The relationship between information and communication technologies and foreign direct investment at the different stages of investment development path

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Abstract

Foreign Direct Investment (FDI) has grown exponentially in the recent past and has become one of the most important measures of globalisation. Today, Information and communication technologies (ICT) are viewed as one of the necessary conditions for the globalisation of business activities. ICT is also seen as a general purpose utility in many developed countries. Additionally, in many developing and so called emerging economies, there have been significant investments in ICT. Very recent studies show that the adoption and investment in ICT leads to economic growth and productivity gains at a macro-level. However, the link between ICT and FDI needs further exploration, especially in least developed and developing countries. This study aims to shed more light on internal factors that might explain the behaviour of FDI in emerging and developing economies and to understand if ICT capabilities of economies play a significant factor in foreign direct investments.

The results from the study show that there is indeed a relationship between ICT and FDI in developing and developed countries; however, this relationship is not significant in least developed countries.

Keywords

Foreign direct investment, Information and communication technologies, international business, Investment development path

Declaration

I declare that this research project is my own work. It is submitted in partial fulfilment of the requirements for the degree of Master of Business Administration at the Gordon Institute of Business Science, University of Pretoria. It has not been submitted before for any degree or examination in any other University. I further declare that I have obtained the necessary authorisation and consent to carry out this research.

Deepu Alexander

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Name	Signature	Date

Acknowledgement

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Chapter 1: Introduction to research problem

Today, Information and Communication Technologies (ICT) is seen as one of the core competitive strategies for the globalisation of business activities, thanks to its ability to empower individuals with information and knowledge, enable better interactions and new ways of doing business, amongst others. ICT has evolved rapidly in the last decade and the underlying infrastructure and technology has since changed to an extent that today it is seen as a General Purpose Technology (GPT) at a macro level (von Tunzelmann, 2003; Jovanovic & Rousseau, 2005) just as electricity was seen as a general purpose technology in the industrial age. Furthermore, there is a general agreement that the adoption and the effective utilisation of ICT at a micro level can bring about competitive advantages (Bharadwaj, 2000) and also lead to financial performance advantages over competitors (Dehning & Stratopoulos , 2000).

Similarly and in parallel to the ICT advancements is the phenomenon of globalisation; where today, economies are very closely linked with each other through the exchange of goods, services, information and knowledge. The close integration of these economies has led to the exponential growth of Foreign Direct Investment (FDI) and it has become one of the important measures of globalisation. According to Organisation for Economic Co-operation and Development(OECD, 1999) the FDI reflects the objective of obtaining a lasting interest by a resident entity in one economy (‘‘direct investor’’) in an entity resident in an economy other than that of the investor (‘‘direct investment enterprise’’).

The lasting interest implies the existence of a long-term relationship between the direct investor and the enterprise and a significant degree of influence on the management of the enterprise. Direct investment involves both the initial transaction between the two entities and all subsequent capital transactions between them and among affiliated enterprises; both incorporated and unincorporated (OECD, 1999).

In the mid to latter part of the twentieth century, we witnessed a significant amount of FDI from developed countries; where developed countries invested in other developed countries (North-North investment) or developing countries (North-South investment). During this timeframe, these countries also invested heavily on technology and know-how and we saw enormous advancements and adoption of ICT in these developed countries. In recent times, we are witnessing the reverse process in terms of FDI: South-North investment flow, where some of the developing economies, as commonly known as the emerging economies, have gathered the know-how and the capital to invest into developed countries (Bonaglia, Goldstein & Mathews, 2006) and again, in many of these emerging economies, there have been significant investments in ICT. This trend would suggest that some form of relationship exists between the investment and adoption of ICT and FDI flows. However, the link between the level of ICT adoption and FDI, especially within developing and least developed economies has not been extensively investigated. Furthermore, within the international business research community, the study of developing and least developed countries is still in its embryonic stages.

Research Motivation

One of the central themes in international business research today revolves around developing economies, specifically the so called emerging economies and how these economies have built their global presence. Today, many of the multinationals are emerging from the so called "emerging markets" such as Brazil, China, India, Mexico and Russia. The acronym BRIC is extensively used to identify Brazil, Russia, India and China as the key emerging powers. South Africa is also considered as an emerging economy; although its inclusion along with these emerging powers to form BRICS is still being debated. Some have claimed that the twenty-first century belongs to the emerging economies (BusinessWeek, 2006); however, these trends are in the early stages and will continue in the years to come. To this end, more attention needs to be directed to these economies to gain more insights into steps and factors that helped them in their internationalisation strategy (Tsui, 2007; Gaur & Kumar, 2010) and furthermore, how other developing countries and least developed countries can adopt these strategies to enable them to be in a better socio-economic position.

Majority of the current literature is based on developed countries (Tsui, 2007; Ramamurti & Singh, 2009; Gaur & Kumar, 2010) and there is still a significant debate around the use of existing models to explain this phenomenon from emerging economies (Dunning, 2006; Mathews, 2006; Narula, 2006). Recent studies such as the one by Ramamurti and Singh (2009) have focused on identifying the emerging country-specific, industry level and the firm level characteristics that provide competitive advantages in the global context. Other

studies such as the one by Mathews (2006) have looked to explain the firm's investment strategy; to understand the motivating factors for internationalisation and the investment development path. However, further in depth understanding of the determinants of FDI is still required.

To this end, the role of ICT in a developing country's drive to internationalise needs further attention: do they play supporting role in developing economies or is ICT seen as a competitive advantage for internationalisation? Leading academics, global organizations and industry analysts tend to agree that there is a direct correlation between the use of ICT and positive macroeconomic growth in developed countries and in certain developing countries (World Economic Forum, 2009). Research (DeMaagd, 2009) also shows that ICT streamlines the costs associated with information search and also enable economies to participate in the global market. However, investment in ICT does not necessarily mean that its full potential has been realised at a macro level. These resources need to be used in an effective manner; however, in some cases these resources largely remain untapped because of a lack of awareness. Additionally, other macroeconomic components such as the level of education and skill are also required to ensure the successful adoption and diffusion of ICT tools and will lead to countries successfully participating in the global market. The link between ICT and FDI has not been fully examined, and the few existing studies show contrary results, with some studies suggest that there is a causal relationship between ICT and FDI; whilst other studies do not find any significant causality with respect to the developing countries (Gholami, Heshmati & Lee, 2005; Ko, 2007).

Research Aim

Generally speaking, leading academics and industry experts have studied FDI using macro, industrial or firm level based approaches. These experts have used macro level analysis to understand the different FDI patterns; how they differ between countries and what strategies countries employ to attract and encourage these activities. Industry level analysis has looked at identifying how the industry structure enables or becomes a deterrent for more FDI activities. At a firm level, the majority of the academics have focused on internationalisation strategies and the motivating factors for internationalisation and these approaches have led to the better understanding on international business activities. This study will consider a macro-level view; with the understanding that all the firm level and industry level FDI activities are aggregated back to a country level and furthermore, the ICT capabilities of country will have an impact on the industry and firm level ICT capabilities. The aim of this study is to shed more light on internal factors that might explain the behaviour of FDI in emerging and developing economies. The intention is to (1) understand if ICT capabilities of economies play a significant factor in foreign direct investments; (2) to understand if the theoretical framework of Investment Development Path (IDP) can be used to explain the link between ICT and FDI in developing economies and (3) the significance of relationship between ICT and FDI in the case of least developed, developing and developed countries.

Research Objectives

The fundamental question that this research looks at answering is: Do the ICT capabilities of a country play a significant factor in foreign direct investments and if so, do they play a more significant role depending on the country's position relative to the investment development path?

The following set of objectives will help in finding answers to the above mentioned question:

1. review the current literature to understand the current stance on the link between the FDI and ICT in least developed, developing and developed countries.
2. to understand if the link between ICT and FDI is influenced by the investment development path of a country
3. to understand if FDI is dependent on ICT or vice versa in developing, and developed countries.

Chapter 2: Literature Review

Following from the above, this chapter of the study provides a brief review of the academic research that has been carried out in the areas of ICT and international business and subsequently looks at the relationship between ICT and FDI. This chapter starts off by providing a brief overview of ICTs as GPTs and then briefly looks at the recent trends and current views on FDI. Since the main purpose of this study is to understand the link between ICT and FDI, this chapter will aim at taking into account some of the prevalent international business theories and its applicability to developing economies (Section 3). After having discussed the literature on the mainstream international business theories, the study will focus on the IDP framework and tries to establish a link between FDI and ICT (Section 4). Section 5 starts off by presenting evidence that suggests that ICT is an enabler of economic growth and how the adoption of ICT plays a crucial role in internationalisation. Subsequently, the study will review existing literature that suggests that there is a relationship link between ICT capabilities of a country and FDI of that specific country. Finally, this chapter ends with a brief summary of the literature review and posits that the relationship between ICT capabilities and FDI activities is closely linked with the country's IDP.

ICT as a General Purpose Technology

General Purpose Technologies (GPTs) are radical new ideas or techniques that have the potential to have an important impact on many industries in an economy and their key

characteristics are: pervasiveness, technological dynamism and innovation complementarities with other forms of advancement (Guerrieri & Padoan, 2007). Thus, it brings overall productivity gains to the economy. ICT is seen as a GPT (von Tunzelmann, 2003; Jovanovic & Rousseau, 2005; Guerrieri & Padoan, 2007) since ICT-related technologies are used in most sectors of the economy and it has brought about new ways of doing business, which includes, but is not limited to, decentralisation of decision making and production (Guerrieri & Padoan, 2007) and new ways of communicating with suppliers and other business partners (Basu & Fernald, 2006). However, one of the main issues analysed within the GPT literature has to do with the attempt to understand why GPTs are mostly, if not always, slow in fulfilling their potential for increasing productivity (Guerrieri & Padoan, 2007). This could be related to the complexity associated with the measurements of the benefits gained (Basu & Fernald, 2006) and the difficulties associated with coordinating between GPT producers and users in general (Guerrieri & Padoan, 2007).

Going beyond the production function, the substantial literature on ICT and its impact on economic performance (the subsequent sections summarises the major contributions) has also led to the recognition of the profound impact ICT has on globalisation. The rapid developments in ICT have also been identified as the main driving force for improving competitiveness behind the globalisation process; it has facilitated government decisions to liberalise and deregulate the economy and business decisions to invest overseas (Dhungana, 2003). To summarise, today ICT is seen as a tool in various sectors in both the

developed and developing countries to improve productivity, efficiency, introduce new business practices and invest globally.

Foreign Direct Investment

As mentioned earlier, one of the important measures of globalisation is the FDI activities of the different economies; however, on the other hand there has been constant debate over the past few decades on the effects that FDI has on both the home and host countries. Be it at a macro-level or a micro-level view, one of the general observations that can be made is that FDI flow has increased dramatic in the last few decades especially from developing economies (Aykut & Ratha, 2004).

The rise in FDI specifically from the so called emerging economies have been witnessed in two occasions in history; the first one being in the early 1980s and more recent one that has occurred at the turn of the century. On the first occasion, FDI from emerging countries had specific features that aligned to the country's peculiar environment - distinct political and economic circumstances and this was reflected in the manner which these firms competed and succeeded (Carvalho, n.d.; Dunning & Narula, 1998). The second and more recent occurrence has been more accelerated; with firms rapidly venturing aboard. Factors such a technological advancement (Carvalho, n.d.; Dunning & Narula, 1998) and the rapid growth in income and wealth in these developing countries (Dunning & Narula, 1998; Aykut & Ratha, 2004) were seen as some of the main reasons for this advancement.

Furthermore, the economic slowdown in the developed countries in the early 1990s increased the attractiveness of developing countries as a destination of FDI and also led to the rapid growth of intra-regional trade and investments (Aykut & Ratha, 2004). The patterns and the context have been significantly different in both these instances. Additionally, the nature of FDI has also changed with time and this could be linked to Dunning's categorisation that there are four types of motivating factors that drive firms to invest abroad: (1) in search for markets; (2) in search for resources; (3) in search for efficiency and (4) in search for strategic assets (Dunning, 2000). Although, these contexts and factors have provided a wealth of information regarding developing countries, it has also begged the question of what does these changes and new patterns mean to the mainstream international business theories and furthermore, which of these theories, if any, could explain the link between ICT and FDI? The following section briefly looks at the existing body of literature that looks to answer these questions.

International Business Theory

As mentioned above, there is a wealth of information that offers to explain the concept of FDI and several FDI theories have gained prominence in the research field. Some of the contemporary theories of FDI are (1) the internalisation theory by Buckley and Casson; (2) Dunning's eclectic paradigm, which focuses on three advantages that a company must have to succeed with FDI: Ownership (O), Location (L) and Internalisation (I); (3) the Uppsala model of internationalisation which characterises the different developmental stages of an multinational company (4) Hymer's theory of international production; (5) the

evolutionary theory by Kogut and Zander; and (6) the Investment Development Path theory by Dunning and Narula. These theories have gained prominence in the international business theory and the growing body of literature have improved on these theories over time. However, one of the main criticisms against these theories is that the majority of the international business literature has been based on studies conducted from the processes by which companies from developed countries have internationalised (Tsui, 2007; Ramamurti & Singh, 2009; Gaur and Kumar, 2010) and that many of these contemporary theories find their base from these literature studies.

