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Influence of Mobile Telephony on Entrepreneurship in BRICs and Beyond: The Mediator Role of Education

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Besides large population and rapid growth (Goldman Sachs 2003) the BRICs - Brazil, Russia, India, China and recently South Africa - have also attracted interest in recent years due to their increased technological diffusion and its impact on domestic entrepreneurship (Saxenian 2002, 2005). The limited studies conducted propose that returning Chinese and Indian migrant entrepreneurs from United States (US) with their 'foreign' acquired human capital (defined as education) are accelerating the process of technological diffusion and innovation in their home countries especially in information and communications technology (ICT) industries (Saxenian 2002, 2005). Yet, to date, previous studies have mainly focused on link between foreign education and innovation mostly in BRICs related countries. Thus, the extent to which domestic education level mediates the impact of technology on 'new business formation rates' across the developing world remains relatively opaque. Considering that mobile phone is one of the key ICT sectors in developing countries, this study examines whether and to what extent 'domestic' education level mediates the relationship between mobile phone diffusion and new business formation rates across the developing world - including BRICs and Non-BRICs Countries. Drawing on Knowledge Spillover Theory of entrepreneurship, the paper posits that due to the recent rise in education in the developing world, mobile phone diffusion will be positively associated with new business formation rates, and education level will facilitate (mediate) the relationship. Utilising Baron and Kenney's mediation test and Sobel's Test on country-level panel data on 66 developing countries, the results clearly demonstrate strong positive effects of education level as a mediator between mobile phone diffusion and new business formation rates not just in Developing Countries (Including BRICs) but also in Non-BRICs Developing Countries with the

exception of least developed countries (LDCs). In LDCs, although the role of education level was not found to be significant, mobile phone diffusion was nevertheless found to be strongly associated with new business formation rates thereby suggesting that entrepreneurs in LDCs may simply be using mobile phone to start non-knowledge intensive businesses. Implications are drawn for policy.

Keywords: Entrepreneurship, New Business Formation, Education, Mobile Phones and BRICs.

1. INTRODUCTION

The analysis of the potential forces influencing entrepreneurship (defined as new business formation rates) across space has received much attention from the Knowledge Spillover Theory of Entrepreneurship (Acs et al. 2009; Audretsch and Keilbach 2007). The Knowledge Spillover Theory suggests that new business formation is a crucial contextual factor that is important for researchers and policymakers to understand, not just in developed countries but also in developing countries, as an important tool for stimulating growth and development (Acs and Virgill 2010). From this perspective, new business formation and its context are viewed as virtually inseparable (Venkataraman 1997). According to Li and Mitchell (2009) and Audretsch, Keilbach and Liemann (2006), Knowledge Spillover Theory takes the inseparability view of new business formation and context into account, suggesting that entrepreneurial opportunities are more likely to be generated in (1) contexts with higher levels of technology diffusion through networks; and that 2) education level will mediate the positive effects of technology on new business formation. As a result, the new business formation rates can vary across geographic regions, depending upon the context as determined by: technology diffusion and education levels. Hence several studies particularly in developed countries have been carried out that examine the influence of education and technology diffusion (especially through networks) on new business formation rates (Abubakar and Mitra, 2007; Abubakar and Mitra 2010; Acs and Armington 2004). However, according to Acs and Virgill (2010: p.491) "while the Knowledge Spillover Theory of Entrepreneurship was intended for developed economies, the externalities (that is education and networks of technology diffusion) identified by Audretsch, Keilbach and Liemann (2006) are valid for developing countries". Yet, very little research, if any, has examined the impact of these externalities on new business formation rates across the developing world. The limited research conducted suggests that returning Chinese and Indian migrant entrepreneurs from advanced countries like US, with their 'foreign' education are accelerating the process of technological diffusion and innovation in their home countries particularly in information and communications technology (ICT) industries (Saxenian, 2002, 2005). However, to date, previous research has mainly focused on the relationship between education acquired by returning entrepreneurs from foreign countries and its impact on innovation mostly in BRICs related countries (BRICs - Brazil, Russia, India, China and recently South

Africa). In contrast, the extent to which 'domestic' education level mediates the impact of technology diffusion on 'new business formation rates' across the developing world remains relatively unclear.

Accordingly, four major observations in developing countries (not only BRICs) provide the motivation for this study. First, in general, developing countries now have increasingly higher levels of education (UNDP 2010: p.36). For example, on average, a person aged 15 or older in 1960 had less than 4 years of schooling; by 2010 this number had doubled globally and more than tripled in developing countries (from 1.9 years to 6.4) (UNDP 2010: p.36). Secondly, developing countries have the fastest growing mobile phone market in the world (GSMA 2011). Thirdly, published 'micro-level' case studies suggest that the diffusion of mobile phone in developing countries has led to the creation of several innovations and extraordinary large amounts of new businesses not only in BRICs (Stanley 2005; Pyramid Research 2010). Fourthly, estimates suggest that mobile phone is having a considerable 'macro-level' impact on economic growth in developing countries (Deloitte 2007; Kathuria, Uppal, and Mam 2009). Taken together, these observations provide a strong motivation for one to investigate whether education level in a country mediates the positive relationship between mobile phone diffusion and new business formation rates in developing countries (BRICs and beyond). Therefore, this paper raises the following questions: 1) ***Across Developing Countries (including BRICs) in general, does level of education mediate the relationship between mobile phone diffusion and new business formation rates?*** 2) ***In Non-BRICs Developing Countries, does level of education mediate the relationship between mobile phone diffusion and new business formation rates?***

Consequently, this paper examines the questions in three key contexts of developing countries. These are: All Developing Countries (including BRICs), Non-BRICs Developing Countries and Least Developed Countries (LDCs). This allows one to examine whether the importance of education in mediating the relationship between mobile phone diffusion and new business formation rates in developing countries depends on inclusion of BRICs, or whether it matters in Non-BRICs developing countries and LDCs. The presentation of the paper is as follows. Section 2 of the paper outlines the Knowledge Spillover Theory of Entrepreneurship, with particular focus on technology diffusion and education as key factors that matter for new business formation rates across space. Section 3 develops a conceptual framework and hypotheses. The methodology is presented in section 4, and the findings in section 5. The final part presents the conclusion and implications for theory and policy.

2. THEORETICAL BACKGROUND: KNOWLEDGE SPILLOVER THEORY OF ENTREPRENEURSHIP

The influential idea that new business formation rates are higher in some countries and regions because of knowledge spillovers is not a completely new phenomenon. Since the 1890s, Sir Alfred Marshall described regions as "having ideas in the air" (Marshall, 1890). According to Breschi and Lissoni (2001: p.258), knowledge spillovers refer to: a) transfer of technology generated within innovative firms to other firms; b) technology that spills over is "freely" available or acquired at less than its original cost by those wishing to search it out (non-excludability), and can be used by many users at the same time (non-rivalry); c) notwithstanding b., technology ideas that spill over are more easily transferred through networks, which are often favoured by being located in the same geographical area; that is, knowledge spillover has a spatial dimension. These suggest that knowledge spillovers happen because knowledge can be transferred to non-investing parties. This implies that entrepreneurs and small firms especially when located close to key knowledge sources can acquire technological ideas more easily, thereby making the new business start-up process easier for spillover beneficiaries (Saxenian 1994; Acs and Armington 2004). According to Acs and Virgill's (2010), research works on the Knowledge Spillover Theory of Entrepreneurship identify technology diffusion through networks as important channel for knowledge spillovers.

