sri Lanka	12. Mexico	12. Japan
13. Tunisia	13. Morocco	13. Netherlands
14. Vietnam	14. Poland	14. New Zealand
15. Venezuela	15. South Korea	15. Norway
	16. South Africa	16. Portugal
	20. Thailand	17. Spain
	21. Turkey	18. Slovak Republic
		19. Sweden
		20. Slovenia
		21. Switzerland
		22. United Kingdom
		23. United States

Table 13A. School of thoughts of defining entrepreneurship, except the firm creation, activity, and opportunity school of thoughts

School of thoughts	Definition	Represented Reference
The psychological characteristics school	Entrepreneurship is a means through which individuals can realize a sense of control in their lives, increase autonomy, and have feelings of distinctiveness, which ultimately lead to a higher level of psychological well-being.	Spivack et al. (2014, p. 652)
The classical school	The crux of entrepreneurship lies in seeking ways to bring about innovation and change through new products, services and organizations, as well as the willingness to overcome obstacles and barriers to do so.	Brenkert (2009, p. 451); Zhang and Arvey (2009)
The leadership school	Social entrepreneurship signifies a valued achievement; entrepreneurship, like the rest of social life, is a collaborative social achievement.	Kao (1989); Choi and Majumdar (2014, p. 366); McKeever et al. (2015, p. 52)
The intrapreneurship school	Intrapreneurs, though with limited power within organizations, act as entrepreneurs and implement their ideas without necessarily becoming owners.	Krueger et al. (2000, p. 411)
The management school	Entrepreneurship can be defined as profit-seeking.	Webster, (1966); McMullen and Warnick (2016, p. 635)
The "Great Person" school	The great person school emphasizes the 'inborn' intuitive faculty of the great person to recognize an opportunity and make the appropriate decision.	Cunningham and Lischeron, (1994)
The rewarding school	Entrepreneurship is a rewarding yet stressful undertaking, as it is associated with risk taking, income and outcome uncertainty, intense work effort, long working hours, decision autonomy, and considerable responsibility.	Uy et al. (2013, p. 583)
The self-employment school	More broadly defined, entrepreneurship comprises self-employment and independent business ownership.	Audretsch et al. (2013, p. 775)
The judgment school	Entrepreneurship is the exercise of judgment over resource uses under uncertainty, and second, viewing the theory of economic organization as a subject of the theory of asset ownership.	Foss et al. (2007, p. 1166)

Source: Authors