Developing economies have received renewed interest in the recent years. The distinctive features from these economies have been an ongoing debate for some time (Mathews, 2006; Narula, 2006; Dunning, 2006), with some researchers arguing that the phenomena that is occurring in the developing and emerging economies can be explained using the existing theory base and that theory is applicable for all aspects of international business. The second school of thought is that the existing theory base cannot describe the phenomenon witnessed in these developing nations and suggest that a whole new set of theories need to be defined specifically for developing countries. However, more recently, there is a third school of thought that suggests that the existing theories can be used to explain some of the characteristics and advantages inherent in these countries but some modifications or additions is required to these theories to explain other aspects of the characteristics that are unique to the developing markets (Ramamurti & Singh, 2009). The majority of the researchers fall under the first or third category. These studies make

use of the existing theories to identify and categorise characteristics that are common across the different countries and investigate which characteristics are unique to these developing countries and cannot be explained by the existing theory base. The view taken in this study is that the existing theory base can explain some of the characteristics and patterns of FDI and that additional research is required to identify other aspects related to the link between FDI and ICT.

Having briefly examined the current stance within the international business research community, the next step is to understand which mainstream business theory could explain the role of ICT on FDI and vice versa for the developed, developing and least developed countries. As such, a framework that aims to capture the patterns of inward and outward Multinational Enterprises (MNE) activities from a macro perspective and links it to the ICT developments at a macro level would be sought for this study. One of the more prominent frameworks that aim to capture this FDI dynamics from the perspective of a particular country is the Investment Development Path (Dunning & Lundan, 2008). The next section focuses of the IDP framework and infers the role of ICT in different stages of IDP. The subsequent section will briefly look at the recent academic contributions related to IDP.

The Investment Development Path

The concept of IDP was put forward by Dunning in 1981 and was further developed by Narula as a means of incorporating a dynamic element into the theory of international production and as such provides a means of describing and analysing the underlying

reasons for FDI induced restructuring at the different stages of development (Dunning & Lundan, 2008). The basic hypothesis is that, as a country develops, the configuration of OLI (Ownership, Location and Internalisation) advantages facing foreign firms that might invest in that country, and of its own firms that might invest overseas changes, and that it is possible to identify the determinants of this change as well as its effects on the trajectory of development (Dunning & Lundan, 2008).

Dunning's OLI framework, which is also known as the eclectic framework suggests that there is a set of general conditions that provides firms with competitive advantages. For example, a firm looking to invest overseas might have access to certain firm specific advantages that enable it to compete effectively in the international market. At a macro level, certain country specific advantages might be certain disequilibrium between countries and this might provide some form of location based advantages or a firm might internalise internationally to compete effectively (Ramamurti & Singh, 2009). According to Dunning, there are five stages in a country's investment development path and these different stages reflect a country's net outward direct investment position in relation to the country's level of economic development. The following figure briefly outlines the five stages of the IDP model.

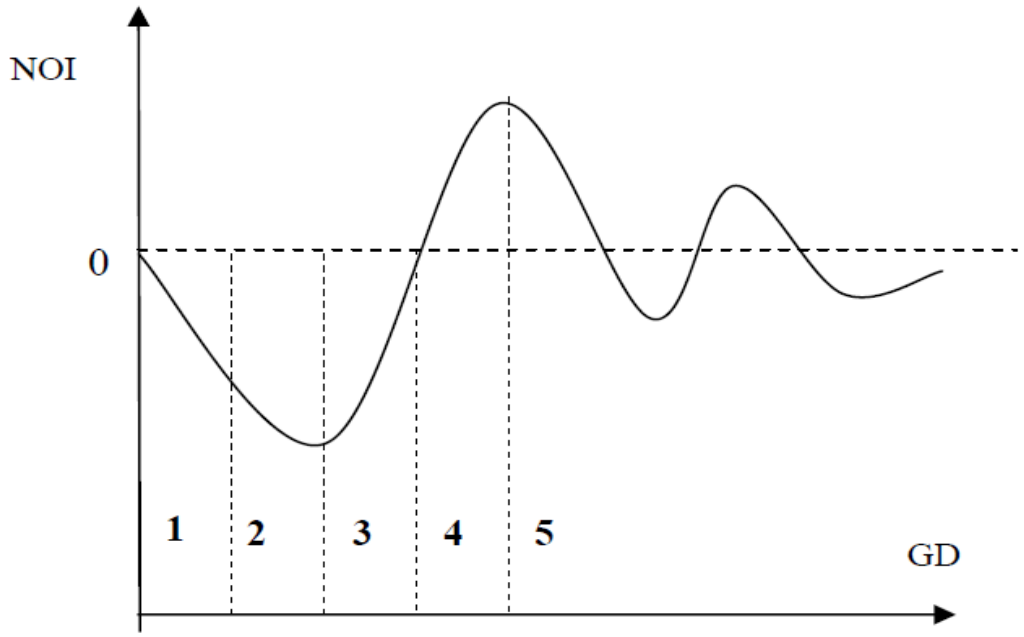


Figure 1: The five stages of the investment development path theory (adapted from (Dong, Haijian, & Xiaoming, 2009))

Stages of IDP

The following section briefly outlines the latest thinking on the different stages of the IDP framework.

Stage 1

In the first stage, countries receive minimal FDI investments and these investments are generally resource based. These countries are net receivers of FDI stocks (negative Net Outward Investment (NOI)) and these investments take advantage of the natural resources available in these countries. Hence, the focus is predominantly on the product sector and labour intensive manufacturing sectors (Dunning & Lundan, 2008). Typically, these are the least developed countries and countries at this stage have limited

infrastructure and technology capabilities. The above would suggest that ICT does not play a significant role for countries in this stage of the IDP.

Stage 2

In the second stage, countries are still net receivers of FDI albeit at a greater rate leading to less NOI. However, these investments are still focused on commodities and natural resources, as well as in industries that are intensive in physical capital and low-qualified work (Fonseca, 2007). The outward investment is still in its embryonic stages. These countries develop and improve on their competitive advantages and there is a huge increase in attention given to institutions promoting secondary education, public health, transport and communications. This improved competition and investments could potentially transform a country and prepare it to pursue an export led development strategy (Dunning & Lundan, 2008). Furthermore, there is an increased focus by governments to ensure that macroeconomic policies and supportive institutions are in place to meet the development strategies. This would suggest that the ICT capabilities of countries at this stage of the IDP would have improved and countries could consider the ICT as an important tool for internationalisation.

Stage 3

In the third stage, countries begin to make investment abroad; however, these countries are still net receivers of FDI. In this stage, the overall competitive power of these countries increases; although, there is a decline in competitive advantages related to labour intensive activities. There is an increased expense in education and training of workers and Research and Development (R&D) (Fonseca, 2007). Additionally, developing

countries in this stage are approaching economic maturity; their income level and industrial structure are beginning to resemble those of a developed country and firms from these countries may also begin to engage in efficiency-seeking or market seeking investments and asset acquiring activity (Dunning & Lundan, 2008). However, the ownership advantages of firms would be very similar to firms originating from developed countries in all sectors but the technology-intensive ones (Sangder, 2009). Based on the review of literature regarding the role of ICT in economic growth, it would imply that ICT plays a key role in these countries and firms originating from these countries. As such, the strength of the relationship between ICT and FDI is expected to be of a greater magnitude for countries in the third stage of IDP when compared with countries in the second stage of IDP.

Stage 4

In the fourth stage, the outward FDI is greater than the inward FDI flows. In this stage, the investments abroad are mainly in search for strategic assets in developed countries and also in search for new markets and cheaper labour (Vavilov, 2006). Economies at stage 4 are likely to be among the leading spenders on R&D, which, for most part, is directed towards the innovation of new products and production methods (Dunning & Lundan, 2008). ICT would play a significant role in bringing about efficiencies in production methods and also facilitating innovation activities. Given that governments at this stage aim to facilitate markets to operate efficiently (Sangder, 2009); it is expected that government would focus on investing in technological capabilities that would reduce

market inefficiencies. Furthermore, this would also suggest that economies at this stage would phase out old technology and start to invest in next generation technologies.

Stage 5

In the fifth stage, the outward and inward FDI cancel out each other; and reach an unstable equilibrium at zero. These trends of the latter stages are observable in today's industrialised nations (Dunning, 1993; Dunning & Narula, 1996 as cited (Vavilov, 2006). Very similar to the previous stage, firms become increasingly globalised and as such their nationalities become blurred (Sangder, 2009). Given the above, the more globalised a firm, the more it is dependent on ICT to facilitate business interactions. Furthermore, government plays an important role in attracting FDI, by continuously improving on its location based advantages such as its technological capabilities.

Limitations of IDP

Although this theory has been widely recognised, it has yielded mixed results in emerging and developing markets and based on the empirical evidences, some weak points in the IDP have been identified (Narula, 1996 as cited in Duran & Ubeda, 2001). Firstly, the cross sectional analysis used in IDP has also received some criticism, mainly because it is seen as a static tool that describes the relationship between variables at a specific point in time, while the IDP is essentially a dynamic concept. Other problems that have been identified are: (1) the econometric models used to date are not an adequate tool for testing IDP (Dunning & Narula, 1996 as cited in Duran & Ubeda, 2001); (2) The net outward investment FDI stock per capita (NOI = Outward FDI stock – Inward FDI stock) is an incomplete indicator for analyzing the effect of structural changes on inward and outward

FDI; (3)Gross domestic product (GDP) per capita alone is an insufficient indicator of the level of economic development of a country (Dunning & Narula, 1996 as cited in Duran & Ubeda, 2001). Duran and Ubeda (2001) suggested the inclusion of structural variables to reflect the degree of economic development, peculiarities of countries and nature of international trade. Dunning also suggested the use of inward and outward FDI stocks and the use of multivariate analysis.

To this end, one of the notable variations to the IDP put forth by Duran and Ubeda (2001) took into consideration the above mentioned issues and grouped economies according to IDP theory using a cluster technique. Based on the economy grouping, the stages of IDP was represented graphically and for each stage of IDP, the mean of outward FDI stock per capita was measured vertically and the mean of inward FDI stock per capita was measured horizontally. The economies that were above the bisecting line would have a positive net position, while those under the line would have a negative net position (Duran & Ubeda, 2001). The following figure provides a graphical representation of the positioning of different countries along the different stages of IDP as suggested by (Duran & Ubeda, 2001).

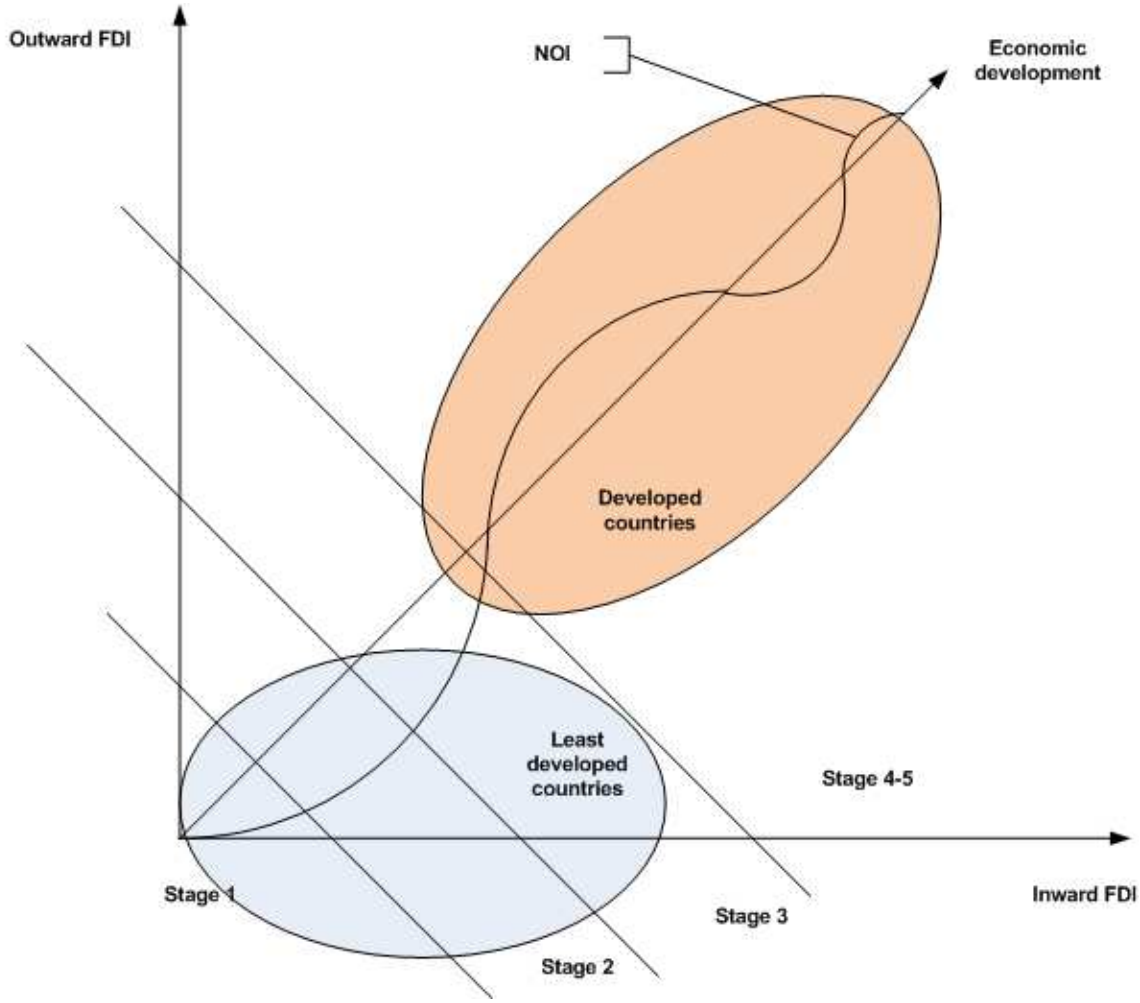


Figure 2: The positioning of different countries along the different stages of IDP proposed by Duran & Ubeda (adapted from (Fonseca,2007)).