2.1 Technology diffusion through geographic networks and its effect on new business formation rates in advanced economies

Technology diffusion generally describes the process whereby a product or service and the knowledge of its use and application move from a source, such as a large research and development (R&D) firm to a point of reception (for example entrepreneurs), which leads to commercialization often through new start-ups (Bozeman 2000; Acs, 2002). A prominent feature of the Knowledge Spillover Theory is that technology diffusion particularly through geographic networks plays a crucial role in creating opportunities for budding entrepreneurs to create new businesses (Zucker et al., 1998; Stuart and Sorenson, 2003). Consider for example Silicon Valley where the diffusion of internet technology created opportunities for new business formation by countless of entrepreneurs around internet technology, such as Jerry Yang (Yahoo), Larry Page and Sergey Brin (Google Inc.), Marc Pincus (Zynga), Aron Levie (Box) etc. This diffusion of technology according to Knowledge Spillover Theory into new businesses often occurs in spatially bounded networks (Saxenian, 1994; Abubakar, 2013). This is because entrepreneurs often find it easier to leverage social ties necessary to mobilize essential resources and knowledge when they reside close to the source of the knowledge that spills over (Stuart and Sorenson, 2003). Thus, in advanced economies, technology diffusion particularly through networks has emerged as a major research topic in the literature on knowledge spillovers (Saxenian, 1994; Stuart and Sorenson 2003). It is well known in the Knowledge Spillover theory that technology differences explain a significant part of the variation observed across space in the rates of new business formation (Zucker et al., 1998). This implies that a major determinant of new business formation is technology diffusion in a region or country. This raises the question: what factor affects the rate at which technology diffuses through new business formation in a society? This is an important question

that should concern researchers today, because it is a question that matters for policy makers trying to encourage the spread of technology and its impact on new business formation, as a means of creating opportunities budding entrepreneurs.

2.2 The role of education as a mediator between technology diffusion and new business formation in advanced economies

There is a vast literature on the link between technology diffusion and education (Nelson and Phelps, 1966; Foster and Rosenzweig 1995; Doms et al., 1997; Eaton and Kortum, 1999; Xu 2000; World Bank, 2008 etc.), and specifically for mobile phone diffusion in developing countries, education is seen as an important factor (Vodafone, 2005; Nyamba and Molozi, 2012). Scholars for a long time argue that the diffusion of technologies often requires human capital in the form of education (Abromovitz, 1986; Cohen & Levinthal, 1989; Cosar, 2011). Nelson and Phelps (1966) initiated this line of thinking by arguing that education helps people to perceive, evaluate and implement new production techniques and inputs. Human capital refers to an individual's stock of education, experience, skills and intelligence (Mitra, Abubakar and Sagagi 2011). Knowledge Spillover Theory suggests that education can make individuals start new businesses by enabling them to exploit technological opportunities (Audretsch, Keilbach and Liemann 2006; Acs and Virgill 2009). This is because education often gives individuals a feeling of autonomy, and the necessary skills to be able to develop technological opportunities (Acs, 2002; Verheul et al. 2002). Particularly in advanced economies, there is empirical support for this approach. For example, at the micro-level in Italy, a study by Colombo et al. (2004) finds that founders' educational background has a crucial influence on entrepreneurs' ability to start-up technology-based new businesses. At the regional level, a study by Zucker et al (1998) finds that the rise of new biotechnology businesses in the U.S. is intertwined with educational human capital. And in United Kingdom (UK), based on county-level data on information and communications technologies (ICT) sector of East of England, Abubakar and Mitra (2007) found that networks between university and industry influence new business formation rates across space. And even beyond new businesses, a study by Doms et al. (1997) on manufacturing plants in the U.S. finds that plants with a higher proportion of workers with higher levels of education tend to use more advanced technologies. Thus, research suggests that educational levels can mediate the relationship between technology diffusion and formation of new businesses. Yet, despite this well recognized role, Knowledge Spillover research does not satisfactorily explain whether educational levels also mediate the relationship between technology diffusion and new business formation rates in developing countries. Nonetheless, as pointed out by Acs and Virgill (2010), although Knowledge Spillover Theory was intended for developed economies, the externalities (that is human capital and technology diffusion through networks), identified by Audretsch, Keilbach and Liemann (2006) may be valid for developing countries. Thus, in the next section, this paper will review studies on knowledge spillovers in developing countries (which largely focus only on innovation not new business formation rates).

3. CONCEPTUAL FRAMEWORK AND HYPOTHESES: EDUCATIONAL LEVEL AS A MEDIATOR BETWEEN TECHNOLOGY DIFFUSION AND NEW BUSINESS FORMATION RATES IN DEVELOPING COUNTRIES

Although there is a growing interest in the importance of education and its role as a catalyst in influencing technology based entrepreneurship in developing countries (Acs and Virgill 2010), there is currently only a limited number of studies on the topic in developing countries, most of which focus mainly on 'innovation' rather than 'new business formation rates' (see Table 1 for a summary). Thus, although progress has been made, there is still a lack of macro-level empirical studies on mediating role of level of education in the relationship between technology diffusion and new business formation rates across developing countries.

Table 1: Previous Research on Knowledge Externalities and Innovation in Developing Countries

Author(s)	Sector/Space	Contribution	Gaps
Saxenian (2002)	*Sector(s):* ICT industries *Space:* China and India	Case studies on spillover effect of transnational entrepreneurs on upgrading of innovation capabilities in China and India	1,2
Saxenian (2005)	*Sector(s):* ICT industries; *Space:* China and India	Case studies on spillover effect of transnational entrepreneurs on upgrading of innovation capabilities in Taiwan, China and India	1,2
Kesidou and Szirmai (2008)	*Sector(s):* Software; *Space:* Uruguay	+ve effect of knowledge spillovers on innovation by Software firms	1,2
Kesidou and Romijn (2008)	*Sector(s):* Software; *Space:* Uruguay	+ve effect of knowledge spillovers on firms' innovation (particularly through labour mobility, company spin-offs, and networks among innovation actors)	1,2
Filatotchev et al (2011)	*Sector(s):* High-tech; *Space:* China	+ve knowledge spillover effects associated with returnee entrepreneurs and multinational enterprise (MNE) employee mobility	1,2

1) Not focused on new business formation rates in developing countries; 2) Does not investigate whether human capital mediates the link between mobile phone diffusion and new business formation in developing countries.

This section there develops a conceptual framework for examining the extent to which educational level mediates the relationship between technology diffusion and new business formation rates in developing countries (that is including BRICs) and beyond BRICs. Thus, the framework is developed in three contexts of developing countries, that is All Developing Countries (Inc. BRICs), Non-BRICs Developing Countries and LDCs.

3.1 The research settings: developing countries

Developing countries are defined as low and middle-income countries (World Bank 2012). The World Bank definition is based on gross national income (GNI) per capita, with low-income countries being those with $1,025 or less and middle-income countries being those with $1,026 - $12,475. Thus, the term 'developing countries' encompasses a diverse group of countries that include leading emerging economies such as BRICs and Next 11 and other least developed countries, known as LDCs. BRIC refers to 'large developing countries' (Goldman Sachs, 2003: p.3) with the potential for growth in the coming few decades, to 'become a much larger force in the world economy' (Goldman Sachs 2003: p.3). While South Africa's population is much smaller than the other four, it was nevertheless included in BRICs because of its economic leadership in Africa (Kahn 2011).

