Does digital proximity between countries impact on entrepreneurship?

Abstract

Purpose: This paper seeks to determine if there is a spatial dependence in the entrepreneurial activity among countries. The existence of a "digital proximity" could explain the spatial pattern of entrepreneurship.

Methodology: This question is empirically addressed by using a five period, 2008-2012 panel data for 35 countries. A spatial fixed effects panel data model is estimated by using the Total Entrepreneurial Activity (TEA) published by the Global Entrepreneurship Monitor (GEM) as the dependent variable.

Findings: A significant negative influence of the digital proximity on the entrepreneurial activity is observed. Mobile broadband direct effect is positive while the indirect effect (the spatial spillovers) is negative, leading to a negative total effect on the total entrepreneurial activity. This result is contrary to non-spatial models' results. Besides, a higher mobile broadband penetration in a country would lead to a competitive advantage fostering its opportunities for entrepreneurship, but reducing of its neighbours'.

Originality/value: Examining the relationship between ICT and entrepreneurship, by introducing the spatial effects is the main contribution. This paper expands the scant literature on the ICT impact on entrepreneurship. Results obtained support policies towards enforcing innovation, education and reducing entry regulations for encouraging entrepreneurship. Meanwhile, mobile broadband policies could counteract the entrepreneurial policies' results due to the spatial dependence.

Paper type: Research paper.

Keywords: Information and Communication technologies, entrepreneurship, mobile technologies, spatial dependence, panel data.

1. Introduction

The relationship between entrepreneurship, Information and Communication Technologies (ICT) and regional economies are intertwined and each contains overlapping cultural, socioeconomic, technological, spatial and temporal elements (Mc Quaid, 2002).

The recognition of the crucial role entrepreneurship plays in the economy explains why most OCDE countries have applied entrepreneurial policies that move from Small and Medium Sized Enterprises (SME) support policies to Innovation as a factor of growth (Dahlstrand and Stevenson, 2007).

One major implication of ICT is they have created main conditions for entrepreneurial discovery and action. Some of the ways in which ICT supports entrepreneurship and innovation include: Increases interconnectedness and collaboration; lowers the cost of entry for new entrepreneurs; enhances the ability of entrepreneurs to develop new business models, products, services, and processes; provides new tools to create, organise, store, and transmit information; and facilitates faster access to regional and international markets, among others. The accessibility of ICT makes it increasingly easier for remote locales to participate in global commerce, diminishing geographic, political, and cultural boundaries (Carayannis et al, 2006).

But while the emerging digital economy is a genuine source and generator of new business models and new wealth, it is also undermining old business models and threatening and even destroying investments and jobs in certain established businesses (Johansson et al, 2006).

There are substantial differences among countries and regions as regards their role in the development of ICT and their propensity to adopt and apply ICT applications in various sectors and activities. Hence, countries and regions differ markedly in how far they have come on the road to the digital economy (Johannson et al, 2006).

Becoming an information society implies the evolution from ICT access to ICT use. While most countries are constantly increasing access to ICT, a number of countries continue to display very low levels of ICT use (IDI, 2013). Countries that have reached very high levels of ICT access and use are in the top ranking of the ICT Development Index (IDI). Nearly two-thirds of the top 30 IDI countries are from Europe, which is explained by the presence of a shared regulatory framework and a clear set of priority areas, goals and targets. For instance, highly competitive ICT markets and ICT services that were privatized and liberalized early on. A higher level of competition and the positive role of the private sector have improved the IDI values and rankings in the most dynamic countries. In many cases, government-driven programs or initiatives have also helped to increase ICT access and use.

However, many developing countries lack the traditional types of ICT infrastructure, such as fixed line phones and internet connectivity. In this group of countries, ICT can become key enablers for achieving international and national development goals and have the greatest development impact (ITU, 2013). In some countries from Central and West Asia, where women are less likely to become entrepreneurs, ICT can be used to overcome challenges specific to women entrepreneurs—time and mobility constraints; access to formal financial services, information, skills, and personalized advice; and participation in business networks (Martinez and Nguyen, 2014).

Technological learning and knowledge have become crucial factors of economic, social and especially entrepreneurial development. In terms of Carayannis et al (2006), not all regions are in the same e-Development stage. Thus, the ICT impact to promote and support entrepreneurship would differ across regions according to their e-development stage.

Most recent research, particularly in ICT4D (ICT for development), could be said to be following a call made by Avgerou (2001) to consider ICT in the contexts in which they are embedded (Avgerou and Walsham, 2000; Braa et al., 2007; Madon, 2010). Contexts, in this case, may be organisational, national or international (Hayes and Westrup, 2012).

Some of the obstacles to the technology's effective deployment are the result of government legislative and regulatory decisions that constrain entrepreneurial initiatives, as recent experience in Turkey demonstrates (Burnham, 2009). These factors explain the different levels of ICT development among countries.

Mobile technologies are playing a growing role in developing countries where subscriptions doubled over the past two years and now outnumber subscriptions in developed countries. For instance, one of mobile broadband applications known as mobile banking can reduce transport costs, thereby reducing expenses of running a business. Not all of mobile networks, however, have been upgraded to 3G technology, which is necessary to qualify as mobile broadband and provide high-speed access to the Internet. By end 2012, the percentage of the world's population covered by a 3G network was around 50 per cent (ITU, 2013); and this figure will grow as more and more mobile broadband networks are deployed, until eventually 3G coverage approaches mobile cellular coverage (93 per cent) (ITU, 2014) .

According to ITU (2013) the correlation between the mobile-broadband and income levels is weak. This evidence suggests that mobile-broadband access depends on other variables such as regulation and policy initiatives dealing with licensing, spectrum availability and the promotion of competition. European countries dominate the global top ten of most affordable mobile-broadband plans, with Austria, Finland and Iceland featuring in the top ten for all categories of mobile-broadband services (ITU, 2014).