The current state of literature on IDP

Following from the above, the following section will briefly explore the recent contributions to IDP literature specifically focusing on the relationship between FDI and IDP and investigate if there is indeed an Investment Development Path. These studies have included a range of developing and developed countries; and usually examined a

cluster of countries or individual countries using combination of statistical and historical data.

Developed countries

Numerous studies (Bellak, 2001; Duran & Ubeda, 2001; Fonseca, 2007; Morawczynski, 2009) have focused on how countries or a group of countries fit into the investment development path and how they transition across the various stages. However, these studies have shown that there is considerable variation across the different countries and how it fits into the Investment Development Path. For example in the case of Austria (Bellak, 2001) the study showed that the Austria being one of the more developed countries in the European region, did not follow the idealised IDP; with the sign of the Net Outward Investment Position (NOIP) having been negative throughout the last two decades of the twentieth century. The study suggested that geographical and institutional structure play a role in the investment position of the country. In the case of Ireland (Barry, Gorg & Mcdowell, 2003), the evidence was consistent with the IDP theory. In the case of Portugal (Fonseca, 2007), the study found that Portugal followed the IDP paradigm. However, this study also evaluated 25 other countries which also included U.S.A., Japan, Republic of Korea and 22 other European Union countries. The study generally found that the countries represented in the study followed the pattern idealised by IDP: a U or J-shape relationship between GDP and NOI. Another study by Boudier-Bensebaa (2008), investigated the IDP paths followed by the Central and Eastern European countries (CEECs) using econometric and statistical analysis. The results

suggested that the position of the CEECs is at stage one or two of the IDP; however, the NOIP position worsened over time which was contrary to the theory.

Developing countries

Recently, there has been significant focus on developing nations and its fit with the IDP; given that many of these developing countries are engaging with outward investments whilst being in the early stages of IDP. Some of these countries include Brazil, China, India, Mexico, South Africa and China (UNCTAD, 2006). In the case of India, Sathye (2008) investigated whether the relationship between India's economic development and its foreign direct investment flows shows a specific pattern, similar to the one described in the IDP theory. The results suggested that in the initial stages of development, this relationship shows a pattern which is similar to the one expected as per the IDP theory. However, in the third stage, the pattern is different from the one identified in the IDP theory. In the case of China, Bucka, Luia and Shub (2005), suggested that the Dunning's original IDP hypothesis was insufficiently developed to accommodate Chinese institutional factors. Although this study proposed additional variables to accommodate the variables unique to China; the study found evidence that China's OFDI patterns were largely consistent with the IDP hypothesis, and there was no need to cite China's institutions and unique path to economic reform as having a direct influence on OFDI. Another recent study by Dong, Haijian, and Xiaoming (2009) investigated the relationship between the inward foreign direct investment and GDP, and found that the relationship between the foreign direct investment and GDP are both in accordance with Dunning's IDP theory. According to this study, China has already entered the third stage in IDP theory.

In summary the existing research would tend to agree with Dunning's IDP framework and confirm that a country's investment position is related to its level of development. As expected, the existing studies also suggest that the IDP for countries vary depending on the socio economic policies that are adopted by these countries. Following from the previous sections, if the existing strand of literature regarding ICT and economic growth is taken for granted; then, at a conceptual level, one could infer that there is a relationship between a country's investment position and ICT. The following section summarises the current literature on the relationship between FDI, which is a major part of the investment position of a country and the ICT capabilities of a country.

The ICT paradigm

The impact and the diffusion of ICT on a country's economy has produced mixed results. It has directly affected some industries such as telecommunications industry and indirectly impacted the whole economic system of some leading countries (Guerrieri & Padoan, 2007). Furthermore, the diffusion of ICT could also to be linked to other factors such as the national institution and policies adopted by a specific country and this could explain the distinct paradigms that are witnessed in developed, developing and least developed countries.

ICT as an enabler of economic growth

There has been considerable research on the economic impact of ICT on growth. A variety of the methodologies such as cross-country regression analysis have been used to measure this relationship and to a certain degree the methodology used depends on the data available and economic specifications (Koutroumpis, 2009). There is a general agreement that ICT is directly correlated to the economic growth of developed countries (Colecchia & Schreyer, 2001; Timmer, vanArk & Ypma , 2003; Siegel & Indjikan, 2005; Oh, Lee & Seo, 2009). These studies suggest that despite the differences between developed countries, these countries have benefitted from the positive effects of ICT investments on economic growth. Colecchia and Schreyer (2001) go on to further suggest that ICT diffusion plays a key role and the right framework conditions play an important role in releasing this growth. Based on evidence from developed countries, many researchers have argued that ICT infrastructure is essential to the rapid development of emerging economies (Morawczynski & Ngwenyama, 2009) and have tried to analyse the relationship between ICT diffusion and economic growth in developing economies.

Mainly, studies have looked to address questions such as (1) Does investment in ICT provide a competitive advantage to developing countries? (2) Does ICT investment widen the growth gaps and if so, what impact this has on latecomers versus early adopters? However, the relationship between ICT and economic growth is not straightforward in the developing economies (Heshmati & Yang, 2006) and various studies show contradictory

results (Osei-Bryson & Samoilenko, 2008). For example, a study by Bedi, Chowdhury and Torero (2002) found the growth effects were the strongest for a telecommunications penetration rate of between five and fifteen percent. This study suggested that the developing countries needed to continue investment into the telecommunication infrastructure to reap positive benefits and that marginal improvements in the telecom infrastructure were not likely to yield any discernible growth effects. A subsequent study by Sridhar and Sridhar (2004) investigated the relationship between telecommunications and the economic growth using data for developing countries. In their study, they found significant effects of main landline and cell phone penetration on economic growth, whilst controlling the effects of capital and labour, but this was lower than that found for OECD countries. However, this study is contrary to a later study by Rouvinen (2006), which suggested that late entrants in digital telephony benefited more than the early adopters and categorised developing countries as late entrants. The study suggested that although the diffusion rate of mobile telephony in developing countries was different when compared with developed countries, the speed of adjustment was not too different. The study attributed the difference in benefits gained to the uncertainties related to telephony standards and dominant designs.

The difference could potentially be a result of the view taken by a specific country regarding ICT in the economic development process of that country. The one view is that technology is deployed based on the benefits that specific technology could provide - a more techno-centric view. An example would be a country that plans to promote services

based activities at a macro level might see a higher value from deploying ICT than another country that is predominately focused on an agrarian or manufacturing based activity. These countries might not see the same benefits from deploying such advanced technologies. On the other hand, the alternate view is that the choice of technology is irrelevant as long as it meets the social requirements and some countries deploy such technology for the sake of meeting some of these requirements promised to its citizens. Additionally, the concept of "leapfrogging" in terms of developing economies deploying next generation technologies and thereby enabling these countries to skip the intermediary steps of economic development could also be one of the reasons behind the exponential growth in FDI.

Chein and Wang (2007) investigated the relationships between technology development and economic performance for The Association of Southeast Asian Nations (ASEAN) countries. Interestingly, this study did not find a positive correlation between information technology and economic performance in the case of Singapore, Malaysia and Brunei. However, there was a negative correlation between technology development and economic performance in the case of Thailand, Indonesia, Philippines, Cambodia, Laos, Myanmar and Vietnam. These results would suggest that it is very difficult to generalise the role of ICT in economic development, given that one would expect that ICT would have played a significant role in countries such as Singapore and Malaysia; countries that are part of the Asian "tiger economies" and usually considered as one of Asia's richest countries.

On the other hand, a very recent study by Oh *et al.* (2009) found a positive correlation between ICT investment and economic growth based on data from 39 countries in the 1990s. This study also consisted of some of the transitioning economies such as Thailand, China, Indonesia and India. This study also found that non ICT investment has a similar influence on growth gap as ICT investment. This study would suggest that both non ICT and ICT investment has a significant impact on the economic growth of a country and could potentially be considered a general purpose technology given that GPTs are techniques and technologies that have the potential to have an important impact on many industries in an economy.

To this end, the current body of literature would suggest that some economies have managed to achieve significant value from ICT expansion; whilst others still face significant difficulties. Many of these studies (Osei-Bryson & Samoilenko, 2008; Jalava & Pohjola, 2007; Morawczynski & Ngwenyama, 2009) also suggest that a certain threshold needs to be reached in terms of ICT investment before economic growth can be achieved and that this threshold condition explains the difference in results. Furthermore, in order to maximise social returns to IT investment, policymakers in developing countries must address two key deficiencies: (1) a lack of knowledge of ‘‘best practices’’ in IT usage and (2) IT-related skill deficiencies in the workforce (Indjikan & Siegel, 2005).

At this point in time, it would seem that it is still premature to reach any conclusions regarding the link between ICT and economic growth in developing and transitional economies. Given the above, the view that one of the primary determinants of globalisation is the rapid introduction and implementation of new technologies, such as ICT, needs to be investigated in greater detail, especially in the developing countries.

The relationship between ICT and FDI

According to te Velde (2006), ICT developments have had a profound impact on the way companies structure their international activities and more importantly it has facilitated more specialised production attracted to those locations that can offer the most competitive environment for any given activity. Additionally, Addison and Rahman (2005) as cited in Gholami *et al*. (2005) suggest that economies that successfully implement new ICT might be able to overcome barriers that have long held them back in their contribution in global trade (for example, the limitation of a remote geography and an unfavourable climate). ICT infrastructure and skills are now critical in integrating local producers into international Business to Business (B2B) networks, and in attracting vertical FDI in services as well as manufacturing (Addison & Heshmati, 2004). As mentioned earlier, at a national level the ability to adapt ICT as business enabler is central to global expansion. One of the earlier studies by Choi (2003) found that the development of the Internet in a host country induced inward FDI significantly and also found evidence that Internet availability in a host country as one of the main factors in inducing FDI. This study used 14 source countries and 53 host countries; however, the study did not differentiate between

developing, emerging and developed countries. Hence, the results cannot be fully analysed keeping in mind the context of emerging and developing countries.

Another empirical study conducted by Gholami *et al*. (2005) on the relationship between investments in ICT and flows of FDI, suggested that there is a correlation from ICT to FDI in developed countries; however, this study did not show any significant correlation from ICT to FDI in developing countries. This study also suggested that FDI inflow promotes investment in ICT and also improves productivity. The study used data from 23 countries with heterogeneous economic development for the period 1976 to 1999. However, another study by Ko (2007) suggested the presence of negative network externalities in developing countries discourages inward FDI, and the presence of positive network externalities in developed countries attracts more FDI. In this study "positive network externality" meant that new internet subscribers increased the value of internet as a service whilst negative network externality meant that the addition of new internet subscribers decreased the value of internet as a service due limited resources. This study goes on to further suggest that increasing internet usage leads to positive network externalities such as lower connectivity charges and the expansion of potential e-markets. Multinational corporations (MNCs) can reduce coordination costs through their own internet investment and thus increase foreign production. In summary, the study suggested that positive network externalities encourage FDI while negative network externalities discourage FDI. Another study by Daniel, Goul, Haluk, and Louis (2007) looked at the relationship between ICT expenditures and foreign direct investment. The

study suggested a positive correlation and posits that FDI begins within one year of the initial ICT expenditure, and that the positive indirect impact of ICT expenditures on foreign direct investment begins approximately one-and-a-half years after the initial ICT expenditure when mediated by institutionalised democracy. Although this study explored how ICT expenditures attract foreign direct investment in twenty-nine low and middle-income developing countries, the lack of high-quality data highlighted as a limitation prevented the examination of the extent to which the same effect holds in dozens of other developing countries around the world. It was therefore quite difficult to determine if the results presented in this study could be generalized to those countries for which data were not available. Furthermore, this study employed regression models that allowed for a single measure of ICT expenditure and FDI to be considered at a time.

In summary, the current body of literature on the relationship between ICT and FDI shows contradictory results. This could be as a result of multiple reasons such as, but not limited to, the lack of high-quality data as confirmed by Daniel *et al*. (2007); the methodology used in studies or time at which the study was conducted.

Summary of literature review

The literature reviewed suggests that the ICT streamlines the costs associated with information search and also enables economies in the global market. Research shows ICT as a catalyst for economic development in developed nations; however, in the case of emerging and developing nations it has shown mixed results. Current literature would suggest that a certain threshold needs to be reached in terms of ICT investment before

economic growth can be achieved and that this threshold condition could explain the difference in results. However, investment in ICT does not necessarily mean that its full potential has been realised at a macro or a micro level. The adoption and diffusion of ICT tools within an environment is critical for it to be an enabler of economic growth and this needs to be taken into consideration in research studies.

However, on the other hand, the concept of leapfrogging in terms of deploying next generation technologies; especially by developing countries also means that these countries have the potential of skipping certain stages of economic development. For example, a country could move from an agrarian economy to services based economy; and this could be a determining factor for the specific country's inward and outward investments. This could also have helped in the rapid emergence of the so called emerging countries.