However, beyond BRICs (that is in Non-BRICs developing countries), there are other emerging economies popularly known as the Next-11 (Goldman Sachs 2007), some of which are also beginning to emerge as key off-shoring destinations, such as Egypt, Mexico and Philippines (CGGC 2010). The Next-11 is made-up of: Bangladesh, Egypt, Indonesia, Iran, South Korea, Mexico, Nigeria, Pakistan, the Philippines, Turkey and Vietnam (Goldman Sachs 2007). While the Next-11 may not have the BRICs like impact, they also have the characteristics of rapidly growing populations combined with significant industrial capacity or potential (Goldman Sachs 2007). Also, among the Non-BRICs Developing Countries, there are poorly developed countries such as LDCs. LDC is defined as a country that meets three criteria (UNCTAD 2011): a) A "low-income" criterion, based on a 3 year average estimate of the GNI per capita, with a threshold of $905 for possible cases of addition to the list, and a maximum of $1,086 for graduation from LDC status; (b) A "human assets weakness" criterion, involving a composite index known as the Human Assets Index, based on indicators of nutrition, health, school enrolment and literacy; and (c) An "economic vulnerability" criterion, made-up of a composite index known as the Economic Vulnerability Index, based on indicators of natural shocks, trade shocks, exposure to shocks, economic smallness; and economic remoteness. Therefore, these are countries characterized by very challenging environments, as they have some of the lowest levels of development among developing countries (UNCTAD 2011). Thus, developing countries encompass diverse countries with differences in levels of development, such as human development (see Figure 1).

3.2 Mobile phone diffusion, externalities and new business formation

This paper focuses specifically on mobile phone diffusion (as a form of technology diffusion) because considerable theory and empirical research suggests that mobile phones are among the most widely spread technologies in developing countries (Pyramid Research 2010), and have huge influence on economic outcomes in developing countries (Waverman, Meschi and Fuss 2005; Qiang, 2009). As mobile phone diffusion grows, its value to the society and economy also increases (Waverman, Meschi and Fuss, 2005). This is because, the more people connect to a communication network, the more such diffusion creates opportunities for budding entrepreneurs to start new businesses in the sector (Aker and Mbiti, 2010) and access

information, markets, and services faster, which in turn often boosts economic activities and growth (Waverman, Meschi and Fuss, 2005). Therefore, several macro-level studies have examined the economic impact of mobile phones on developing countries and found it to be positive and significant (Waverman, Meschi and Fuss 2005; Qiang, 2009: see Table 2 for a summary).

Table 2: Empirical Studies: Mobile Phones and Economic Performance in Developing Countries

Author	Context	Findings	Gaps
Waverman, Meschi and Fuss (2005)	92 developing and developed countries	Impact of mobile telephony on the GDP of developing countries is twice as great as that of developed countries	1,2
Sridhar and Sridhar (2007)	63 developing countries	Mobile phones contribute positively to national output, on average, 16.2 percent for all developing countries	1,2
Muto and Yamano (2009)	Uganda	Mobile phone coverage expansion seems to induce the market participation of farmers in remote areas who produce perishable crops	1,2
Kathuria, Uppal and Mam (2009)	Indian states	Indian states with higher mobile penetration can be expected to grow faster, with a growth rate 1.2 percent points higher for every 10 percent increase in the mobile penetration rate.	1,2
Qiang (2009)	120 developing and developed countries	For every 10 percentage point increase in the penetration of mobile phones, there is an increase in economic growth of 0.81 percentage points in developing countries, versus 0.60 percentage points in developed countries	1,2
Djiofack and Keck (2009)	177 countries, 45 of which are Sub-Saharan	1 percent increase in access to mobile phones is associated with 0.5 percent increase in real GDP per capita	1,2
Barberousse, Bernard and Pescatori (2009)	Haiti	Data confirms that mobile phone development acts as an engine for economic growth	1,2
Delloite (2009)	Sudan	6 percent increase in mobile penetration might be associated with a 0.72 percent of Sudan's increase in total GDP	1,2
Blauw and Franses (2011)	Uganda	Mobile phone use positively impacts economic development	1,2

1) Does not examine at the macro-level whether mobile phone diffusion is positively associated with new business formation 'rates' across developing countries; 2) Does not investigate whether level of education mediates the link between mobile phone diffusion and new business formation rates in developing countries.

In this context, one of the major ways in which mobile phone diffusion impacts on developing countries is through new business formation (Aker and Mbiti, 2010). This is because large mobile phone companies in developing countries create indirect job

opportunities for budding entrepreneurs by giving them to start new businesses, such as third party application developers, content providers, recharge card sellers, phone repairers and call center operators (Pyramid Research, 2010; Andjelkovic and Imaizumi, 2012: see Table 3 for examples).

Table 3: Micro-Level Case Studies Linking Mobile Phone Diffusion Networks between Mobile Phone Corporations and Local Entrepreneurs with New Business Formation In Developing Countries

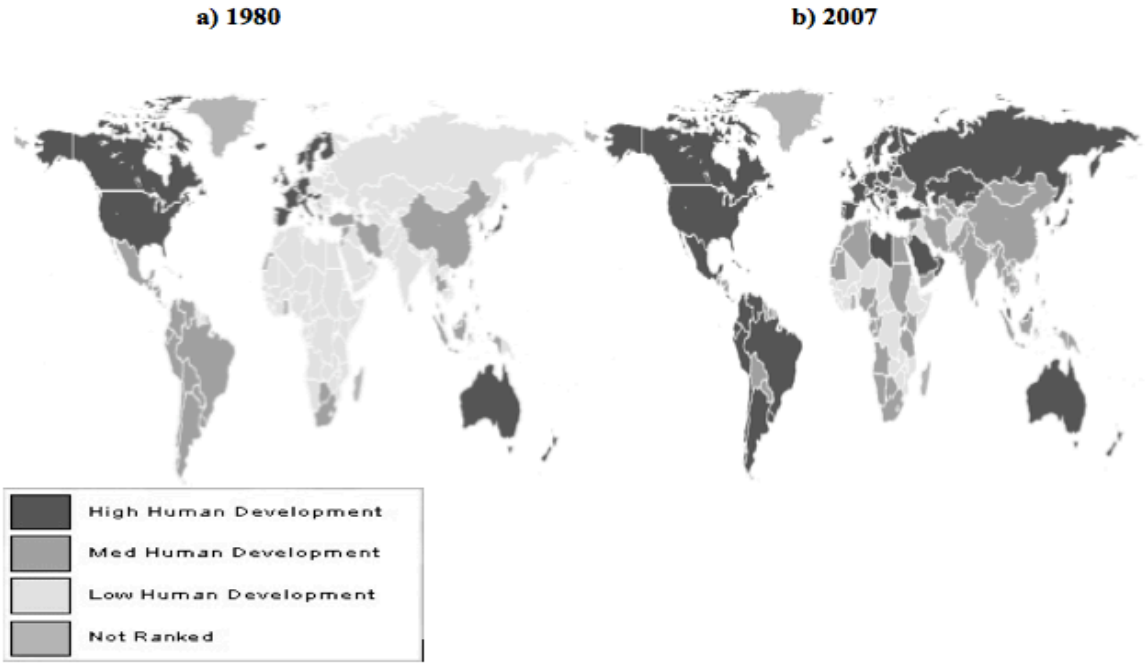
Author(s)	Country	Networks between Mobile phone corporations and local entrepreneurs	Impact on New Business Formation	Gaps
World Resources Institute (2007)	Philippines	*Smart Communications and Globe Telecom:* created financial innovations that allow people to transfer cash from Bank to cell phone.	By 2007, over 1.5 million new entrepreneurs and shops had been created, helping customers with electronic uploads of voice or text messaging units	1,2
Sey (2008)	Ghana	In 2004, Spacefon *(now MTN Ghana)* cooperated with local entrepreneurs aimed at penetrating low-income markets.	By 2008, over 25,000 operators had been established around the country by local entrepreneurs	1,2
Stanley (2005) and UN (2010)	Bangladesh	Grameen started supporting local entrepreneurs in 1997 to set-up phone operating business in Bangladesh targeting lower income markets	By 2008, there were over 350,000 phone operators created by entrepreneurs	1,2
Pyramid Research (2010)	Nigeria	Operators of mobile services in Nigeria have distribution networks with local entrepreneurs.	By 2010, local entrepreneurs had generated over 3 million indirect related to mobile services.	1,2
	Uganda	In 2003, Grameen Foundation, MTN etc launched Village Phone Uganda to promote connectivity and entrepreneurship for the poor.	By 2010 a total of about 35,000 active phone operators, 16,397 of which relate to village phone program.	1,2
	South Africa	*Vodacom*, supplies community phones to shops run by local businesses under franchise.	By 2010, a total, of 22,000 entrepreneur phone shops were established.	1,2
	Kenya	Safaricom in Kenya targeted low-income markets with M-PESA mobile money transfer.	The MPESA agent network expanded dramatically, reaching about 18,000 by April	1,2