Mobile technologies, specially, are useful to communicate and to upload and share information on the internet or within the personal online network. The integration of mobile networks, devices and applications has formed an ecosystem that becomes the most dynamic platform for bringing ICT benefits to our economics and society (Tiarawut, 2013). However, fixed broadband is still the main option for medium- and high-end users, including businesses and many residential customers (ITU, 2013).

The increasing penetration of ICT, the use of efficient transportation, the decrease in governments' protectionist policies, and the resulting decrease in the number of geographically protected market niches has foster the international entrepreneurship (Dougall and Oviatt, 2000). The Internet yields an influence on entrepreneurial internationalization with the argument that virtual supported marketplaces may provide platforms for internationalizing both new and existing businesses (Katz et al., 2003).

The emergence of born global firms or the research on international entrepreneurship followed an accelerated process, yet not readily explained by traditional theories (Evangelista 2005; Rialp et al. 2005). Part of the explanation did seem to come from changes in the business environment resulting from globalization. International markets had become more competitive and interdependent with technological changes (Knight et al. 2004). Therefore, the business model by which firms operate needs to accommodate the spatial dimensions indicated by globalization; and the emergence of global technology markets (Onetti, 2012).

Moore, Palfrey and Gasser (2001) focus on aspects of digital business ecosystems and digital entrepreneurship as key concepts of sustainable socio-economic development and poverty alleviation. This approach suggests that digital business ecosystems require a number of specialized complementary contributions on different layers.

The importance of the digital ecosystems for entrepreneurship (Moore, Palfrey and Gasser, 2001) is evidenced in the experience of some developing countries. For instance, BusyInternet is an entrepreneurship in Ghana that provides high speed internet bandwidth by satellite. Computers are powered by reliable electricity provided through a combination of the notorious central power authority grid, and a $30,000 industrial-grade oil-fired generator-and-battery system.

In Perú, two entrepreneurs developed their business model based on alliances with strategic partners, such as large cinema chains with a regional presence and the leading electronic payment systems. Cinepapaya not only features movie times and reviews, but also sells the tickets by means of a mobile phone or a computer (Kantis et al, 2014).

Other experiences are entrepreneurs that use mobile phones to resell telecommunications services to their local community. This has a productivity enhancing effect of moving part of the population from (often) low productivity farming to (potentially) high value added telecommunication service providers. The flagship of this business model is Grameen Phone (Cohen, 2001). Under this model, a local entrepreneur purchases mobile phone service through Grameen Telecom, often is using a micro-loan provided by Grameen Bank, and then reselling this service with the community. Besides, a Latin-American case of reselling mobile communication takes place in Colombia. The entrepreneurship *" Venta de Minutos"* consists of a seller, the owner of the mobile phone, that sells in the street, and a consumer who pays for calling/using some minutes of the mobile phone service. However, the paper does not strictly focus on ICT entrepreneurship but on entrepreneurships enabled by ICT.

The objective of this paper is to examine the relationship between ICT and entrepreneurship, by introducing the spatial effects. In particular, the study pretends to determine if there is a spatial dependence in the entrepreneurial activity among countries. Does "digital proximity" among countries could explain the spatial pattern of entrepreneurship?. Are fixed and mobile broadband explanatory factors of entrepreneurship? The paper analyses to what extent the entrepreneurial activity is affected by indirect spillovers due to ICT development. The paper is structured as followed. Firstly, a theoretical framework defines the concepts of entrepreneurship and analysis the theoretical and empirical evidence of the relationship between entrepreneurship and ICT development. Secondly, the methodology employed, a spatial panel data model, is described. Thirdly, the descriptive analysis and the results estimated are explained. Finally, the conclusions are exposed.

2. Theoretical framework

Entrepreneurship is considered a process that consists in the formation of new firms, the birth of new or nascent firms in a country. Determinants of entrepreneurship can be classified in push and pull factors. Push factors embody the demand side of entrepreneurship; thus, opportunities to engage in entrepreneurial activity, and are related to technological development (Cáceres, 2005; Shane, 2003; Schumpeter, 1934), government regulation (Stel et al, 2006), and the stage of economic development (Porter and Stern, 2002; Thurow, 2003; and Audretsch and Thurik, 2001), for instance. The pull factors represent the supply side of entrepreneurship and are determined by characteristics of the population such as the income level (Belso, 2004; Carree et al., 2002), the degree of unemployment (Thurik et al., 2008; Carree and Thurik, 2003), institutional environment, among others.

The role of the educational system in shaping individuals with entrepreneurial capabilities is important, as education can help expand the existing basis for entrepreneurial human capital in society (Kantis et al, 2014). However, focusing on regional attributes alone overlook the networks that individuals construct through their associations with institutions or by virtue of personal leadership (Lawton Smith et al, 2005). The role of the entrepreneurial human capital in the creation and development of new dynamic companies is more significant in Latin America than in other parts of the world. A possible explanation for this is that in more complex environments, the future of an enterprise will depend on the entrepreneur's capacity more than in places where the entrepreneurial ecosystem functions better (Kantis et al, 2014).

Audretsch and Keilbach (2004) introduce the concept of 'entrepreneurial capital' to link entrepreneurship, economic performance and regional development. The concept is defined as the capacity for economic agents to generate new firms. The authors consider that as well as an action process or activity it can also be considered to constitute a stock of capital, 'as it reflects a number of different factors and forces, legal, institutional and social which create a capacity for this activity' (Audretsch and Keilbach, 2004). For instance, the experience of Silicon Valley is not just explained by the concentration of skilled labour, suppliers and information but the networks that transcend sectorial barriers which are characterized as entrepreneurial capital. Entrepreneurial activity itself is also driven by spillovers, acting either through the transmission and availability of innovative ideas, or through the existence of an infra-structure which supports new entrepreneurial efforts (Acs et al, 2007).