By the same token, the rapid growth of emerging multinational corporations (EMNCs) has brought about renewed interest in emerging economies; however, majority of the existing theory is based on developed countries. Literature covered in the previous section suggests that the phenomenon witnessed in emerging and developing economies cannot be fully explained using existing international business models. The view taken in this study is that the existing theory base can explain some of the characteristics and patterns of FDI and that additional research is required to identify others aspects and the relationship between ICT and FDI is one such area. Very few studies have investigated the

link between ICT and FDI, especially in emerging and developing economies. Literature shows contradictory results and this could be attributed to a number of reasons such as, but not limited to , the lack of high-quality data; the methodology used in studies; the variables used in the studies or time at which the study was conducted. Moreover, most of literature available is based on the early part of the decade when the diffusion of ICT instruments was still taking place in these economies.

Finally, having presented the current state of literature, this study suggests that the contradictory results thus far, on the relationship between ICT and FDI, is because previous studies have not taken into consideration the different stages in a country's IDP. To this end, this study posits that the link between ICT and FDI is closely associated with the investment development path of a country and that ICT plays a more significant role in promoting FDI activities as a country progresses through the five stages in a country's investment development path. Countries in the first stage of IDP would be are net receivers of FDI stocks, mainly focused on natural resources and they would have limited need for ICT. Typically, these are the least developed countries. In the middle stages of IDP, countries are still net receivers of FDI stocks, albeit at a greater rate. This leads to country development and the infrastructure and ICT capabilities of the country would improve. In the fourth stage of IDP, countries start to invest abroad mainly in search for new markets and better efficiency and these countries are technologically very capable. At the fifth stage of IDP, countries are heavily service oriented and therefore it is expected that FDI movement is predominately based on the knowledge capabilities of countries and

hence very much dependent on ICT. The following table brief summarises the findings of the literature study.

Table 1: Summary of literature study

Stages of IDP	Characteristics of Investment	ICT capabilities of countries	Type of Countries	Type of relationship between ICT capabilities and FDI
Stage 1	Natural resource based	Very low	Least Developed countries, developing countries	No significant relationship
Stage 2	Investment driven	Low to Medium	Developing Countries	Positive relationship
Stage 3	Innovation driven	Medium	Developing countries	Positive relationship with higher effect size
Stage 4 and 5	Increasing knowledge and service intensity; knowledge economy	High	Developed Nations	Significantly positive relationship

Chapter 3: Research Hypotheses

Based on the literature review, the following hypotheses were tested to enable better understanding of the relationship between ICT and FDI.

Hypothesis 1: Least developed countries

In the first stage of IDP, countries are net receivers of FDI stocks (negative NOI) and these investments take advantage of the natural resources available in these countries. Typically, these are the least developed countries and countries at this stage have limited infrastructure and technology capabilities. This would lead to the following hypothesis:

For least developed countries, there is no significant relationship between inward FDI stock and the level of ICT readiness.

The null hypothesis states that there is a relationship between these two variables.

Hypothesis 2(a): Developing countries

In the middle stages of IDP, countries are still net receivers of FDI stocks, albeit at a greater rate. This leads to country development and the infrastructure and technology capabilities of the country improves. These countries are in the early stages of industrialisation. Thus, it possible to derive the following hypothesis:

For developing countries, there is a significant relationship between inward FDI stock and the level of ICT readiness.

The null hypothesis states that there is no relationship between these two variables.

Hypothesis 2(b): Developing countries

In the middle stages of IDP, countries are still net receivers of FDI stocks; however, there is an increased growth in outward FDI stocks in developing countries. These countries have accelerated their industrialisation process and started to develop their competitive advantages at a macro and micro-level. Countries in this stage include the emerging markets. Based on the above, the following hypotheses can be generated:

For developing countries, there is a significant relationship between outward FDI stock and the ICT readiness; though this is a weak relationship when compared to IFDI and ICT readiness

The null hypothesis states that there is no relationship between these two variables.

Hypothesis 3: Developed countries

In the fourth stage of IDP, countries have a positive NOI position; their outward FDI stocks exceed their inward FDI stocks. These countries are the so called newly developed countries; their investment abroad is mainly in search for new markets and better efficiency. At this stage, these countries have developed very good infrastructure and are

technologically very capable. At the fifth stage of IDP, the countries NOI position fluctuates towards zero and these countries are heavily service oriented. FDI movement at this stage is predominately based on the knowledge capabilities of countries. Based on this, the following hypothesis is derived:

For developed countries, there is a significant relationship between the inward and outward FDI stocks and the level of ICT readiness.

The null hypothesis states that there is no relationship between these variables.

Chapter 4: Research Methodology

This chapter of the study briefly outlines the research approach used in this study and will go into detail regarding the unit of analysis, the population, the data, data collection process and the data analysis process. The chapter concludes with a note on the limitation of this study.

Research Approach

Previous studies have been predominately based on case studies of individual countries using time series analysis. Other studies have focused on categorising countries according to classifications used by international bodies such as UNCTAD and focused on cross-sectional or longitudinal studies. The literature review has shown that the factors affecting FDI are heterogeneous in nature and differ across countries. In order to reduce the effects of this issue, a panel data analysis was proposed for this study. A panel or longitudinal data set takes into consideration the time series and cross-sectional aspects by following a given sample of individuals over time; and thus provides multiple observations on each individual in the sample. Panel datasets for economic research possess several major advantages over conventional cross-sectional or time-series data sets (Hsiao, 2007) by better controlling for individual heterogeneity among the observations than time-series or cross-sectional data. Panel data usually give the researcher a large number of data points, increasing the degrees of freedom and reducing the collinearity among explanatory variables - hence improving the efficiency of econometric estimates and allows a researcher to analyse a number of important

economic questions that cannot be addressed using cross-sectional or time-series data sets (Hsaio, 2003). One of the disadvantages with panel data is that it requires more extensive data than simple time-series or cross sectional data. This could lead to potential issues related to the lack of data available from certain countries as highlighted in the previous sections. The unavailability of certain data points could lead to incorrect data modelling and the misinterpretation of the results. As such, certain countries such as Iraq and Mongolia were dropped from the analysis due to lack of data on specific variables used for this study. Furthermore, in order to exploit the advantages of the panel, it was critical to ensure that the underlying statistical methodology was compatible with the data generating process as highlighted by Hsiao (2007).

Unit of analysis

The unit of analysis were the different countries and these countries were classified according to the categories used by the UNCTAD FDI database. The country distributions presented in the UNCTAD follow those used by the Statistics Division, Department of Economic and Social Affairs (DESA) of the United Nations (United Nations, 2006).

Population of relevance and the sample size

The population of relevance consisted of all the 232 countries covered by the UNCTAD FDI database and the study looked at 8 year data between 2000 and 2008. For the purposes of this study, the following classifications were used: (1) least developed countries (LDC); (2) developing countries and (3) developed countries. According to this classification, the

sample consisted of 42 least developed countries; 74 developing countries and 36 developed countries.

Data

The study was based on secondary data collected from the UNCTAD database and the World Bank databank. Normally, the choice of variables used for a study would depend on the issue considered for the investigation and the availability of data. The literature review highlighted the lack of data from developing countries as one of the concerns in international business research. Therefore, this study has opted to use socio-economic variables that were more readily available. With respect to the specific variables chosen for this study, the UNCTAD database was used to collect FDI related information, specifically the inward FDI stocks and outward FDI stocks of a specific country.

The World Bank's databank was used to gather ICT related information for each country, specifically the mobile cellular subscriptions, the telephone lines and the internet users. Variable such as telephone lines per 100 people, internet per 100 people and mobile cellular subscription per 100 people were chosen for the multivariate analysis. These variables were chosen such that the effects of collinearity were alleviated in the analysis. The GDP per capita and GDP growth rate were used as control variables. Previous studies identified the GDP per capita as one of the determinants of FDI (Adeoye, 2009). Furthermore, the GDP per capita was also used as a proxy for market size, since it took into consideration the population of the country.

Data Analysis

As mentioned in the previous chapter, the purpose of this study was to shed more light on the relationship between ICT and FDI using the economic conditions to group different countries together. There exist various tools to statistically evaluate the assumptions and to evaluate if the proposed model accurately describes the data. Given the mixed results obtained from previous studies; the first step was to conduct a descriptive statistical analysis to understand the location and variability of the different variables.

The next step was to access the relationship between the different variables using bivariate analysis. This test measured the strength of the linear relationship between two numerical variables, specifically the ICT variables and the FDI variables. This helped in analysing the trends and making better predictions of the variables influencing IFDI. The variables were normalised using logarithmic transformation, mainly because the data was substantially non-normal. The type of behaviour exhibited was observed on a scatterplot and this exercise was conducted for the three different categories of countries. The third step was to analyse the dependence of FDI on ICT variables using regression analysis using multiple variables. The intention was to refine the bivariate analysis by taking into account the possible influences of other variables on the original bivariate analysis. The multivariate analysis would also show the combined effects of all the ICT variables and control variables on the FDI. The relationship between the variables was analysed using two additional measurements; that is whether the relationship is statistically significant

(low probability of occurrence in the sample if there was no relationship in the population) and how large the effect size (strength of the relationship) is.

The following section gives a brief overview of the statistical techniques used to evaluate the assumptions and the model proposed for the regression analysis.

Panel data model

A panel data regression takes the following form:

$$y_{i,t} = \beta_0 + \beta_1 x_{1,i,t} + \beta_2 x_{2,i,t} + \ldots + \beta_k x_{k,i,t} + \varepsilon_{i,t}$$

The cross-sectional index is denoted by letter "*i*" and the time index by "*t*". Thus, the following models were formulated for the bivariate analysis.

Model 1:

$$Log(IFDI_{i,t}) = \beta_0 + \beta_1 log(ICT_{1,i,t}) + \varepsilon_{i,t}$$

Model 2:

$$Log(OFDI_{i,t}) = \beta_0 + \beta_1 log(ICT_{1,i,t}) + \varepsilon_{i,t}$$

where,

'i'- country of observation; Afghanistan, Albania etc.

't'- year of observation; 2003, 2004 etc.

'β'- Intercept

'IFDI' - Inward Foreign Direct Investment

'OFDI' - Outward Foreign Direct Investment

'ICT' - ICT *specific variables; internet users, telephone lines, mobile cellular subscriptions*

'ε'- *error term*

In the case of the multivariate analysis the following models were tested.

Model 1:

$$IFDI_{i,t} = \beta_0 + \beta_1 IU_{1,i,t} + \beta_2 TL_{1,i,t} + \beta_3 MCS_{1,i,t} + \beta_4 GDPpc_{1,i,t} + \beta_5 GDP_{1,i,t} + \varepsilon_{i,t}$$

Model 2:

$$OFDI_{i,t} = \beta_0 + \beta_1 IU_{1,i,t} + \beta_2 TL_{1,i,t} + \beta_3 MCS_{1,i,t} + \beta_4 GDPpc_{1,i,t} + \beta_5 GDP_{1,i,t} + \varepsilon_{i,t}$$

where,

'i'- country of observation; Afghanistan, Albania etc.

't'- year of observation; 2003, 2004 etc.

'β'- Intercept

'IFDI' - Inward Foreign Direct Investment

'OFDI' - Outward Foreign Direct Investment

'IU' - Internet users per 100 people

'TL' - Telephone lines per 100 people

'MCS' - Mobile cellular subscription per 100 people

GDPpc' – Gross Domestic Product per capita

GDP' – Gross Domestic Product

'ε'- *error term*

The FDI stocks data was used to estimate NOI position of different countries and the different ICT variables were used as proxy for ICT readiness of the different countries.

Research limitations

The research conducted had the following limitations:

- The research was dependent on historical macro level data from different countries and some of these data were absent or not published for specific years. In certain instances, no data was available for specific countries; thus having to exclude them from the study.

- There was limited data available on most of the countries for years prior to 2000, especially the ICT related variables, thus this study only took into consideration data from 2000-2008.

- This research was dependent on FDI related data which are typically gathered by authorities in the individual countries. However, the method of data capture might differ from country to country making comparison and grouping of countries difficult.

- The designation of the different countries into “developed”, “developing” and “least developed” were done according to the grouping used by DESA of the United Nations; however, these groupings could lead to wrong statistical analysis

given that some countries such as China and India, due to their market size and not necessarily the level of development, are strong participants in FDI activities.

- The pooled regression technique used in the study assumes that countries pooled together are similar in nature. It is expected that if the model yields large standard errors, one of the reasons could be that the groups are not that similar.

Chapter 5: Results

This section of the study documents the results of the quantitative analysis as outlined in Chapter 4. The first subsection focuses on the descriptive component of the analysis and is structured around the different country categories, that is, least developed countries, developing countries and developed countries. The subsequent sections summarises the results of the three hypotheses and where applicable inferences are made in relation to these hypotheses. These sections are structured around the hypotheses and test the hypotheses based on the models proposed in the previous chapter.

Descriptive statistics

The following section provides a summary of the descriptive measures related to the variables that were used for the analysis of the different countries.

Least developed countries

The following section provides a summary of the measures of the individual variables that were used in the analysis of least developed countries. This will help in getting a better sense of whether these variables are related to FDI.