			2010.	

1) Does not examine at the macro-level whether mobile phone diffusion is positively associated with higher network externalities in terms of new business formation 'rates' across developing countries; 2) Does not investigate whether human capital mediates the link between mobile phone diffusion and new business formation rates in developing countries.

However, none of the studies investigates the extent to which level of education matters in the relationship between mobile phone diffusion and new business formation rates in developed countries at the macro-level. Yet, education may matter, especially because the Knowledge Spillover Theory suggests that an educated populace is more likely to have the ability to exploit technologies for new business formation (Zucker et al, 1998; Audretsch, Keilbach and Liemann, 2006).

Figure 1: Rise in Human Development Index in Developing Countries: Comparing 1980 and 2007

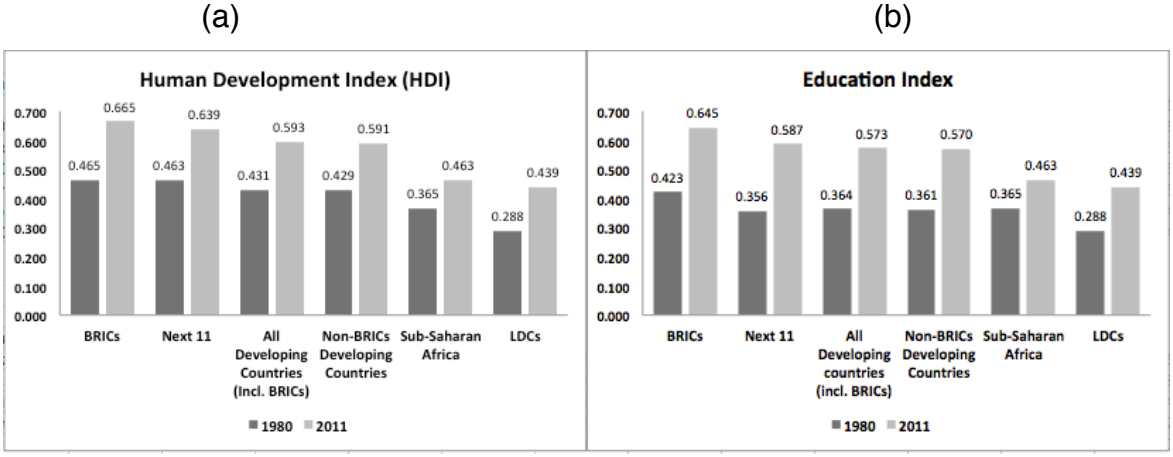


Source: UNDP (2012)

As shown in Figures 1 and 2a and b, there is a general rise in education across developing countries, with BRICs and Next 11 having higher levels than the average for All Developing Countries in both Human Development Index (HDI) and Education Index. Among the three main groups that form the focus of this study, the group All Developing Countries (Including BRICs) has the highest level of both HDI

and Education Index, followed by the Non-BRICs Developing Countries and then LDCs.

Figure 2: Human Development Index & Education Indexes – 1980-2011 (Average)



Note: The focus of this study are mainly: All Developing Countries Including BRICs), Non-BRICs Developing Countries and LDCs.

Source: UN Human Development Index (UNDP, 2012)

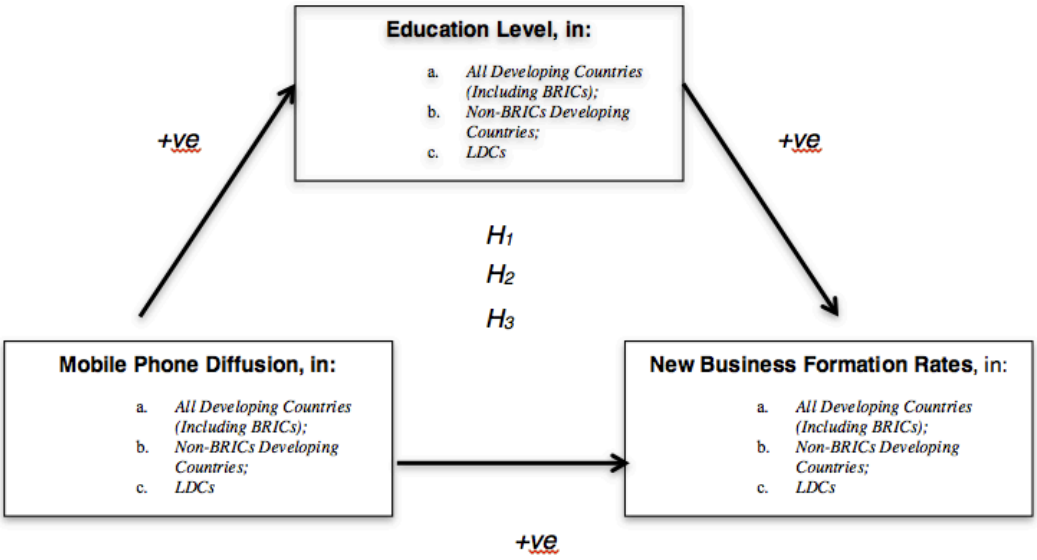
Therefore, considering that: 1) micro-level case studies suggest that mobile phone diffusion has positive externalities for new business formation in developing countries on a large scale (World Resources Institute, 2007; Pyramid Research, 2010); and 2) mobile phone diffusion is mediated by level of education (Abromovitz, 1986; Cohen & Levinthal, 1989; Cosar, 2011); and 3) that education is significantly related to new business formation rates (Zucker et al., 1998; Acs and Armingto, 2004; Abubakar and Mitra, 2007), we argue that this proposition is likely to hold not just for BRICs but also Non-BRICs developing countries, considering that there are rising levels of education across developing countries in general even beyond BRICs (UNDP, 2012). Therefore, based on the above, I put forth 3 hypothesis that to test the central proposition:

> ***H_1:*** In Developing Countries (including BRICs), *Mobile Phone Diffusion* will be positively related to *New Business Formation Rates* and Education Level mediates this relationship.
>
> ***H_2:*** In Non-BRICs Developing Countries, *Mobile Phone Diffusion* will be positively related to *New Business Formation Rates* and *Education Level* mediates this relationship.
>
> ***H_3:*** In LDCs, *Mobile Phone Diffusion* will be positively related to *New Business Formation Rates* and *Education Level* mediates this relationship.