The value of ICT extends far beyond direct economic benefits (Brynjolfsson and Hitt, 1995, 2000; Mansell et al, 2007; Novick et al, 2011). ICT is a driving force in fostering entrepreneurship (Leitao and Baptista, 2011) and innovation, making it easier to identify and develop good ideas, and create and disseminate new products and services (INTEL, 2012). There is direct evidence that access to personal computers increases entrepreneurship (Fairlie, 2006). By using these technologies, the tasks needed to run a business such as accounting, inventory, communications, are complete more easily.

The availability of ICT infrastructure is a necessary but not sufficient condition for ICT development. The quality of these tools will be determinant to become feasible and effective for the business. Access to broadband indicates the quality of the ICT infrastructure. It has been shown that broadband has positive impact on the economy, both in terms of fostering growth and creating employment (Katz and Koutroumpis, 2013). According to Koutroumpis (2009), a 20 per cent of the population connected to the networks creates a vision for countries to capitalize on the beneficial effects that the network can provide; it also implies a 0.89 per cent aggregate growth rate due to broadband externalities.

Some of the ways in which ICT supports entrepreneurship and innovation include: Increases interconnectedness and collaboration; lowers the cost of entry for new entrepreneurs; enhances the ability of entrepreneurs to develop new business models, products, services, and processes; provides new tools to create, organize, store, and transmit information; and facilitates faster access to regional and international markets, among others (Alderete, 2014). Klapper (2008) states the importance of electronic registration procedures to encourage greater business registration. By electronic registration, the information is generally available to customers through the internet for a small fee. Klapper (2010) also shows that countries with e-registries tend to have shorter incorporation time frames, with less bureaucratic and cheaper procedures, and hence, higher entry rates compared to countries without them.

At a macro-level, mobile telephony adoption has been found to have a positive impact on economic welfare and gross domestic product (GDP). It generates employment opportunities in the sector and improves the productivity of other sectors, as it contributes to business expansion, to entrepreneurship, to banking the unbanked and to reduced transaction costs (Stork et al, 2013).

At the social or microeconomic level, Bhavnani et al.(2008) point out that mobile telephony adoption enhances entrepreneurship and job search, since it reduces the costs of starting a business; further, it reduces information asymmetries and market inefficiencies and, in some instances, it might substitute transportation. A study on the impact of mobile telephony on the development of micro-enterprises in Nigeria conducted by Jagun et al.(2008) concludes that mobile phones reduce some information failures which constrain investment and business activities in developing countries. On the other hand, the mobile application market opens up opportunity for new generation of entrepreneurs. It equips them with access to global market, bypassing incumbent operators' revenue model and creating an innovation-based economy (Tiarawut, 2013).

On the contrary, Misra et al (2012) recently analyse the determinants of new venture creation time using the number of fixed and mobile lines (phone subscribers) as a control variable to identify the country's infrastructure. Results show a negative incidence of phone subscribers on the new venture creation time.

Dana, Eternad and Wright (2001) argues that an entrepreneur who wished to avoid uncertainties inherent in foreign countries could simply keep a business local by refraining from expanding internationally, thereby avoiding the risks of facing foreign competition. However, opportunities for entrepreneurship are becoming less restricted to domestic markets due to the technological facilities. The use of low cost communication technologies fosters the ability to search and discover new business opportunities. Hence, ICT fosters the entrepreneurial activity.

Moreover, local entrepreneurship will not necessarily be a sufficient condition for take-off. The success of entrepreneurs is a function of their ability to be globally competitive, even if they refrain from competing globally (Dana et al, 2008). In a number of cases, government-driven programmes or initiatives have also helped to increase ICT access and use. This point is illustrated by the UK's DTI initiative to attract people from overseas to set up businesses in the intellectual property-led areas of information and communications technology and life sciences (Adegoke, 2003).

In Latin America, Start Up Chile (SUPC) was built as an instrument to attract foreign entrepreneurs, who wish to create new businesses with a high potential of growth, to Chile. To achieve this goal, SUPC organizes international calls offering to the selected entrepreneurs a working visa for a year and a wealth of US$40.000 as capital seed. According to Rivas (2014) the program follows three objectives: i) attract a number of entrepreneurs to Chile, ii) the presence of foreign entrepreneurs could positively impact on the potential Chilean entrepreneurs attitude towards the global markets, and iii) the national technological community could develop more strengths ties with the rest of the world.

Some authors have analysed the technological proximity as a spatial indicator. For instance, Parent (2008) models knowledge spillovers using a connectivity structure between regions that can reflect geographical proximity in conjunction with technological and other types of proximity. It is well known that there are large differences between European regions in terms of technological competencies (Parent, 2008). Baldacci et al (2011) assumes alternative weighting matrices using “economic distances”, such as correlation of output gaps across countries, the relative trade intensity between countries, etc. They found qualitatively similar results as when using geographic distances.

Following this line, Parent and LeSage (2008) investigate the pattern of knowledge spillovers arising from patent activity between European regions. They use a connectivity structure between regions that can reflect geographical proximity in conjunction with technological and other types of proximity.

According to Levratto et al (2014), looking at the spatial structure of entry rates immediately convinces us that entrepreneurship can no longer be regarded as independently generated within regions and that possible spillover effects have to be taken into consideration. Firm creation in a given employment area may exert a strong influence on the entrepreneurial spirit in the surrounding areas, either because it generates an imitation effect (positive externality) or because it serves a market which becomes thus unavailable for other potential entrepreneurs in the neighbourhood.

3. Methodology

This paper seeks to determine if the “digital proximity” can be considered as an explanatory factor of entrepreneurship. This question is empirically addressed by using a five period, 2008-2012 panel data for 35 countries by estimating a spatial fixed effects panel data model. By using a fixed effects panel data it is assumed that something within the individual country may impact or bias the entrepreneurial activity.

Using a 35-countries sample responds to the availability of data (for achieving a strongly balanced panel data). The Global Entrepreneurship Monitor (GEM)[1] has published the TEA indicator for a different sample of countries each year. While in 2008, 43 economies participated; in 2012 the total number raised to 54. Hence, the sample is not fixed, different countries are examined.