Internet users in least developed countries

Figure 3 summarises the distribution for internet users in the least developed countries. The histogram shows a low degree of variability and skewness towards the left, where majority of the countries are represented. The outlier box plot depicted in figure 3 also

captures the possible outliers; however, these outliers could be misleading and hence a better measure is the median, as it is less influenced by the outliers. The median for the internet users is approximately 30000 and a mean of 135752 internet users.

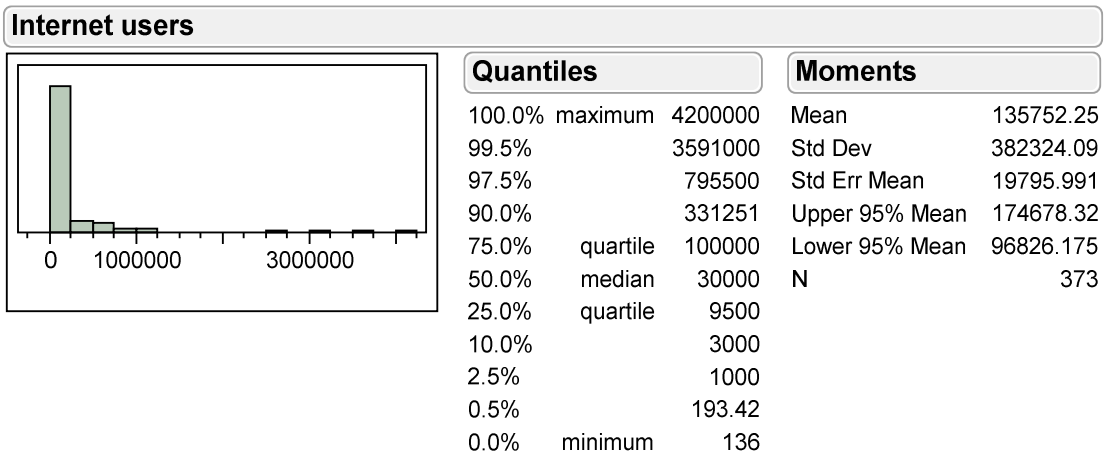
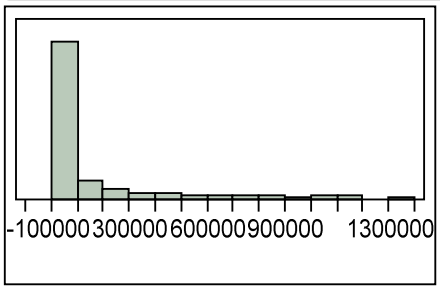


Figure 3: The distribution of internet users in least developed countries

Telephone lines in least developed countries

Figure 4 summarises the distribution for telephone lines in the least developed countries. When compared with the internet users, the histogram and the box plot shows a higher degree of variability; however, with skewness towards the left, where majority of the countries are represented. The mean for the telephone lines is approximately 114828 and a median of 35260 telephone lines.

Telephone lines



Quantiles		
100.0%	maximum	1344456
99.5%		1208186
97.5%		824587
90.0%		344331
75.0%	quartile	93320.3
50.0%	median	35260
25.0%	quartile	14121
10.0%		7434.9
2.5%		4332.5
0.5%		2041.52
0.0%	minimum	2000

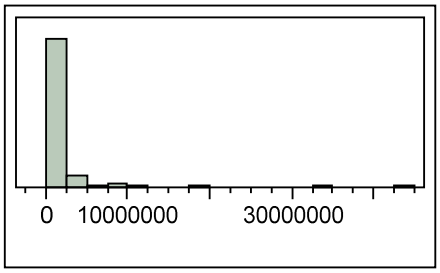
Moments	
Mean	114828.79
Std Dev	206640.89
Std Err Mean	10713.831
Upper 95% Mean	135896.24
Lower 95% Mean	93761.344
N	372

Figure 4: The distribution of telephone lines in least developed countries

Mobile cellular subscriptions lines in least developed countries

Figure 5 summarises the distribution for mobile cellular subscription lines in the least developed countries. Similar to the internet users, the histogram and the outlier box plot shows a low degree of variability and skewness towards the left. The mean for the mobile cellular subscription lines is approximately 943888 and a median of 136193 mobile cellular subscription lines. The figure below would also suggest that there are higher number of mobile cellular subscription lines than telephone lines and internet users. This is expected in least developed countries, where deploying a cable infrastructure for telephone lines is more challenging than deploying a mobile network.

Mobile cellular subscriptions



Quantiles

100.0%	maximum	4.46e+7
99.5%		3.57e+7
97.5%		6254272
90.0%		2124648
75.0%	quartile	600000
50.0%	median	136193
25.0%	quartile	25951.5
10.0%		2000
2.5%		0
0.5%		0
0.0%	minimum	0

Moments

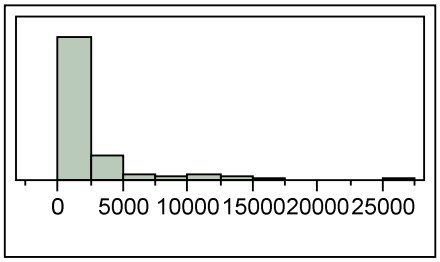
Mean	943888.68
Std Dev	3334503.1
Std Err Mean	172423.05
Upper 95% Mean	1282931.8
Lower 95% Mean	604845.6
N	374

Figure 5: The distribution of mobile cellular subscriptions in least developed countries

IFDI in least developed countries

Figure 6 summarises the distribution for IFDI in the least developed countries. The histogram and the outlier box plot show a low degree of variability and skewness towards the left. The mean for the IFDI is approximately $1568 million and a median of $384 million.

IFDI



Quantiles

100.0%	maximum	26749.5
99.5%		17415.9
97.5%		11644.6
90.0%		4266.78
75.0%	quartile	1889.8
50.0%	median	384.549
25.0%	quartile	115.089
10.0%		45.0239
2.5%		11.916
0.5%		3.5763
0.0%	minimum	2.98

Moments

Mean	1568.4085
Std Dev	2890.836
Std Err Mean	148.88563
Upper 95% Mean	1861.1613
Lower 95% Mean	1275.6557
N	377

Figure 6: The distribution of IFDI in least developed countries

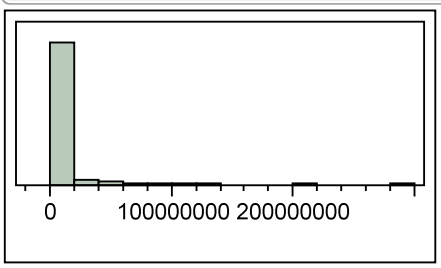
Developing countries

The following section provides a summary of the measures of the individual variables that were used in the analysis of developing countries.

Internet users in developing countries

Figure 7 summarises the distribution for internet users in the developing countries. The histogram shows a low degree of variability and skewness towards the left, where majority of the countries are represented. As mentioned earlier, the outliers could be misleading and hence a better measure is the median, as it is less influenced by the outliers. The mean for the internet users is approximately 4383727 and a median of 382000 internet users.

Internet users



Quantiles

100.0%	maximum	2.98e+8
99.5%		1.36e+8
97.5%		3.28e+7
90.0%		8110193
75.0%	quartile	2260000
50.0%	median	382000
25.0%	quartile	80000
10.0%		24000
2.5%		6600
0.5%		2912
0.0%	minimum	2400

Moments

Mean	4383727.9
Std Dev	18289557
Std Err Mean	732755.62
Upper 95% Mean	5822702.5
Lower 95% Mean	2944753.2
N	623

Figure 7: The distribution of internet users in developing countries

Telephone lines in developing countries

Figure 8 summarises the distribution for telephones lines in the developing countries. Similar to the internet users, the histogram shows a low degree of variability and skewness towards the left, where there are a few countries with telephone lines that are

represented with extremely high values. The mean for the telephone lines is approximately 6730095 and a median of 491000 telephone lines.

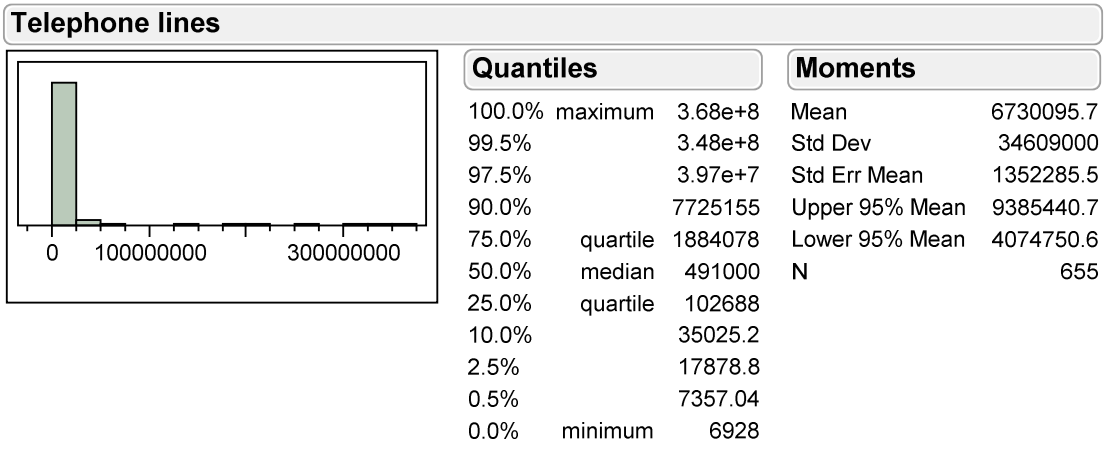
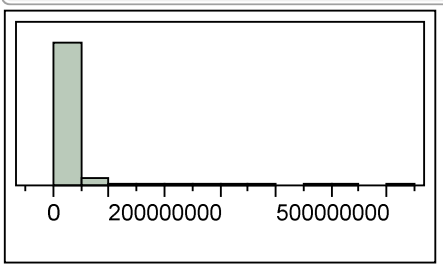


Figure 8: The distribution of telephone lines in developing countries

Mobile cellular subscriptions lines in developing countries

Figure 9 summarises the distribution for mobile cellular subscription lines in the developing countries. Similar to the internet users and telephone lines, the histogram and the outlier box plot shows a low degree of variability and skewness towards the left, where majority of the countries are represented. The mean for the mobile cellular subscription lines is approximately 13545279 and a median of 1169000 mobile cellular subscription lines. The figure below would also suggest that there are higher number of mobile cellular subscription lines than telephone lines and internet users. This is very similar to the least developed countries.

Mobile cellular subscriptions



Quantiles		
100.0%	maximum	6.41e+8
99.5%		4.48e+8
97.5%		9.37e+7
90.0%		3.01e+7
75.0%	quartile	6310916
50.0%	median	1169000
25.0%	quartile	187500
10.0%		46174.4
2.5%		7702.15
0.5%		190.64
0.0%	minimum	0

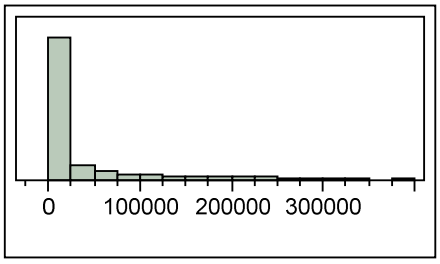
Moments	
Mean	13545279
Std Dev	50831750
Std Err Mean	2014027.3
Upper 95% Mean	17500226
Lower 95% Mean	9590331.6
N	637

Figure 9: The distribution of mobile cellular subscriptions in developing countries

IFDI in developing countries

Figure 10 summarises the distribution for IFDI in the developing countries. The histogram and the outlier box plot show a higher degree of variability when compared with the other variables. The skewness is towards the left, where there are a few countries with extremely high IFDI. The mean for the IFDI is approximately $23717 million and a median of $3854 million.

IFDI



Quantiles		
100.0%	maximum	378083
99.5%		321282
97.5%		218665
90.0%		67576.7
75.0%	quartile	17339.7
50.0%	median	3882.97
25.0%	quartile	920.446
10.0%		354.208
2.5%		82.3994
0.5%		14.7497
0.0%	minimum	0

Moments	
Mean	23681.524
Std Dev	52668.132
Std Err Mean	2053.2175
Upper 95% Mean	27713.184
Lower 95% Mean	19649.865
N	658

Figure 10: The distribution of IFDI in developing countries

OFDI in developing countries

Figure 11 summarises the distribution for OFDI in the developing countries. Similar to IFDI, the histogram and the outlier box plot show a higher degree of variability. The skewness is towards the left, where there are a few countries with extremely high OFDI. The mean for the OFDI is approximately $7583 million and a median of $260 million. As expected in the case of developing countries, the OFDI mean and median is lower than the IFDI measures.