Figure 3 depicts the hypothesized relationships. The link between mobile phone

diffusion and new business formation rates in developing countries is based on large number of micro-level case studies suggesting that the diffusion of mobile phones through networks between mobile phone operators and local entrepreneurs are generating opportunities for new business formation in developing countries (Stanley, 2005; World Resources Institute, 2007) and Knowledge Spillover literature suggesting that technology diffusion through networks creates opportunities for entrepreneurship (Acs and Virgil, 2009). The role of education in mediating the capabilities of entrepreneurs to utilise technology for new business formation is derived from the argument that technology diffusion often requires education (Abromovitz, 1986; Cohen & Levinthal, 1989; Cosar, 2011; see Section 5.2 of this paper for explanation of control variables).

Figure 3: Conceptual Framework of the Study



4.0 METHODOLOGY

4.1 Sample selection

Panel data set was used to test the hypotheses. The sample under study is made-up of developing countries for which data is available on new business formation rates from *World Development Indicators* (WDI, 2012). Developing countries are defined based on World Bank's classification of low-income countries (those with $1,025 or less) and middle-income countries (those with $1,026 - $12,475.) as developing countries. The sample was selected based on the following criteria: 1) developing countries, that is low and middle-income countries (this ensures that only developing countries are selected); 2) having data on new business formation rates (so as to ensure that an acceptable measure of entrepreneurship is employed) (Acs and Armington, 2004). Based on the above criteria, a sample of 66 developing countries (out of a total of 144 developing countries) was generated, for which data is available on new business formation rates 2005 – 2009 from *World Development Indicators* (WDI, 2012). Thus, the sample represents 46 percent of the total population of developing countries. The sample is further divided into the following groups: All Developing Countries (Including BRICs), Non-BRICs Developing Countries and LDCs (see Table 4).

Table 4: List of the Countries in Each Sample

Developing Countries (Inc. BRICs)	Non-BRICs	LDCs
Albania	Albania	Bhutan
Algeria	Algeria	Burkina Faso
Argentina	Argentina	Cambodia
Armenia	Armenia	Ethiopia
Azerbaijan	Azerbaijan	Madagascar
Belarus	Belarus	Malawi
Belize	Belize	Maldives
Bhutan	Bhutan	Niger
Bolivia	Bolivia	Rwanda
Bosnia and Herzegovina	Bosnia and Herzegovina	Senegal
Brazil[a]	Bulgaria	Uganda
Bulgaria	Burkina Faso	Vanuatu
Burkina Faso	Cambodia	Zambia
Cambodia	Colombia	
Colombia	Costa Rica	
Costa Rica	Dominica	
Dominica	Dominican Republic	
Dominican Republic	El Salvador	
El Salvador	Ethiopia	
Ethiopia	Gabon	
Gabon	Georgia	
Georgia	Guatemala	
Guatemala	Indonesia	

India[a]	Jamaica	
Indonesia	Jordan	
Jamaica	Kazakhstan	
Jordan	Kosovo	
Kazakhstan	Kyrgyz Republic	
Kosovo	Latvia	
Kyrgyz Republic	Lithuania	
Latvia	Macedonia, FYR	
Lithuania	Madagascar	
Macedonia, FYR	Malawi	
Madagascar	Malaysia	
Malawi	Maldives	
Malaysia	Mauritius	
Maldives	Mexico	
Mauritius	Moldova	
Mexico	Montenegro	
Moldova	Morocco	
Montenegro	Niger	
Morocco	Nigeria	
Niger	Pakistan	
Nigeria	Panama	
Pakistan	Peru	
Panama	Philippines	
Peru	Romania	
Philippines	Rwanda	
Romania	Senegal	
Russian Federation[a]	Serbia	
Rwanda	Sri Lanka	
Senegal	Suriname	
Serbia	Tajikistan	
South Africa[a]	Thailand	
Sri Lanka	Tunisia	
Suriname	Turkey	
Tajikistan	Uganda	
Thailand	Ukraine	
Tunisia	Uruguay	
Turkey	Uzbekistan	
Uganda	Vanuatu	
Ukraine	Zambia	
Uruguay		
Uzbekistan		
Vanuatu		
Zambia		

a) Member of BRICs countries. However, the data from World Development Indicators on New Business registration is not available for China, so China is not included in the sample.

4.2 The dependent variables

***New Business Formation Rates*:** The dependent variable for this study is a measure of the national rates of new business formation as measured by the number of new businesses registered per working age population in the formal sector (Acs and Armington, 2004; World Bank, 2010). The data is drawn from *World Development Indicators* (WDI, 2012), which provides panel data on the number of limited liability firms registered for the first time between 2005 and 2009 (WDI, 2012). The study is limited to new business registration in the formal sector, not only because of lack of cross-country data on informal sector business start-ups (World Bank, 2010) but also because of advantages of formal sector participation, which include greater high-growth potentials (Schneider and Enste, 2000; World Bank, 2010).

4.3 The independent and mediator variables

***Mobile Phone Diffusion*:** To measure mobile phone diffusion across countries, this paper uses data on mobile cellular subscriptions (per 100 people) from 2005-2009 WDI (WDI, 2012). These are subscriptions made for mobile phone services based on cellular technology that gives access to the public switched telephone network (WDI, 2012).

Education Level: To measure the level of education in each country, this study uses the UN Education index, which is one of the most recognized measures of education level across countries. This measures the mean of years of schooling for adults aged 25 years and also expected years of schooling for children of school entering age. The data for the Education index was obtained from UNDP's Human Development Index for the years 2005-2009 (UNDP, 2012).

4.4 Controls: other factors that may affect new business formation rates in different developing economy contexts

In order to ensure rigorous tests of the hypothesized relationships, this study uses a range of control variables on other factors that may affect new business formation rates in different developing economy contexts. Since the number of new businesses in each geographical area or country would tend to be proportional to the size of the area (Acs and Armington, 2004), control is applied for the size of country by using numbers of new businesses 'per working age population' (WDI, 2012). This is because ***working age population*** is preferred to population or employment as a size indicator, because it is a better measure of the number of potential entrepreneurs (Acs and Armington, 2004: p.250). This labour market approach has a particular appeal in that the entrepreneur starting a new business is assumed to live in the same geographic area as the new business and to have benefited from spillovers within that

geographic area (Acs and Armington, 2004). Using controls for working age population is particularly important especially when BRICs are considered in the sample, because large workforce is considered as one of the key determinants of the economic performance of BRICs (Goldman Sachs, 2003). A control variable for ***Migrant Returnees from Developed Countries*** was also included into the analysis, since returning migrants from developed countries may also contribute to entrepreneurship in developing countries (Saxenian, 2005). This again is particularly important because some studies in some BRICs countries and some emerging countries have observed that migrants in developed countries are contributing to entrepreneurial experimentation and upgrading in their home countries (Saxenian, 2005; Yang, 2005; Wahba and Zenou, 2012). The data for *Migrant Returnees from Developed Countries* was obtained from OECD StatExtracts - 2005-2009, data on outflows of foreign population from OECD countries (OECD, 2012). Controls are also included for *University Research,* because the Knowledge Spillover Theory argues that it is an important input in the entrepreneurship process as it generates the new knowledge needed for new businesses formation (Audretsch, Lehmann and Warning, 2005). *University Research* is measured using data on number of scientific and technical journal articles published, which was obtained from *World Development Indicators* 2005-2009 (WDI, 2012). Also, control for ***Population Growth*** was added because a growing population often increases the supply of potential founders of new businesses, or even growth in existing businesses (Acs and Armington, 2004). This is especially important because some LDCs are included in the sample, and economic performance in LDCs may be affected by population growth (UNCTAD, 2011: p.3). The data was obtained from *World Development Indicators* 2005-2009 (WDI, 2012). In addition, control was applied for varying rates of ***Economic Growth*** across the developing countries, as research suggests that economic growth as measured by GDP growth may influence entrepreneurship (Wong, Ho and Autio, 2005). Economic growth was measured using GDP growth, as reported in data from *World Development Indicators* 2005-2009 (WDI, 2012). Further, controls are also applied for ***Foreign Direct Investment (FDI)***, because research suggests that FDI influences entrepreneurship in some developing countries like China (Fu, 2008). FDI was measured using data on FDI, net inflows from *World Development Indicators* 2005-2009 (WDI, 2012).