The use of spatial econometric estimation techniques enables to measure the effect of spatial dependence and the influence of entrepreneurship in one country on the propensity to create firms in digital neighbour countries.

A widely used criterion to select the weightings wi,j is the geographic distance or proximity. However, this criterion is not necessarily valid to all the applications as the alotopy principle expresses (Ancot et al, 1982): Usually, what happens in a region is related to another phenomenon of different and remote places. In some applications, geography can be substituted by other domains such as the similarity of the socio-economic structures in order to obtain the measures of distance (Herrera Gómez et al, 2011).

A spatial contiguity matrix is used that assumes a spatial interaction between a country and its immediate digital neighbours. To build this interaction, data from the ICT Development Index (IDI) is employed. This index is published by the International Telecommunication Union and ranges from 0 to 10. Countries are considered digital neighbours if their IDI gap or difference does not exceed 2.

Although this 2 values gap is ad-hoc[2], it resembles other studies. For instance, Nam Sang (2014) divides the Asia-Pacific Economic Cooperation (APEC) member economies into three groups, the leader group, middle group and follower group, in terms of IDI values in 2012. These groups differ in their IDI values by less than 2 (1.5 on average). The standard deviation of the world's IDI in 2012 was 2.19.

In this paper a contiguity spatial weight matrix was chosen. In such a matrix (named W), the same weight is attributed to all neighbours of an observation (wij= 1if i and j are neighbours). This square matrix has N rows × N columns corresponding to the 35 countries studied. Its diagonal elements are set to zero by assumption, since no unit can be viewed as its own neighbour.

W is a binary contiguity matrix. The row and columns sum of W before W is row normalized should a) be uniformly bounded in absolute value as N goes to infinity; b) should not diverge to infinity at a rate equal to or faster than the rate of the sample size N (Elhorst, 2010). W matrix is symmetric and row normalized. By contrast, when the spatial weights matrix is an inverse distance matrix, a) may not be satisfied (Elhorst, 2010).

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[1] The GEM was built in 1997 to study the economic impact and determinants of the entrepreneurial activity. Collecting information about the participation of the adult population in entrepreneurship is its main activity.

[2] To probe the robustness of the spatial effects, the model was also estimated using a similar matrix but with a more restricted notion of digital proximity or neighborhood. Countries were considered digital neighbors if their IDI gap or difference does not exceed 1.5. The model estimated was robust to this change (spatial effects matter and the significance of the variables is preserved).

As Stakhovych and Bijmolt (2009) state, although the wrong choice of a spatial weights matrix can distort the coefficient estimates severely, the probability that this really happens is small if spatial dependence is strong.

In order to examine spatial patterns of entrepreneurship activities, their global pattern is assessed using Moran's I test (Moran 1950, Cliff and Ord, 1981), a measure of global spatial autocorrelation:

$$I = \left(\frac{n}{\sum_{i=1}^{n}\sum_{j=1}^{n} w_{ij}}\right) * \left(\frac{\sum_{i=1}^{n}\sum_{j=1}^{n} w_{ij}(y_i-\bar{y})(y_j-\bar{y})}{\sum_{i}^{n}(y_i-\bar{y})^2}\right)$$

where n is the number of spatial units indexed by i and j; y is the outcome variable of interest; $\bar{y}$ is the mean of y; and w_{ij} is an element of spatial weighting matrix, W, which corresponds to the spatial weights assigned to pairs of units i and j (Anselin 1994).

Values range from -1, corresponding to a perfect negative correlation, to +1, corresponding to a perfect positive correlation, whereas 0 implies no spatial correlation.

If the null hypothesis of residuals spatial autocorrelation is rejected by Moran's I for most periods of time, it can be interpreted as a good signal that, once controlled for spatial fixed effects and spatial lag dependence in dependent and independent variables, the residuals are free of spatial autocorrelation.

Once the spatial correlation is controlled, a spatial panel data model is estimated in order to identify explanatory factors of entrepreneurial activity at country level. The spatial dependent nature of entrepreneurship has been analysed during the last years (Levratto, 2014; Plummer 2010; Backman and Karlsson, 2013). However, the importance of the "digital proximity" or the presence of groups of countries based on their ICT development levels has not yet been studied.

The Spatial Durbin Model (SDM) is an extended version of the Spatial Autorregresive Regression (SAR) that includes the lag dependent variable and the spatial lag of independent variables (Anselin, 1988). This model was developed because the dependencies in the spatial relationships not only occur in the dependent variable, but also in the independent variables (Anselin 1988, Brasington and Hite 2005, Kissling and Carl 2007; Satolo and Bacchi, 2013; Dell'Erba et al, 2013). According to LeSage and Pace (2009), the SDM model has several advantages with respect to SAR and Spatial Error Model (SEM). It produces unbiased coefficients in case of problems with the data generating process and, in addition, is not affected by the problem of bias caused by omitted variables (Levratto, 2014). Another strength is that it does not impose prior restrictions on the magnitude of potential spatial spillover effects. In contrast to other spatial regression specifications, these spillover effects can be global or local and be different for different explanatory variables (Le Sage and Pace, 2009).

The SDM model is determined by the following equation:

$$Y_{it} = \delta\sum_{J=1}^{N} W_{ij}Y_{it} + \alpha + X_{it}\beta + \sum_{i=1}^{N} W_{ij}X_{it}\Theta + \varepsilon_{it}$$

Where Θ denotes the spatial dependence effect of the independent variables on the dependent variable, using a spatial average of each neighbours.

WY denotes the endogenous interaction effect among the dependent variables, and WX the exogenous interaction effect among the independent variables.

The scalar parameter rho, (the spatial lag coefficient for the dependent variable), is another measure of the overall strength of spatial dependence between the observations in the dataset (Kirby and LeSage, 2009). The bounds of the spatial lag coefficient are -1 and 1, where is the smallest characteristic root of the spatial weights matrix (Elhorst, 2010). It's interpretation is similar with that of the Moran's I statistic: a positive spatial lag coefficient illustrates positive product space spillovers between the units of analysis as regards the variable of interest (entrepreneurial activity), while a negative rho parameter illustrates negative spatial spillovers between the units of analysis as regards the variable of interest.