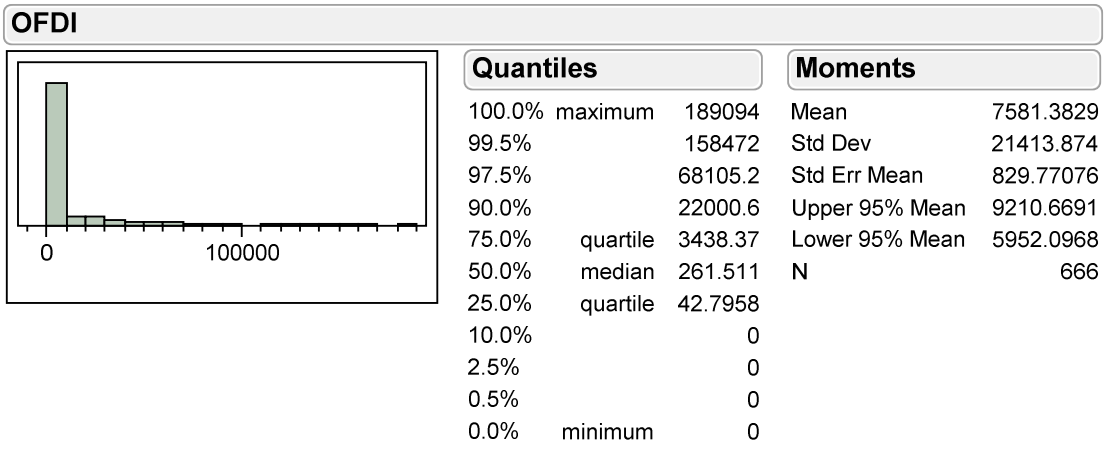


Figure 11: The distribution of OFDI in developing countries

Developed countries

The following section provides a summary of the measures of the individual variables that were used in the analysis of developed countries.

Internet users in developed countries

Figure 12 summarises the distribution for internet users in the developed countries. The histogram shows a skewness towards the left, where majority of the countries are

represented. The mean for the internet users is approximately 14234572 and a median of 3395225 internet users.

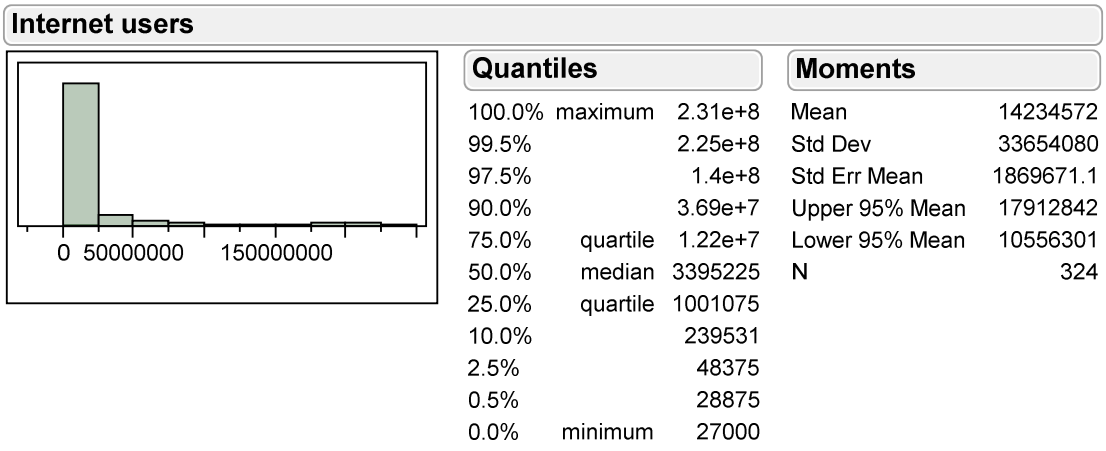
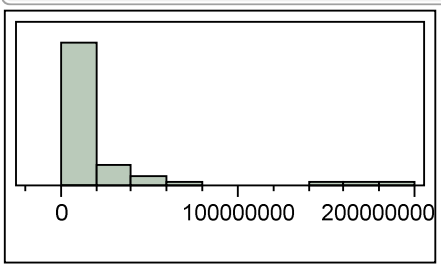


Figure 12: The distribution of internet users in developed countries

Telephone lines in developed countries

Figure 13 summarises the distribution for telephones lines in the developed countries. Similar to the internet users, the histogram shows a low degree of variability and skewness towards the left, where there are a few countries with telephone lines that are represented with extremely high values. The mean for the telephone lines is approximately 14198914 and a median of 3809627 telephone lines.

Telephone lines



Quantiles

100.0%	maximum	1.93e+8
99.5%		1.92e+8
97.5%		1.58e+8
90.0%		3.46e+7
75.0%	quartile	1.04e+7
50.0%	median	3809627
25.0%	quartile	1303243
10.0%		248457
2.5%		57606.8
0.5%		53332.9
0.0%	minimum	52471

Moments

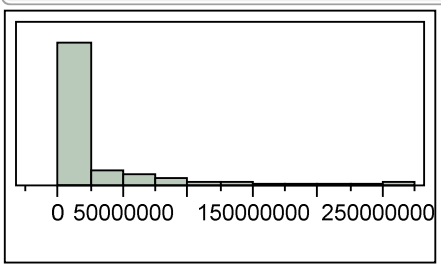
Mean	14198914
Std Dev	31031980
Std Err Mean	1723998.9
Upper 95% Mean	17590598
Lower 95% Mean	10807230
N	324

Figure 13: The distribution of telephone lines in developed countries

Mobile cellular subscriptions lines in developed countries

Figure 14 summarises the distribution for mobile cellular subscription lines in the developed countries. Similar to the internet users and telephone lines, the histogram and the outlier box plot shows a low degree of variability and skewness towards the left, where majority of the countries are represented. The mean for the mobile cellular subscription lines is approximately 21183889 and a median of 7355079 mobile cellular subscription lines. The figure below would also suggest that there are higher number of mobile cellular subscription lines than telephone lines and internet users. This is very similar to the least developed and developing countries.

Mobile cellular subscriptions



Quantiles		
100.0%	maximum	2.71e+8
99.5%		2.66e+8
97.5%		1.26e+8
90.0%		6.38e+7
75.0%	quartile	1.72e+7
50.0%	median	7355079
25.0%	quartile	2470500
10.0%		413499
2.5%		70250
0.5%		13208.1
0.0%	minimum	13000

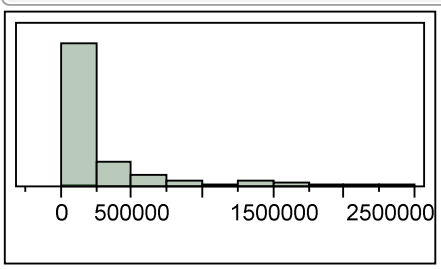
Moments	
Mean	21183889
Std Dev	38118296
Std Err Mean	2117683.1
Upper 95% Mean	25350082
Lower 95% Mean	17017695
N	324

Fgure 14: The distribution of mobile cellular subscriptions in developed countries

IFDI in developed countries

Figure 15 summarises the distribution for IFDI in the developed countries. The histogram and the outlier box plot show a higher degree of variability when compared with the other variables. The skewness is towards the left, where there are a few countries with extremely high IFDI. The mean for the IFDI is approximately $193857 million and a median of $66405 million.

IFDI



Quantiles		
100.0%	maximum	2278892
99.5%		2176637
97.5%		1325582
90.0%		513178
75.0%	quartile	223769
50.0%	median	66405.4
25.0%	quartile	15615.9
10.0%		3528.76
2.5%		1157.42
0.5%		290.089
0.0%	minimum	264.8

Moments	
Mean	193857.35
Std Dev	326301.68
Std Err Mean	18240.819
Upper 95% Mean	229744.86
Lower 95% Mean	157969.85
N	320

Figure 15: The distribution of IFDI in developed countries

OFDI in developed countries

Figure 16 summarises the distribution for OFDI in the developed countries. Similar to IFDI, the histogram and the outlier box plot show a higher degree of variability. The skewness is towards the left, where there are a few countries with extremely high OFDI. The mean for the OFDI is approximately $252291 million and a median of $48417 million. As expected in the case of developed countries, the OFDI mean and median is lower than the IFDI measures.

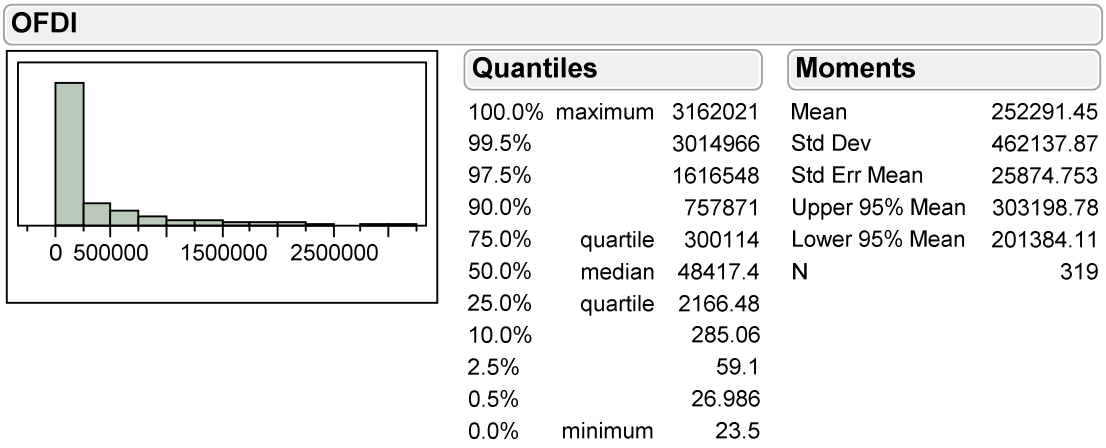


Figure 16: The distribution of OFDI in developed countries

Hypothesis testing

The previous section focused on the descriptive components of this study and following sections focuses on testing the hypotheses.

Hypothesis one: Least developed countries

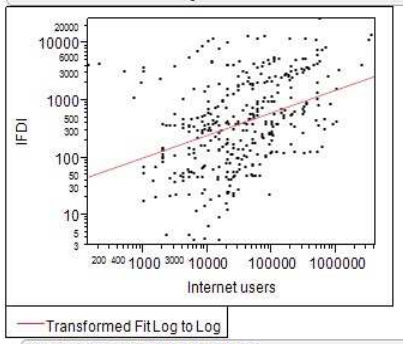
The following two sections focus on least developed countries and try to estimate the relationship between various ICT variables and FDI. The first section focuses on a bivariate

analysis between IFDI and individual ICT variables. The subsequent section tries to refine on the bivariate analysis by conducting a multivariate analysis of the different ICT variables and IFDI in least developed countries.

Bivariate analysis: Estimating relationships in least developed countries

The following section presents the results obtained from a bivariate analysis using a model for relating the IFDI to all the individual ICT variables (for least developed countries). Figure 17 presents the results from the bivariate analysis.

Bivariate Fit of IFDI By Internet users



Transformed Fit Log to Log

Log(IFDI) = 1.9172331 + 0.3930534*Log(Internet users)

Summary of Fit

RSquare	0.144423
RSquare Adj	0.142111
Root Mean Square Error	1.677254
Mean of Response	5.989962
Observations (or Sum Wgts)	372

Lack Of Fit

Source	DF	Sum of Squares	Mean Square	F Ratio
Lack Of Fit	162	466.9177	2.88221	1.0445
Pure Error	208	573.9591	2.75942	Prob > F
Total Error	370	1040.8768		0.3822
				Max RSq
				0.5282

Analysis of Variance

Source	DF	Sum of Squares	Mean Square	F Ratio
Model	1	175.7022	175.702	62.4568
Error	370	1040.8768	2.813	Prob > F
C. Total	371	1216.5790		<.0001*

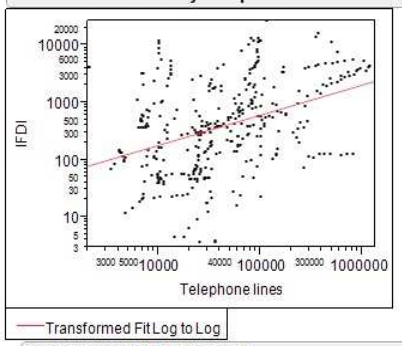
Parameter Estimates

Term	Estimate	Std Error	t Ratio	Prob>|t|	Std Beta
Intercept	1.9172331	0.522628	3.67	0.0003*	0
Log(Internet users)	0.3930534	0.049735	7.90	<.0001*	0.380031

Fit Measured on Original Scale

Sum of Squared Error	3.2531e+9
Root Mean Square Error	2965.1557
RSquare	-0.041992
Sum of Residuals	391796.12

Bivariate Fit of IFDI By Telephone lines



Transformed Fit Log to Log

Log(IFDI) = 0.3711623 + 0.5256209*Log(Telephone lines)

Summary of Fit

RSquare	0.157813
RSquare Adj	0.155531
Root Mean Square Error	1.667215
Mean of Response	5.970411
Observations (or Sum Wgts)	371

Lack Of Fit

Source	DF	Sum of Squares	Mean Square	F Ratio
Lack Of Fit	342	962.4725	2.81425	1.2022
Pure Error	27	63.2024	2.34083	Prob > F
Total Error	369	1025.6749		0.2904
				Max RSq
				0.9481

Analysis of Variance

Source	DF	Sum of Squares	Mean Square	F Ratio
Model	1	192.1965	192.197	69.1452
Error	369	1025.6749	2.780	Prob > F
C. Total	370	1217.8715		<.0001*

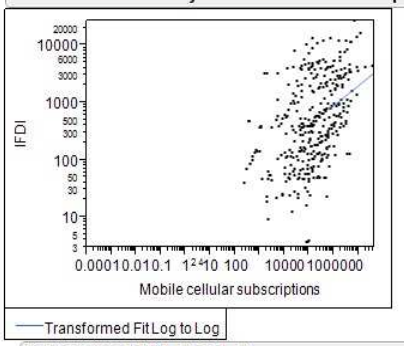
Parameter Estimates

Term	Estimate	Std Error	t Ratio	Prob>|t|	Std Beta
Intercept	0.3711623	0.678903	0.55	0.5849	0
Log(Telephone lines)	0.5256209	0.063211	8.32	<.0001*	0.397257