4.5 Analytic methods and robustness

Baron and Kenney's (1986) test of mediation and Sobel's (1982) Test of indirect effects were both used for the analysis in order to ensure robust results. Baron and Kenney's (1986) test of mediation involves establishing four conditions: 1) ***Step One:*** *The Independent Variable* (that is Mobile Phone Diffusion) is significantly related to the *Dependent Variable* (that is New Business Formation Rates); 2) ***Step Two:*** The *Independent Variable* (that is Mobile Phone Diffusion) is significantly related to the *Mediator Variable* (Education Level); ***Step Three:*** The *Mediator Variable* (Education Level) is significantly related to *the Dependent Variable* (that is New Business Formation Rates); ***Step Four:*** When controlling for the effects of the *Mediator Variable* (Education Level) on *Dependent Variable* (that is New Business Formation

Rates), the effect of the *Independent Variable* (that is mobile phone diffusion) on the *Dependent Variable* (that is New Business Formation Rates) is no longer significant. Baron and Kenney's procedure is a common approach used to test mediators (Berger, Cunningham and Kozinets, 1999; Suliman, 2002; Preacher and Hayes, 2004; Zhu, Chew and Spranger, 2005). The regressions are based on ordinary least squares (OLS). Hierarchical regressions were also in testing the Steps 3 and 4 of Baron and Kenney's procedure.

Table 5 presents descriptive statistics for the key variables. The results reveal some important findings in relation to the key variables (that is *New business formation rates, Mobile phone diffusion rates* and *Human Capital*). First, the full sample containing ALL DEVELOPING COUNTRIES (INC. BRICS) has only slightly higher values than the sample containing NON-BRICS DEVELOPING COUNTRIES in relation to the key variables. Thus, although the ALL DEVELOPING COUNTRIES (INC. BRICS) sample appears to have slighter higher values, the difference does not appear to be much, in comparison to the NON-BRICS DEVELOPING COUNTRIES sample. This is likely because of the existence of other emerging economies such as the Next11 in the NON-BRICS DEVELOPING COUNTRIES sample. Secondly however, the sample containing LDCs appears to have significantly lower values in comparison to ALL DEVELOPING COUNTRIES (INC. BRICS) in all the key variables (that is *New Business Formation Rates, Mobile Phone Diffusion* and *Human Capital*). This suggests considerably lower levels of *New Business Formation Rates*, *Mobile Phone Diffusion Rates* and *Human Capital* in LDCs.

Table 5: Key Variables: Summary Statistics for developing countries

	ALL DEV. COUNTRIES (INC. BRICS)			**NON-BRICS DEV. COUNTRIES**			**LDCs**		
	Obs.	**Mean**	**S.D.**	***Obs.***	**Mean**	**S.D.**	***Obs.***	**Mean**	**S.D.**
New Business Formation Rates	317	1.8315	2.35147	298	1.8254	2.39544	64	.7942	1.42972
Mobile Phone Diffusion Rate	325	63.7149	39.56118	305	63.0114	39.43357	65	23.6761	29.74651
Education Level	310	.6257	.16527	290	.6248	.16753	55	.3749	.13013
GDP Growth	330	5.1531	5.39840	310	5.1710	5.47036	65	6.6120	4.44473
Population Growth	330	1.2145	1.08715	310	1.2400	1.10411	65	2.5419	.67489
Scientific and Technical Journal Articles	325	25.6812	33.58535	310	24.1141	32.75131	65	3.9835	3.65166
FDI, Net Inflows	323	3.9907E9	8.43611E9	308	2.6233E9	4.47590E9	65	3.0721E8	3.33341E8
Migrant Returnees from Developed Countries	325	.4066	.68537	310	.4205	.69861	65	.0819	.11473

5. RESULTS: TESTING FOR MEDIATION USING BARON AND KENNEY'S PROCEDURE

5.1 Step One

First, based on Baron and Kenney's (1986) procedure, the relationship between *Mobile Phone Diffusion* (independent dependent variable) and *New Business Formation Rates* (dependent variable) is investigated. Therefore, the standardised regression coefficient (beta) is assessed to determine the size of the relationship and whether it is significant. I employ several control variables, and the analysis for each research context is carried-out separately. If this association is not significant, there is no mediation as there is no relationship to mediate. Different results are presented in Table 6 for ALL DEVELOPING COUNTRIES (INC. BRICS) and NON-BRICS DEV. COUNTRIES and LDCs based on Baron and Kenney's Step 1 procedure for testing mediation (Baron and Kenney's, 1986; Zhu, Chew and Spranger, 2005). The Table shows the Adjusted R^2 for ALL DEVELOPING COUNTRIES (INCLUDING BRICS) *(Adj. R^2 =.147)* and NON-BRICS DEVELOPING COUNTRIES *(Adj. R^2 =.137)* and LDCs *(Adj. R^2 =.440)*. Although only a small amount of variance is explained in *New Business Formation Rates* by *Mobile Phone Diffusion*, this Table shows that the relationship is significant for ALL DEVELOPING COUNTRIES (INCLUDING BRICS) *(F = 11.231, p <.001)* and NON-BRICS DEVELOPING COUNTRIES (F = 10.045, p <.001); and LDCs (F = 10.820, p <.001). Thus, in all the three contexts, the relationship between *Mobile Phone Diffusion* (independent dependent variable) and *New Business Formation Rates* (dependent variable) appears to be significant.

Table 6: Mobile Phone Diffusion and New Business Formation Rates in Developing Countries

	ALL DEVELOPING COUNTRIES (INCLUDING BRICS)	**NON-BRICS DEVELOPING COUNTRIES**	**LDCs**
	New Business Formation Rates *(Model 1)*	**New Business Formation Rates** *(Model 1)*	**New Business Formation Rates** *(Model 1)*
Mobile Phone Diffusion	.185** (2.788)	.178*** (2.629)	.418*** (3.353)
Education Level			
GDP Growth	.064 (1.219)	.060 (1.108)	.418*** (3.353)
Population Growth	-.103 (-1.530)	-.096 (-1.401)	.087 (.933)

Scientific And Technical Journal Articles	.046 (.705)	.037** (.557)	-.087 (-.829)
FDI, Net Inflows	-.002 (-.046)	-.044 (-.817)	-.066 (-.711)
Migrant Returnees From Developed Countries	.188*** (3.191)	.200*** (3.292)	-.097 (-.756)
Constant	(2.215)*	(2.273)*	(.015)
F	11.231***	10.045***	10.820***
Obs.	358	342	76
Adjusted R^2	.147	.137	.440

$^{+}$Sig. at the 0.1 level; *Sig. at the 0.05 level; **Sig. at the 0.01 level; ***Sig. at the 0.001 level (2-tailed)