The method used to estimate the SDM model is the maximum likelihood (ML). Other methods are instrumental variables or generalized method of moments (IV/GMM) or the Bayesian Markov Chin Monte Carlo (MCMC). One disadvantage of IV/GMM estimators is the possibility of ending up with a coefficient estimate for □ (the spatial autoregressive coefficient)[3] outside its parameter space (Elhorst, 2010).

Anselin (2010) states that models with spatially lagged variables should be estimated with Maximum likelihood methods or the Generalized Method of Moments. The ML assumes the error term is normally distributed, while the second method only assumes independence and identically distribution error to any type of distribution. Estimation by GMM can lead to inconsistency of SDM estimators when regressors are spatially autocorrelated (Pace et al, 2011).

Considering the properties of the models pointed out by LeSage and Pace (2009), SDM should be used when one believes that there are omitted variables in the model that are spatially correlated and that, in addition, these spatially correlated omitted variables are correlated with an excluded variable in the model. Whenever these two conditions hold, the SDM is the appropriate model (Levratto, 2014). In this model, a potentially omitted variable may be a measure of telecommunication regulations, speed of connections, entrepreneurial capital, among others.

Dependent variable

The dependent variable is the Total Entrepreneurial Activity (TEA), the number of Adults (18-64 years old) per 100 involved in a nascent firm (Nascent entrepreneurs) or young firm (baby entrepreneurs) or both (if doing both, still counted as one active person). Source: GEM, Global Entrepreneurship Monitor.

GEM data captures informality of entrepreneurship, particularly relevant in developing countries. This informality explains the difference between firm formation and firm registration. GEM data includes a large set of entrepreneurial activities, from businesses that performs in the formal sector

[3] In the log-likelihhod function of ML estimators coefficients are restricted by the Jacobian term, while they are unrestricted using IV/GMM since these estimators ignore the Jacobian term.

to businesses that can be part of the informal economy, to entrepreneurial initiatives that are at the very early stage and are likely to become businesses operating in the formal sector but do not yet actually do so.

Independent variables

The Independent variable of interest is Active mobile-broadband subscriptions per 100 inhabitants which measured the potential of mobile-cellular subscriptions to access, for example, 3G networks. It includes subscriptions that have been used to connect to the Internet using a mobile-cellular telephone. It constitutes one of the ICT use indicators computed by the International Telecommunication Union.

The top ranking economies are primarily high-income countries from the developed world, whereas the least developed countries rank towards the bottom of the index. Despite impressive growth in the uptake of mobile telephony in many countries, the magnitude of the digital divide remains almost unchanged.

MobileB = Active mobile-broadband subscriptions per 100 inhabitants. It covers actual subscribers, not potential. Source: ITU, International Telecommunications Union.

Hypothesis: The higher the percentage of active mobile broadband subscriptions of a country, the higher the total entrepreneurial activity will be.

FixedBB= Fixed broadband subscriptions per 100 inhabitants, refers to the number of subscriptions for high-speed access to the public internet. High-speed access is defined as downstream speeds equal to, or greater than, 256 kbit/s. Fixed (wired) broadband includes cable modem, DSL, fibre and other fixed (wired)-broadband technologies. Source: ITU, International Telecommunications Union.

Hypothesis: The higher the percentage of fixed broadband subscriptions of a country, the higher the total entrepreneurial activity will be.

Both ICT (mobile and fixed) are included in the model since it is assumed that no substitution effect exists between them. This is evidenced especially in developing countries where fixed broadband is difficult to achieve. A major difference between developed and developing countries is that, in developed countries, mobile broadband is often a complement to rather than a substitute for fixed-broadband access (ITU, 2013).

GDP= is the sum of value added by all resident producers plus any product taxes (less subsidies) not included in the valuation of output plus net receipts of primary income (compensation of employees and property income) from abroad. Data are in constant 2005 U.S. dollars, per capita. Source: The World Bank. The Gross Domestic Product is included to control for economic development differences among countries.

Hypothesis: the higher the Gross Domestic Product, the higher the entrepreneurial activity.

Unemployment= Rate of unemployment as percentage of total labour force. Source: The World Bank. It refers to the share of the labour force that is without work but available for and seeking employment. The Unemployment Rate is a push factor.

Hypothesis: The higher the level of unemployment, the higher the total entrepreneurial activity will be.

Trademarks= Trademark applications filed are applications to register a trademark with a national and regional Intellectual Property (IP) Office. A trademark is a distinctive sign which identifies certain goods or services as those produced or provided by a specific person or enterprise. Source: The World Intellectual Property Organization (WIPO). This variable is an indicator of the impact of innovation on the entrepreneurial activity.

Hypothesis: The higher the number of trademarks (level of innovation), the higher the total entrepreneurial activity will be.

DaysDB= The Number of days for starting a Business pretends to measure the time spent by starting a business in a country. This indicator is one of the Doing Business Ranking that investigates the regulations enhancing business activity and those that constrain it. Source: The World Bank Doing Business Reports. A high number of days mean the regulatory environment is less conducive to the starting and operation of a local firm. A few numbers of days on starting a business means the regulatory environment is more conducive to the starting and operation of a local firm.

Hypothesis: The less the number of administrative procedures (the less the number of days for starting a business), the higher the entrepreneurial activity.