Fit Measured on Original Scale

Sum of Squared Error	3.3095e+9
Root Mean Square Error	2994.7938
RSquare	-0.060999
Sum of Residuals	381735.97

Bivariate Fit of IFDI By Mobile cellular subscriptions



Transformed Fit Log to Log

Log(IFDI) = 1.9900791 + 0.348908*Log(Mobile cellular subscriptions)

Summary of Fit

RSquare	0.205703
RSquare Adj	0.203459
Root Mean Square Error	1.567709
Mean of Response	6.114388
Observations (or Sum Wgts)	356

Lack Of Fit

Source	DF	Sum of Squares	Mean Square	F Ratio
Lack Of Fit	320	759.50400	2.37345	0.7301
Pure Error	34	110.52593	3.25076	Prob > F
Total Error	354	870.02993		0.9118
				Max RSq
				0.8991

Analysis of Variance

Source	DF	Sum of Squares	Mean Square	F Ratio
Model	1	225.3155	225.316	91.6770
Error	354	870.0299	2.458	Prob > F
C. Total	355	1095.3455		<.0001*

Parameter Estimates

Term	Estimate	Std Error	t Ratio	Prob>|t|	Std Beta
Intercept	1.9900791	0.438686	4.54	<.0001*	0
Log(Mobile cellular subscriptions)	0.348908	0.03644	9.57	<.0001*	0.453545

Fit Measured on Original Scale

Sum of Squared Error	3.1745e+9
Root Mean Square Error	2994.5791
RSquare	-0.024768
Sum of Residuals	374024.47

Figure 17: The bivariate analysis of IFDI and the various ICT variables for least developed countries

Relationship between IFDI and internet users in least developed countries

The following equation expresses the bivariate fit of IFDI by internet users:

$$\log(\text{IFDI}) = 1.9172331 + 0.3930534 \times \log(\text{internet users})$$

The R-squared value for internet users and IFDI is 0.14. This would suggest that the model is not a good fit and internet users only explain 14% of the variation in IFDI. The regression sum of square of the model is 175.7022 and the residual sum of squares is 1040.8768 giving a total of 1216.5790. The variation among the observed values of IFDI could be attributed to random variation or attributed to some changes in internet users. The p value less than 0.0001 indicates that the linear fit to the IFDI patterns is significantly better than the horizontal line that fits the sample mean to the data. The F statistic of 62.4568 derived from the ratio of the model mean square to the error mean square and the associated p value of less than 0.0001 suggests that the coefficient of the variable is not zero. The strength of the relationship (effect size) between the two variables is 0.380.

Relationship between IFDI and telephone lines in least developed countries

The following equation expresses the bivariate fit of IFDI by telephone lines:

$$\log(\text{IFDI}) = 0.3711623 + 0.5256209 \times \log(\text{telephone lines})$$

The R-squared value for telephone users and IFDI is 0.15. This would suggest that the model is not a good fit and telephone lines only explain 15% of the variation in IFDI. The

regression sum of square of the model is 192.1965 and the residual sum of squares is 1025.6749 giving a total of 1217.8715. The variation among the observed values of IFDI could be attributed to random variation or attributed to some changes in telephone users. The p value less than 0.0001 indicates that the linear fit to the IFDI patterns is significantly better than the horizontal line that fits the sample mean to the data. The F statistic of 69.1452 derived from the ratio of the model of error mean square and the associated p value of less than 0.0001 suggests that the coefficient of the variable is not zero. The strength of the relationship (effect size) between the two variables is 0.397.

Relationship between IFDI and mobile cellular subscriptions in least developed countries
The following equation expresses the bivariate fit of IFDI by mobile cellular subscriptions:

$$\log(\text{IFDI}) = 1.9900791 + 0.348908 \times \log(\text{mobile cellular subscriptions})$$

The R-squared value for mobile cellular subscriptions and IFDI is 0.21. This would suggest that the model is not a good fit and mobile cellular subscriptions only explain 21% of the variation in IFDI. The regression sum of square of the model is 225.3155 and the residual sum of squares is 870.0299 giving a total of 1095.3455. The variation among the observed values of IFDI could be attributed to random variation or attributed to some changes in mobile cellular subscriptions. The p value less than 0.0001 indicates that the linear fit to the IFDI patterns is significantly better than the horizontal line that fits the sample mean to the data. The F statistic of 91.6770 derived from the ratio of the model to the error mean square and the associated p value of less than 0.0001 suggests that the coefficient

of the variable is not zero. The strength of the relationship (effect size) between the two variables is 0.453.

Multivariate Analysis: Refining the relationships in least developed countries

The following section presents the results obtained from a regression analysis conducted on a model for relating the IFDI to all the ICT variables and control variables in least developed countries.

Response IFDI

Summary of Fit

RSquare	0.548283
RSquare Adj	0.541679
Root Mean Square Error	1990.994
Mean of Response	1518.904
Observations (or Sum Wgts)	348

Analysis of Variance

Source	DF	Sum of Squares	Mean Square	F Ratio
Model	5	1645526666	329105333	83.0223
Error	342	1355707781	3964057.8	Prob > F
C. Total	347	3001234447		<.0001*

Parameter Estimates

Term	Estimate	Std Error	t Ratio	Prob>|t|	Std Beta	VIF
Intercept	457.76201	150.548	3.04	0.0025*	0	.
Internet users (per 100 people)	87.621716	50.69751	1.73	0.0848	0.087409	1.9365312
Telephone lines (per 100 people)	-276.6637	57.96924	-4.77	<.0001*	-0.22985	1.7560979
Mobile cellular subscriptions (per 100 people)	10.218706	9.99474	1.02	0.3073	0.052336	1.9838837
GDP per capita (current US$)	0.4584552	0.051709	8.87	<.0001*	0.347496	1.1630354
GDP (current US$)	1.3967e-7	9.422e-9	14.82	<.0001*	0.566766	1.1067481

Effect Tests

Source	Nparm	DF	Sum of Squares	F Ratio	Prob > F
Internet users (per 100 people)	1	1	11841052	2.9871	0.0848
Telephone lines (per 100 people)	1	1	90291948	22.7777	<.0001*
Mobile cellular subscriptions (per 100 people)	1	1	4143705	1.0453	0.3073
GDP per capita (current US$)	1	1	311606568	78.6080	<.0001*
GDP (current US$)	1	1	871082548	219.7452	<.0001*

Figure 18: The multivariate analysis of the various ICT variables and control variables for least developed countries

The R-squared value of 0.54 for the model suggests that a moderate portion of the variation of IFDI can be explained by all the independent variables in the model. In the case of a multivariate analysis, the adjusted R-squared value is a better alternative and again the adjusted R-squared value of 0.54 would still suggest that a moderate portion of the variation of cost could be explained by the independent variables. The F statistic value of 121.25 and the associated p value, shown as < 0.0001 under Prob > F indicates that at least one of the coefficients is not zero. The p values for the intercept and the other the individual variables vary from 0.30 to less than 0.0001, as highlighted in the figure 18.

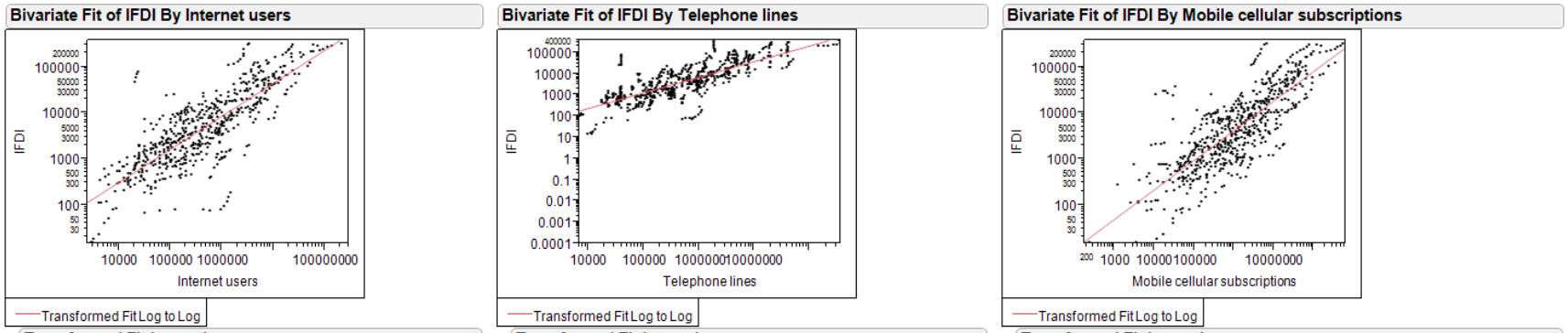
The p value associated with telephone lines (per 100 people) is less than 0.0001. This indicates that there is a variation in IFDI due to telephone lines (per 100 people) that is not due to mobile cellular subscriptions (per 100 people), internet users (per 100 people), GDP per capita and GDP. The p values for GDP per capita and GDP indicates similar variations in IFDI. The p value associated with internet users (per 100 people) is 0.08 which is greater than the significance level, suggesting that the reverse is true. This is also case for mobile cellular subscriptions (per 100 people). The standardised beta suggests that GDP has a moderate effect on the model, in the context of all the other variables in the model. GDP per capita has a modest effect on the model; whilst all the other variables have a weak effect on the model, in the context of all the other variables in the model. The VIF statistics in the parameter estimate tables show that the VIF values are relatively low. The VIF values vary between 1.1 and 1.98 and this suggests that there is a low probability of a multicollinearity problem.

Hypothesis two: developing countries

The following two sections focus on developing countries and try to estimate the relationship between various ICT variables and FDI. The first section focuses on a bivariate analysis between IFDI and individual ICT variables. The subsequent section tries to refine on the bivariate analysis by conducting a multivariate analysis of the different ICT variables and IFDI in developing countries.

Bivariate Analysis: Estimating relationships in developing countries

The following section presents the results obtained from a regression analysis using a model for relating IFDI and OFDI to all the individual ICT variables (internet users, mobile cellular subscriptions and telephone users) for developing countries. The goal was to understand the influence of individual ICT variables on IFDI. Figure 19 presents the results of the bivariate analysis between IFDI and all the individual ICT variables. The subsequent figure presents the results of the bivariate analysis between OFDI and all the individual ICT variables.



Transformed Fit Log to Log

Log(IFDI) = -0.813864 + 0.7152802*Log(Internet users)

Summary of Fit

RSquare	0.666293
RSquare Adj	0.66575
Root Mean Square Error	1.130868
Mean of Response	8.470524
Observations (or Sum Wgts)	616

Lack Of Fit

Source	DF	Sum of Squares	Mean Square	F Ratio
Lack Of Fit	425	529.39951	1.24565	0.9203
Pure Error	189	255.82189	1.35355	Prob > F
Total Error	614	785.22140		0.7551
				Max RSq
				0.8913

Analysis of Variance

Source	DF	Sum of Squares	Mean Square	F Ratio
Model	1	1567.8084	1567.81	1225.940
Error	614	785.2214	1.28	Prob > F
C. Total	615	2353.0298		<.0001*

Parameter Estimates

Term	Estimate	Std Error	t Ratio	Prob>|t|	Std Beta
Intercept	-0.813864	0.269053	-3.02	0.0026*	0
Log(Internet users)	0.7152802	0.020429	35.01	<.0001*	0.816268

Fit Measured on Original Scale

Sum of Squared Error	7.783e+11
Root Mean Square Error	35603.258
RSquare	0.5679219
Sum of Residuals	5206555.4

Transformed Fit Log to Log

Log(IFDI) = -1.28862 + 0.7358115*Log(Telephone lines)

Summary of Fit

RSquare	0.618041
RSquare Adj	0.617447
Root Mean Square Error	1.221248
Mean of Response	8.398975
Observations (or Sum Wgts)	645

Lack Of Fit

Source	DF	Sum of Squares	Mean Square	F Ratio
Lack Of Fit	626	931.41031	1.48788	0.9168
Pure Error	17	27.58998	1.62294	Prob > F
Total Error	643	959.00029		0.6415
				Max RSq
				0.9890

Analysis of Variance

Source	DF	Sum of Squares	Mean Square	F Ratio
Model	1	1551.7381	1551.74	1040.425
Error	643	959.0003	1.49	Prob > F
C. Total	644	2510.7383		<.0001*

Parameter Estimates

Term	Estimate	Std Error	t Ratio	Prob>|t|	Std Beta
Intercept	-1.28862	0.304163	-4.24	<.0001*	0
Log(Telephone lines)	0.7358115	0.022812	32.26	<.0001*	0.786156

Fit Measured on Original Scale

Sum of Squared Error	1.233e+12
Root Mean Square Error	43794.407
RSquare	0.321013
Sum of Residuals	4058466.1

Transformed Fit Log to Log

Log(IFDI) = -0.546009 + 0.6435029*Log(Mobile cellular subscriptions)

Summary of Fit

RSquare	0.654984
RSquare Adj	0.654434
Root Mean Square Error	1.157735
Mean of Response	8.418567
Observations (or Sum Wgts)	629

Lack Of Fit

Source	DF	Sum of Squares	Mean Square	F Ratio
Lack Of Fit	614	827.29592	1.34739	1.3367
Pure Error	13	13.10428	1.00802	Prob > F
Total Error	627	840.40020		0.2846
				Max RSq
				0.9946

Analysis of Variance

Source	DF	Sum of Squares	Mean Square	F Ratio
Model	1	1595.4317	1595.43	1190.309
Error	627	840.4002	1.34	Prob > F
C. Total	628	2435.8319		<.0001*

Parameter Estimates

Term	Estimate	Std Error	t Ratio	Prob>|t|	Std Beta
Intercept	-0.546009	0.263905	-2.07	0.0390*	0
Log(Mobile cellular subscriptions)	0.6435029	0.018652	34.50	<.0001*	0.809311

Fit Measured on Original Scale

Sum of Squared Error	9.471e+11
Root Mean Square Error	38866.477
RSquare	0.4743183
Sum of Residuals	6488016.9

Figure 19: The bivariate analysis of IFDI and the various ICT variables for developing countries

Relationship between IFDI and internet users in developing countries

The following equation expresses the bivariate fit of IFDI by internet users:

$$\log(\text{IFDI}) = -0.813864 + 0.7152802 \times \log(\text{internet users})$$

The R-squared value for internet users and IFDI is 0.66. This would suggest that the model is a good fit and internet users explain 66% of the variation in IFDI. The regression sum of square of the model is 1567.8084 and the residual sum of squares is 785.2214 giving a total of 2353.0298. The variation among the observed values of IFDI could be attributed to random variation or attributed to some changes in Internet users. The F statistic of 1225.940 derived from the ratio of the model to the error mean square and the associated p value of less than 0.0001 suggests that the coefficient of the variable is not zero. The strength of the relationship (effect size) between the two variables is 0.81.