5.2 Step Two

Second, the relationship between *Mobile Phone Diffusion* and *Education level* is tested and the beta examined for its size, its direction and significance. Again, many control variables are employed and each research context is analysed separately. If this relationship is not significant, then the hypothesised role of Education Level as a mediator cannot hold. Table 7 below presents the results. Separate results are presented for ALL DEVELOPING COUNTRIES (INC. BRICS) and NON-BRICS DEVELOPING COUNTRIES and LDCs. This is based on Baron and Kenney's Step 2 procedure for analysing mediation (Baron and Kenney's, 1986; Zhu, Chew and Spranger, 2005). Table 7 depicts the Adjusted R^2 for ALL DEVELOPING COUNTRIES (INCLUDING BRICS) *(Adj. R^2 =.584)* and NON-BRICS DEVELOPING COUNTRIES *(Adj. R^2* =.582) and LDCs *(Adj. R^2* =.486*)*. The findings suggest that *Mobile Phone Diffusion* is significantly related to the *Education Level* for ALL DEVELOPING COUNTRIES (INCLUDING BRICS) *(*F = 71.751, p <.001*)* and NON-BRICS DEVELOPING COUNTRIES (F = 67.710, p <.001); and LDCs (F = 9.507, p <.001). Therefore, in all the research contexts, the relationship between *Mobile Phone Diffusion* and *Education level* appears to be significant.

Table 7: Mobile phone diffusion is significantly related to the Education Level in Developing Countries

	ALL DEVELOPING COUNTRIES (INCLUDING BRICS)	NON-BRICS DEVELOPING COUNTRIES	LDCs
	Education Level *(Model 1)*	**Education Level** *(Model 1)*	**Education Level** *(Model 1)*
Mobile Phone Diffusion	.244*** (4.745)	.223*** (4.268)	.406* (2.211)
Education Level			
GDP Growth	-.007 (-.167)	-.005 (-.128)	.016 (.158)
Population Growth	-.575*** (-11.020)	-.592*** (-11.116)	-.433*** (-3.448)
Scientific And Technical Journal Articles	.060 (1.231)	.038 (.780)	.301* (2.344)
FDI, Net Inflows	-.036 (-.902)	.059 (1.468)	.363*** (3.636)
Migrant Returnees From Developed Countries	-.019 (-.433)	-.023 (-.503)	-.315 (-1.669)
Constant	(26.664)***	(26.228)***	(5.915)***
F	71.751***	67.710***	9.507***
Obs.	303	288	55
Adjusted R^2	.584	.582	.486

[+]Sig. at the 0.1 level; *Sig. at the 0.05 level; **Sig. at the 0.01 level; ***Sig. at the 0.001 level (2-tailed)

5.3 Steps Three and Four

Finally, a hierarchical regression is performed in two steps. At Step Three of Baron and Kenney, the association between *Education Level* and *New Business Formation Rates* in Developing Countries is examined in the three research contexts. At Step Four, the relationship between *Mobile Phone Diffusion* and *New Business Formation* (tested earlier in Step One above) is examined again.

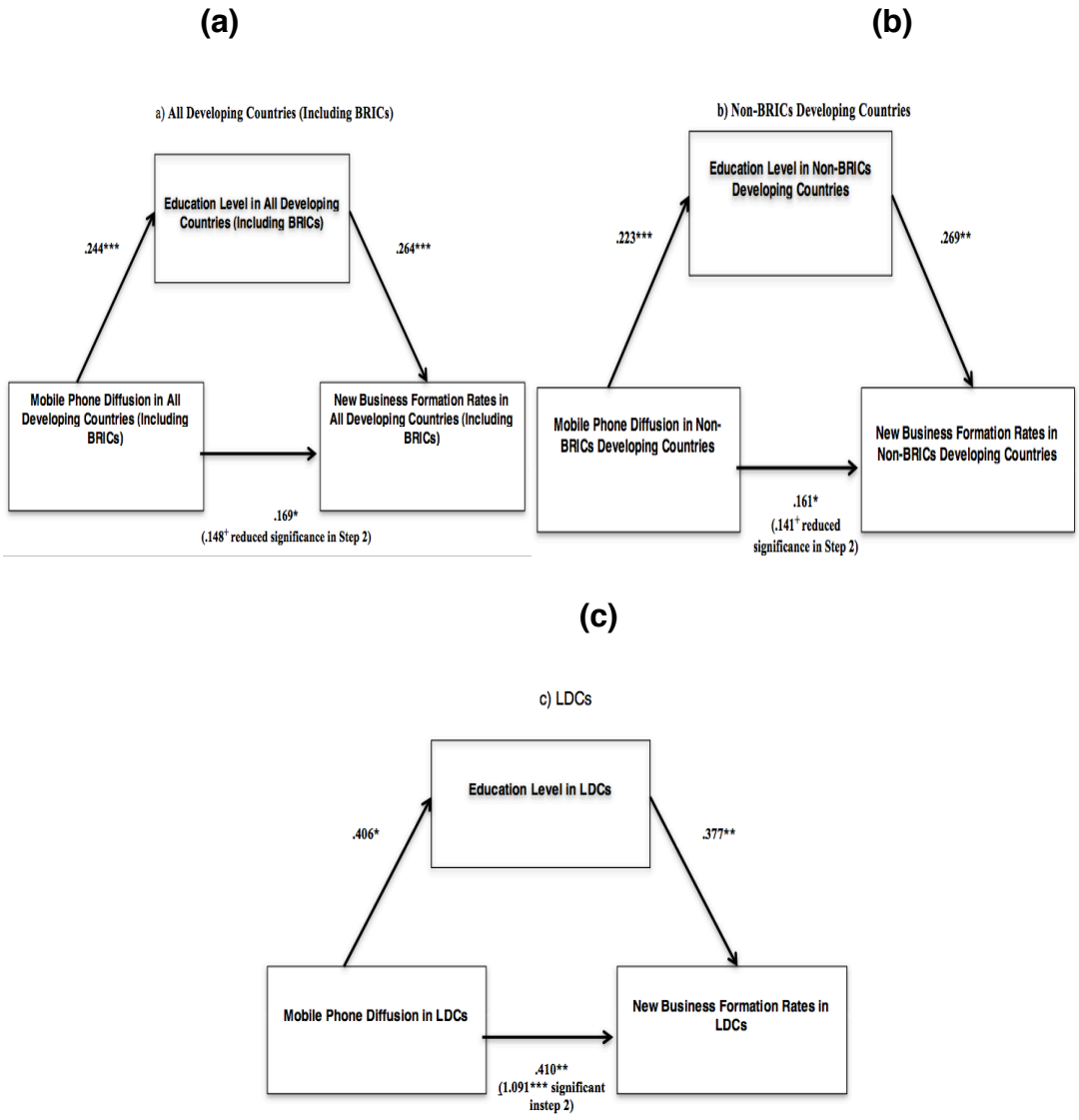
Partial vs. full mediation: The beta for Step Four is now examined. If *Education Level* is indeed a mediator, then the significant association between *Mobile Phone Diffusion* and *New Business Formation* observed in Step One (above) should no longer be significant. But if the regression coefficient is considerably reduced at the final step, but remains significant, then that implies partial mediation. Table 8 shows the two-step analysis. For ALL DEVELOPING COUNTRIES (INCLUDING BRICS), at Step Three, *Education Level* explains 26.4 percent of the variance in *New Business Formation Rates* (p<0.001). At Step Four, the effect of *Mobile Phone Diffusion* is reduced to only being significant at (p <0.1). Therefore, the final step suggests partial mediation for ALL DEVELOPING COUNTRIES (INCLUDING BRICS). For NON-BRICS DEVELOPING COUNTRIES at Step Three, *Education Level* explains 26.9 percent of the variance in *New Business Formation Rates* (p<0.001). At Step Four, the effect of *Mobile Phone Diffusion* is reduced to only being significant at (p <0.1). Therefore, the final condition for establishing partial mediation has also been met for NON-BRICS DEVELOPING COUNTRIES. For LDCs at Step Three, *Education Level* explains 37.7 percent of the variance in *New Business Formation Rates* (p<0.001). At Step Four, *Mobile Phone Diffusion* still adds significantly to the variance explained (p<0.001). Therefore unlike the other research contexts, for LDCs the final condition for establishing mediation has 'not' been met (see Figure 4a,b and c for a summary of empirical results).