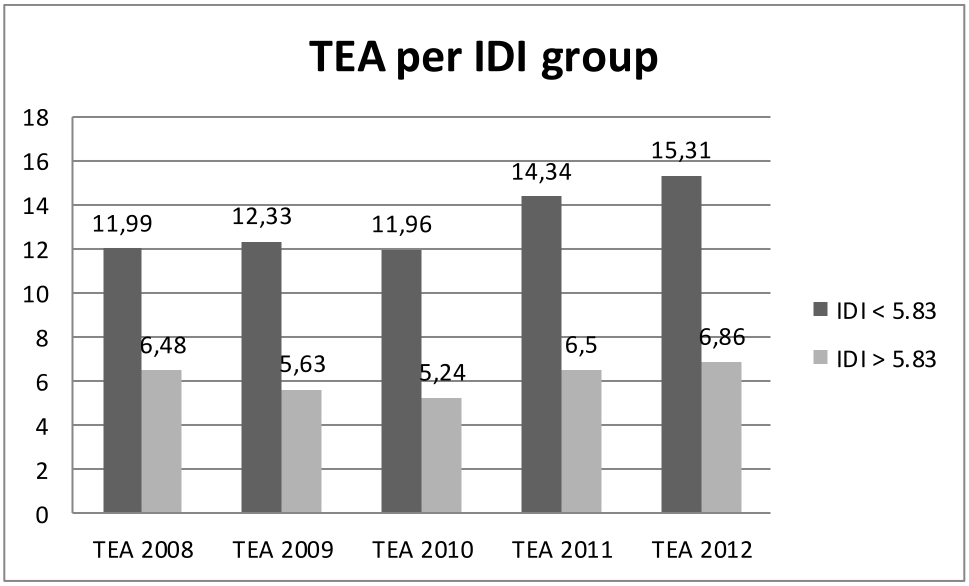
Secondratio: The secondary gross enrolment ratio. The total enrolment in secondary education, regardless of age, expressed as a percentage of the eligible official school-age population corresponding to secondary education in a given school-year. It is one of the ICT skills indicators published by ITU.

Hypothesis: The higher the secondary gross enrolment ratio, the higher the entrepreneurial activity.

4. Exploratory analysis

The average value of the entrepreneurial activity over the period 2008-2012 per IDI group is reported in Figure 1. At first glance, it is evidenced that TEA shows a different rate according to the IDI group of reference. The largest ICT developed countries (those with an IDI value higher than the average) are less entrepreneurial than those where IDI is lower than the average. Hence, it can be assumed a clustering pattern.

Figure 1: Spatial distribution of TEA



Source: The author based on ITU and GEM data. Note: 5.83 is the average IDI.

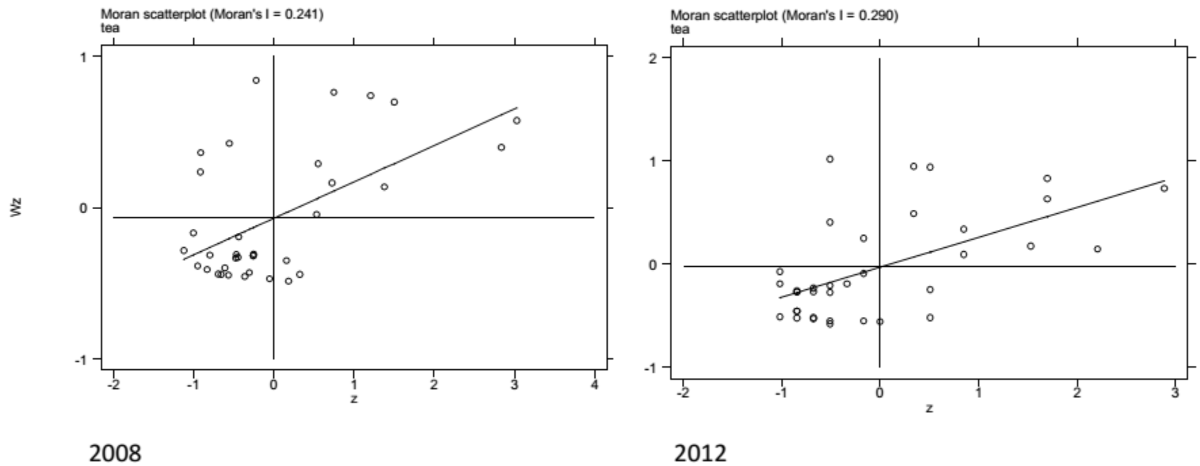
To confirm the existence of spatial clustering, a global Moran's I test statistics was calculated for the dependent variable in each cross section. Moran's I and Geary's C (Table 1) reveal a non-clear spatial autocorrelation. The value of Moran approximates a positive spatial autocorrelation which is statistically more significant as time passes. On the other side, the Geary's C shows a non-significant negative spatial autocorrelation.

Table 1: Moran's I and Geary's C values for the dependent variable

	2008	2009	2010	2011	2012
Moran's I	0,24	0,287	0,311	**0,295**	**0,29**
	(0,1)	(0,09)	(0,09)	**(0,08)**	**(0,07)**
Geary's C	1,47	1,396	1,27	1,312	1,37
	(0,26)	(0,239)	(0,271)	(0,239)	(0,26)

Source: The author. Note: p-values are in parentheses.

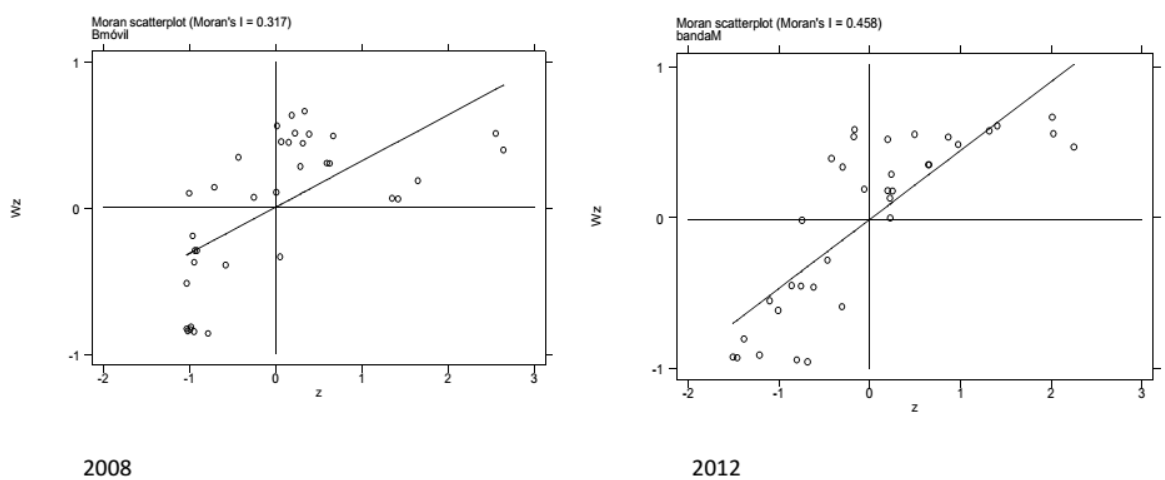
Figure 2: Moran's I for TEA year 2008 and 2012, respectively



Source: The author using STATA 12.

Points in the upper right quadrant of the scatter plots indicate countries with high TEA that are close to other countries with high TEA (Figure 2). Besides, points in the lower left quadrant indicate countries with low TEA that are close to other countries with low TEA. The points of the scatter plots have a positive skew over the period that is decreasing in time.

Figure 3: Moran's I for mobile broadband subscriptions for year 2008 and 2012



Source: The author using STATA 12.

In the case of the mobile broadband (one of the explanatory variable of interest), the Moran I's shows a positive spatial autocorrelation, stronger than with the dependent variable (Figure 3). Countries with large penetration of mobile broadband (MB) have digital neighbours with large MB penetration, and countries with low MB have neighbours with the same low MB level. Since variables present a spatial autocorrelation, the estimation of the ICT contribution to the entrepreneurial activity should contemplate the digital proximity as an explanatory factor.

5. Results

To examine the ICT contribution to the entrepreneurial activity of a group of 35 countries during the period 2008-2012, a SDM model was estimated (Table 2). In this specification, the entrepreneurial activity of a country might be affected not only by their own indicators, but also by the indicators of other countries. A spatial dependence seems to exist within the data as shown in the exploratory analysis. Thus, a non-spatial model may suffer from misspecification.

Table 2: SDM with spatial fixed-effects

	Variables	coefficient	Standard error	Z	p value
Main	MobileB	0.0298023	0.0213857	1.39	0.163
	FixedBB	.1843314	.1501464	1.23	0.220
	daysDB	.0236328	.0193847	1.22	0.223
	Gdp	.0001869	.0002382	0.78	0.433
	Unemployment	-.044667	.1218161	-0.37	0.714
	Secondratio	.0390113	.0721649	0.54	0.589
	Trademark	3.45e-06	5.34e-06	0.65	0.519
Wx	MobileB	-.1573972	.0544386	-2.89	0.004
	FixedBB	-.1186071	.6506136	-0.18	0.855
	daysDB	-.1517063	.1694416	-0.9	0.371
	Gdp	.001882	.0007972	2.36	0.09
	Unemployment	1.376571	.7685847	1.79	0.073
	Secondratio	.4679546	.1255532	3.73	0
	Trademark	.0000813	.0000357	2.28	0.023
Spatial	**Rho**	**-1.008299**	**.3436883**	**-2.93**	**0.003**
Variance	sigma2_e	2.379687	.517199	4.60	0
Direct	**MobileB**	.0349341	.0190993	1.83	**0.067**
	FixedBB	.2061301	.1693464	1.22	0.224
	daysDB	.0299502	.0235575	1.27	0.204
	GDP	.0001362	.0002481	0.55	0.583
	Unemployment	-.0720834	.1169145	-0.62	0.538
	Secondratio	.0355588	.0729762	0.49	0.626
	Trademark	4.79e-07	5.77e-06	0.08	0.934
Indirect	**MobileB**	**-.100611**	.0325121	-3.09	**0.002**
	FixedBB	-.2312873	.3318822	-0.70	0.486
	daysDB	-.1141475	.1069079	1.81	**0.070**
	GDP	.0009895	.000546	1.44	0.149

	Unemployment	.8012475	.4669685	1.72	0.086
	Secondratio	.2252177	.1023543	2.20	**0.028**
	Trademark	.0000392	.0000208	1.88	**0.060**
Total	**MobileB**	-.0656769	.0299758	-2.19	**0.028**
	FixedBB	-.0251572	.3180457	-0.08	0.937
	daysDB	-.0841972	.0938965	-0.90	0.370
	GDP	.0011257	.000467	2.41	**0.016**
	Unemployment	.729164	.4780289	1.53	0.127
	Secondratio	.2607764	.0523697	4.98	**0**
	Trademark	.0000397	.000022	1.81	**0.071**
R-square	**Within**	0.2753			
	Between	0.3983			
	Overall	0.3405			
	Log-pseudo likelihood	-327.2460			
	N obs	175	**N groups**	35	

Source: The author. Estimation output obtained after 4 iterations

The importance of the spatial dependence phenomenon is confirmed by the significant value of Rho which is equal to -1.008 and significant at 1%. This negative spatial dependence is similar to Parent and LeSage (2008), who argues that leading regions might exploit their development advantage by acquiring innovations from their less developed neighbours. In this study, the negative spatial autocorrelation represents that increases in the TEA of a country decreases the TEA of its neighbours. This result confirms the spatial dependence shown in the exploratory analysis but with an opposite sign.

A possible explanation for this result arises from Carayannis et al (2006). The authors introduced the concepts of Knowledge Economy (KE) and E-development. "E-Development is a set of tools, methodologies, and practices that leverage ICT to catalyze and accelerate social, political and economic development or in other words, e-Development is ICT-enabled and KE-inspired development that may enable the economies of developing and especially transitioning countries to become Knowledge Economies (Carayannis et al, 2006: p 422)." The relevance of e-Development to entrepreneurial development is based on the ability of ICT to perform several vital functions.