Table 8 Education Level as Mediator between Mobile Phone Diffusion and New Business Formation Rates in Developing Countries

	ALL DEVELOPING COUNTRIES (INCLUDING BRICS)		NON-BRICS DEVELOPING COUNTRIES		LDCs	
	Education Level *(Step 1)*	**New Business Formation** *(Step 2)*	**Education Level** *(Step 1)*	**New Business Formation** *(Step 2)*	**Education Level** *(Step 1)*	**New Business Formation** *(Step 2)*
Mobile Phone Diffusion		.148+ (1.927)		.141+ (1.819)		1.091*** (10.087)
Education Level	.264*** (3.218)	.221** (2.604)	.269** (3.170)	.229** (2.631)	.377** (2.662)	.096 (1.140)
GDP Growth	.072 (1.318)	.106+ (1.847)	.071 (1.264)	.102 (1.745)	.058 (.585)	.195** (3.366)
Population Growth	-.029 (-.332)	.003 (.029)	-.012 (-.133)	.020 (.221)	-.155 (-1.118)	-.045 (-.569)
Scientific And Technical Journal Articles	.050 (.707)	.019 (.271)	.042 (.603)	.014 (.200)	.119 (.876)	.131+ (1.720)
FDI, Net Inflows	.008 (.137)	.003 (.047)	-.058 (-.983)	-.061 (-1.039)	-.182 (-1.587)	-.120+ (-1.845)
Migrant Returnees From Developed Countries	.202** (3.167)	.195* (3.067)	.216*** (3.278)	.210** (3.186)	.325* (2.269)	-.404*** (-3.726)
Constant	(-1.023)	(-1.306)	(-1.019)	(-1.313)	(-.350)	(-1.275)
Obs.	291	291	277	277	54	54
Adjusted R^2	.170	.178	.162	.169	.506	.843
R Square	.187	.198	.180	.190	.562	.864
R Square Change	.187	.011	.180	.010	.562	.301
F Change	10.888***	3.714+	9.899***	3.309+	10.060***	101.757***

+Sig. at the 0.1 level; *Sig. at the 0.05 level; **Sig. at the 0.01 level; ***Sig. at the 0.001 level (2-tailed)

Figure 4: Summary of Empirical Results



5.4 Sobel Test and the indirect effects

The Baron and Kenney's (1986) procedure utilised above does not indicate whether or not the indirect effect of the *Mobile phone diffusion* through the *Education Level* is significant. The Sobel Test (Sobel, 1982) can be used to test whether the indirect effect of the *Mobile Phone diffusion* on the *New business formation rates* through the *Education Level* is significantly greater than zero. The Sobel test entails the use of unstandardised regression coefficients for the effects of the independent variable (Mobile phone diffusion) on the Mediator Variable (Education Level) and the Mediator Variable (Education Level) on the Dependent Variable (New business formation rates) and their standard errors. The unstandardised coefficients and their standard errors for the relationship between *Mobile phone diffusion* and *Education*

Level for ALL DEVELOPING COUNTRIES (INCLUDING BRICs) are: (unst. coefs: 001; Std. Error: 000); NON-BRICs DEVELOPING COUNTRIES (unst. coefs: 001; Std. Error: 000); LDCs (unst. coefs: 002; Std. Error: 001). The unstandardised coefficients and their standard errors the relationship between Education Level and New business formation rates) are: ALL DEVELOPING COUNTRIES (INCLUDING BRICs) (unst. coefs: 3.750; Std. Error: 1.165); NON-BRICs DEVELOPING COUNTRIES (unst. coefs: 3.838; Std. Error: 1.211); LDCs (unst. coefs: 2.962; Std. Error: 1.112). A Sobel test performed for ALL DEVELOPING COUNTRIES (INCLUDING BRICs) shows that the indirect effect of *Mobile phone diffusion* on *New business formation rates* through *Education Level* is significant (p <0.001). For NON-BRICs DEVELOPING COUNTRIES, the indirect effect of *Mobile phone diffusion* on *New business formation rates* through *Education Level* is significant (p <0.001). In contrast, for LDCs the indirect effect of *Mobile phone diffusion* on *New business formation rates* through *Education Level* is not significant (p <0.1).

6. CONCLUSIONS AND IMPLICATIONS

This paper examines the extent to which *Education level* mediates the relationship between *Mobile phone diffusion* and *New business formation* rates in three contexts: ALL DEVELOPING COUNTRIES (INCLUDING BRICS), NON-BRICS DEVELOPING COUNTRIES and LDCs. The central finding of the paper is that while the relationship between *Mobile phone diffusion* and *New business formation* rates in ALL DEVELOPING COUNTRIES (INC. BRICS) follows a positive pattern, that relationship appears to be partially mediated by *Education level* of the developing countries. This finding also appears to hold even in NON-BRICS DEVELOPING COUNTRIES, which is likely due to existence of other emerging economies like the Next11 highlighted by Goldman Sachs (2007). However, in the context of LDCs, it was found that although the relationship between *Mobile phone diffusion* and *New business formation rates* also follows a positive pattern, the relationship is not appear to be significantly mediated by *Education Level*.

6.1 Implications for theory and policy

The analysis contributes to the Knowledge Spillover Theory of entrepreneurship in developing countries in at least three important ways. First, it establishes a macro-level connection (for the first time) between a developing country's level of technology, that is, *Mobile phone diffusion* and the country's *New business formation rates*. Secondly, the paper suggests that although the relationship between *Mobile phone diffusion* and *New business formation rates* in developing countries is mediated by *Education level* even in NON-BRICS DEVELOPING COUNTRIES, the role of *Education Level* as a mediator of the relationship does not appear to be significant in LDCs. Thus, within developing countries, differences in contextual settings need to be taken into account when analyzing the role of *Education Level* in mediating the link between *Mobile phone diffusion* and *New business formation rates*. Thirdly, the

empirical analysis is based upon rigorously collected authoritative multi-country data from WDI that answers the concern voiced by researchers for the dearth of macro-level empirical research on viability of Knowledge Spillover Theory across developing countries (Acs and Virgill, 2010).

The findings imply that governments in developing countries may need to consider developing appropriate policies for encouraging mobile phone corporations to network with local entrepreneurs, which can result in more opportunities for new business formation for local entrepreneurs. Secondly, the findings suggest that such mobile phone start-ups in LDCs may simply be non-knowledge-based mobile start-ups, which contrasts with those in emerging economies, that is BRICs and Next11 where education appears to significantly matter. As such governments in LDCs may wish to strengthen the relationship between *Mobile phone diffusion* and *New business formation rates* by making it more knowledge-based through encouraging education especially related to mobile phone technology. Such education development may have the effect of building the citizen's capacity to become knowledge-based innovative entrepreneurs in the mobile phone industry (Acs and Armington, 2004).

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