Since, there are economies more e-developed than others, there could be a "clustering" of economies based on their ICT development level, where the more e-developed economies would lead to more advanced levels of entrepreneurial development, and thus, of economic development. This result is evidenced at inter-group level (among groups of countries with different IDI). However, at intra-group level (among digital neighbour countries) the entrepreneurial activity rates of the neighbours matter. This means that the higher the levels of entrepreneurship of the neighbours, the lower the levels of entrepreneurship of a corresponding country.

If a group or pair of countries are digital neighbours (belong to the same group or cluster of e-developed economies) but achieve different entrepreneurial activity levels, this means that there are other explanatory factors (such as regulatory burdens) affecting them differently. For instance, if an entrepreneurship needs an advanced bandwidth infrastructure (such a 4G) but the country imposes bureaucratic burdens that restraints its development, it is likely that the entrepreneurial activity could perform better in a digital neighbour country with less barriers. In Latin America, Chile is one of the countries in the region with the highest average number of days required to open a new business. On the contrary, Argentine is less restrictive. Both countries are digital neighbours according to the 2012 IDI (Argentine 5.36 and Chile 5.46).

As any SDM model, the effect of the variables is classified in direct, indirect and total effects. The direct effect of a change in a country's ratio of secondary school does not affect the entrepreneurial activity of that country. It is not significant. However, the indirect effect that quantifies the spatial spillovers, is significant and positive. Hence, if the rate of secondary school in a given country increases, the TEA of the digital neighbour countries also increases. For each 10% of increase in the secondary school ratio of a given country, the TEA of digital neighbour countries increases in 2.6%.

In the case of mobile broadband subscriptions, both the direct and indirect effects are significant. However, while the direct effect is positive and significant al 10% level, the indirect effect is significantly negative. This means that increases in the number of mobile broadband subscriptions in a given country, increases the TEA of that country, but it decreases the TEA of its neighbours' countries. This is consequence of the competitive advantages that a country achieves due to the mobile broadband penetration increase in comparison to its neighbours. This competitive advantage arises from a better ICT infrastructure quality (faster Internet connectivity, high speed Internet, 3g to 4G networks) that leads to a better opportunities seeking; enhances the ability of entrepreneurs to develop new business models, products, services, and processes; facilitates faster access to regional and international markets. The total effect of mobile broadband on TEA is negative.

Furthermore, the possibility of using a time-fixed effect model (by adding explicitly time period dummies) was considered. To prove the time- effects when running the FE model, the command testparm was used, a joint test to see if the dummies for all years are equal to zero. According to the test, no time fixed effects are needed, the null hypothesis that all years coefficients are jointly equal to zero is rejected ($p>0.01$).

The model does not pretend to explain causality among entrepreneurship, ICT and innovation. Causality among these variables cannot be explained due to the multidirectional nature of the phenomenon. However, using a panel data model has the advantage of eliminating the omitted variable bias problem of modeling. The panel data econometrics literature (dynamic models in space and time) should be able to deal with unobservable spatial and/or time period specific effects and endogeneity of one or more of the regressors (Elhorst, 2012).

6. Conclusions

The objective of this paper is determining if the entrepreneurial activity is affected by ICT factors, and whether entrepreneurship follows a spatial pattern. This spatial pattern is explained by the digital proximity rather than the geographic proximity between countries. Is there any evidence that the entrepreneurial activity of a country affects its neighbours'?

As Parent and LeSage (2008) state, although any measure of technological proximity is bound to be imperfect, this model allows alternative proximity weights, This spatial effects estimates can be used to quantify the influence of ICT developed clusters of neighbouring countries on the entrepreneurial activity.

Contrary to the hypothesis stated, the digital proximity among countries affects negatively entrepreneurship. As countries from the same ICT group benefits from the same amenities, a larger entrepreneurial activity or start up rate in a country reduces the entrepreneurial activity of the digital neighbours. Digital proximity does not imply entrepreneurial proximity but a stronger competence among countries.

According to the Spatial Durbin Model estimated, the Rho sign suggest a negative spatial autocorrelation. Being part of a group of digital neighbours (with similar ICT indexes) reduces the entrepreneurial activity of a certain country. The indirect effects of the explanatory variables due to the negative spatial spillovers are strong enough to counteract the direct effect.

According to the estimated model, mobile broadband direct effect is positive while the indirect effect is negative, leading to a negative total effect on the total entrepreneurial activity. This result is contrary to other studies on the relationship between ICT and entrepreneurship (Martinez and Nguyen, 2014; Alderete, 2014; Leitao and Baptista, 2011) which do not include a spatial pattern of entrepreneurship. One of the explanations of these contrary results could be that the relationship between ICT and entrepreneurship at the country level reveals a more ambiguous pattern than at individual level (Bhavnani et al.2008; Tiarawut, 2013).

This result could explain why countries such as South Korea and Finland, one of the highest ICT developed countries, present low rates of entrepreneurship. Understanding the spatial pattern of entrepreneurship will make it easier to identify those regions/countries that will have the most influence. For instance, Denmark and Netherlands are digital neighbours, countries well ICT-developed. However, while the former has a low entrepreneurial rate, the latter presents a higher level of entrepreneurship.

The more entrepreneurial neighbours become, the less entrepreneurial the local players are. All this, therefore, necessarily implies that entrepreneurship is not only a local activity but also has a broader technological context. The entrepreneurial activity of a country could be more easily followed by another country whose entrepreneurial activities occur within a different ICT development context.

Rapid mobile adoption presents an opportunity for developing economies to jump, potentially catching up on the track of economic development. As a result, mobiles are a promising technological innovation for economic growth. However, since mobile broadband is not yet a standard technology worldwide, a higher penetration in a country would lead to a competitive advantage by fostering the opportunities for entrepreneurship, but reducing of its neighbours. In entrepreneurial terms, countries do not necessarily compete globally but rather locally, within their digital neighbours or counterparts.

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