Relationship between IFDI and telephone lines in developing countries

The following equation expresses the bivariate fit of IFDI by telephone lines:

$$\log(\text{IFDI}) = -1.28862 + 0.7358115 \times \log(\text{telephone lines})$$

The R-squared value for telephone users and IFDI is 0.62. This would suggest that the model is a good fit and telephone lines explain 62% of the variation in IFDI. The regression sum of square of the model is 1551.7381 and the residual sum of squares is 959.0003 giving a total of 2510.7383. The variation among the observed values of IFDI could be attributed to random variation or attributed to some changes in telephone users. The F statistic of 1040.425 derived from the ratio of the model to the error mean square. The

associated p value of less than 0.0001 suggests that the coefficient of the variable is not zero. The strength of the relationship (effect size) between the two variables is 0.78.

Relationship between IFDI and mobile cellular subscriptions in developing countries

The following equation expresses the bivariate fit of IFDI by telephone lines:

$$\log(\text{IFDI}) = -0.546009 + 0.6435029 \times \log(\text{mobile cellular subscriptions})$$

The R-squared value for mobile cellular subscriptions and IFDI is 0.65. This would suggest that the model is a good fit and explains 65% of the variation in IFDI. The regression sum of square of the model is 1595.4317 and the residual sum of squares is 840.4002 giving a total of 2435.8319. The variation among the observed values of IFDI could be attributed to random variation or attributed to some changes in mobile cellular subscriptions. The F statistic of 1190.309, derived from the ratio of the model to the error mean square and the associated p value of less than 0.0001 suggests that the coefficient of the variable is not zero. The strength of the relationship (effect size) between the two variables is 0.80.

Figure 20 presents the results of the bivariate analysis between OFDI and all the individual ICT variables for developing countries.

Figure 20: The bivariate analysis of OFDI and the various ICT variables for developing countries

Relationship between OFDI and internet users in developing countries

The following equation expresses the bivariate fit of OFDI by internet users:

$$\log(\text{OFDI}) = -3.803836 + 0.7888037 \times \log(\text{internet users})$$

The R-squared value for Internet users and OFDI is 0.46. This would suggest that the model is a close fit and explain 48% of variation in OFDI. The regression sum of square of the model is 1488.8149 and the residual sum of squares is 1724.4774 giving a total of 3213.2924. The variation among the observed values of OFDI could be attributed to random variation or attributed to some changes in Internet users. The F statistic of 453.2549 derived from the ratio of the model to the error mean square and the associated p value of less than 0.0001 suggests that the coefficient of the variable is not zero. The strength of the relationship (effect size) between the two variables is 0.68.

Relationship between OFDI and telephone lines in developing countries

The following equation expresses the bivariate fit of OFDI by telephone lines:

$$\log(\text{OFDI}) = -3.823761 + 0.7759702 \times \log(\text{telephone lines})$$

The R-squared value for telephone lines and OFDI is 0.4. This would suggest that the model is a close fit and only some variation in OFDI can be explained by the independent variable in the model. The regression sum of square of the model is 1336.2197 and the residual sum of squares is 2057.3680 giving a total of 3393.5877. The variation among the observed values of OFDI could be attributed to random variation or attributed to some changes in telephone lines. The F statistic of 352.6677 derived from the ratio of the model

to the error mean square and the associated p value of less than 0.0001 suggests that the coefficient of the variable is not zero. The strength of the relationship (effect size) between the two variables is 0.62.

Relationship between OFDI and mobile cellular subscriptions in developing countries

The following equation expresses the bivariate fit of OFDI by internet users:

$$\log(\text{OFDI}) = -3.667543 + 0.7201132 \times \log(\text{mobile cellular subscriptions})$$

The R-squared value for mobile cellular subscriptions and OFDI is 0.43. This would suggest that the model is a close fit and some variation in OFDI can be explained by the independent variable in the model. The regression sum of square of the model is 1346.3858 and the residual sum of squares is 1796.0423 giving a total of 3142.4280.The variation among the observed values of OFDI could be attributed to random variation or attributed some changes in mobile cellular subscriptions. The F statistic of 396.5597, derived from the ratio of the model to the error mean square and the associated p value of less than 0.0001 suggests that the coefficient of the variable is not zero. The strength of the relationship (effect size) between the two variables is 0.65.

Multivariate Analysis: Refining the relationships in developing countries

The following figure presents the results obtained from a regression analysis conducted on a model for relating the IFDI to all the ICT variables and the control variables.

Response IFDI

Summary of Fit

RSquare	0.705803
RSquare Adj	0.703208
Root Mean Square Error	30319.09
Mean of Response	26188.27
Observations (or Sum Wgts)	573

Analysis of Variance

Source	DF	Sum of Squares	Mean Square	F Ratio
Model	5	1.2504e+12	2.501e+11	272.0556
Error	567	5.2121e+11	919247104	Prob > F
C. Total	572	1.7716e+12		<.0001*

Parameter Estimates

Term	Estimate	Std Error	t Ratio	Prob>|t|	Std Beta	VIF
Intercept	362.89411	2334.254	0.16	0.8765	0	.
Internet users (per 100 people)	1160.5403	168.617	6.88	<.0001*	0.288873	3.3950168
Telephone lines (per 100 people)	-282.1992	151.4795	-1.86	0.0630	-0.05868	1.9119083
Mobile cellular subscriptions (per 100 people)	-83.15464	62.11123	-1.34	0.1812	-0.05086	2.7811179
GDP per capita (current US$)	0.4084527	0.203254	2.01	0.0450*	0.060105	1.7241125
GDP (current US$)	1.2295e-7	3.534e-9	34.79	<.0001*	0.797579	1.0127707

Effect Tests

Source	Nparm	DF	Sum of Squares	F Ratio	Prob > F
Internet users (per 100 people)	1	1	4.3546e+10	47.3715	<.0001*
Telephone lines (per 100 people)	1	1	3190335129	3.4706	0.0630
Mobile cellular subscriptions (per 100 people)	1	1	1647650066	1.7924	0.1812
GDP per capita (current US$)	1	1	3712249621	4.0384	0.0450*
GDP (current US$)	1	1	1.1128e+12	1210.543	<.0001*

Figure 21: The multivariate analysis of IFDI to various ICT variables and control variables in developing countries

The R-squared value of 0.70 for the model suggests that a major portion of the variation of IFDI can be explained by all the independent variables in the model. However, when comparing with the bivariate analysis the adjusted R-squared value is much better alternative and again the adjusted R-squared value of 0.70 would also suggest that a major portion of the variation of cost could be explained by the independent variables and

the R-squared values do not change significantly from the bivariate analysis. This would suggest that the ICT variables plays more important role in IFDI activities. The F statistic value of 272.05 and the associated p value, shown as < 0.0001 under Prob > F indicates that at least one of the coefficients is not zero.

The p value associated with internet users (per 100 peoples) is less than 0.0001. This indicates that there is a variation in IFDI due to internet users (per 100 people) that is not due to telephone lines (per 100 people), mobile cellular subscriptions (per 100 people), GDP per capita and GDP. The p values for GDP per capita and GDP show similar variations in IFDI. The p value associated with mobile cellular subscriptions (per 100 people) is 0.18 which is greater than the significance level, suggesting the reverse is true. This is also the case for telephone lines (per 100 people).The F statistic of 272.05 derived from the ratio of the model to the error mean square suggests that the null hypothesis can be rejected. Furthermore, the standardised beta suggests that GDP has a moderate effect on the model with a value of 0.79, in the relation to all the other variables in the model. The standardised beta for internet users (per 100 people) is 0.288 and this would suggest that this variable has a modest effect on the model; whilst GDP per capita has a weak effect on the model, in the context of all the other variables in the model. Telephone lines (per 100 people) and mobile cellular subscriptions (per 100 people) are negatively correlated. The VIF values vary between 1.01 and 3.39 and this suggests that there is a low probability of a multicollinearity problem.

The figure below presents the results obtained from a regression analysis conducted on a model for relating the OFDI to all the ICT variables and the control variables.

Response OFDI

Summary of Fit

RSquare	0.491048
RSquare Adj	0.486607
Root Mean Square Error	16075.06
Mean of Response	8061.265
Observations (or Sum Wgts)	579

Analysis of Variance

Source	DF	Sum of Squares	Mean Square	F Ratio
Model	5	1.4286e+11	2.857e+10	110.5688
Error	573	1.4807e+11	258407504	Prob > F
C. Total	578	2.9093e+11		<.0001*

Parameter Estimates

Term	Estimate	Std Error	t Ratio	Prob>|t|	Std Beta	VIF
Intercept	-2417.471	1222.912	-1.98	0.0485*	0	.
Internet users (per 100 people)	720.87664	89.38771	8.06	<.0001*	0.444554	3.4210663
Telephone lines (per 100 people)	-178.8354	80.08317	-2.23	0.0259*	-0.09229	1.9229379
Mobile cellular subscriptions (per 100 people)	-85.109	32.8882	-2.59	0.0099*	-0.12896	2.7957298
GDP per capita (current US$)	0.4226291	0.107656	3.93	<.0001*	0.153606	1.723653
GDP (current US$)	3.6072e-8	1.873e-9	19.26	<.0001*	0.577785	1.013417

Effect Tests

Source	Nparm	DF	Sum of Squares	F Ratio	Prob > F
Internet users (per 100 people)	1	1	1.6806e+10	65.0379	<.0001*
Telephone lines (per 100 people)	1	1	1288633541	4.9868	0.0259*
Mobile cellular subscriptions (per 100 people)	1	1	1730517428	6.6969	0.0099*
GDP per capita (current US$)	1	1	3982425120	15.4114	<.0001*
GDP (current US$)	1	1	9.5836e+10	370.8704	<.0001*

Figure 22: The multivariate analysis of OFDI to various ICT variables and control variables in developing countries

The R-squared value of 0.49 for the model suggests that a portion of the variation of OFDI can be explained by all the independent variables in the model as compared to the

variation of IFDI. The adjusted R-squared value is much better alternative and again the adjusted R-squared value of 0.48 would suggest that a portion of the variation of cost could be explained by the independent variables. The p value associated with internet users (per 100 people) is less than 0.0001 indicating that there is a variation in OFDI due to internet users (per 100 people) that is not due to telephone lines (per 100 people), mobile cellular subscriptions (per 100 people), GDP per capita and GDP. The p values and the associated with telephone lines (per 100 people), mobile cellular subscriptions (per 100 people), GDP per capita and GDP shows that there is variations in OFDI due to that specific variable and not due to the other variables in the model.

The F statistic of 110.56, derived from the ratio of the model to the error mean square suggests that at least one of the coefficients is not zero. The standardised beta indicates that GDP and internet users (per 100 people) have a modest effect on the model with a value of 0.57 and 0.44 respectively, in the relation to all the other variables in the model. The standardised beta for GDP per capita is 0.153 and this would suggest that this variable has a weak effect on the model; whilst all the other variables are negatively associated in relation to all the other variables in the model. The VIF values vary between 1.01 and 3.42 and this suggests that there is a low probability of a multicollinearity problem.

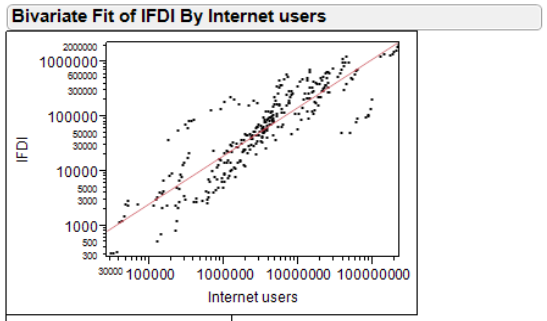
Hypothesis three: developed countries

The following two sections focus on developed countries and tries to estimate the relationship between various ICT variables and FDI. The first section focuses on a bivariate

analysis between IFDI and individual ICT variables. The subsequent section tries to refine on the bivariate analysis by conducting a multivariate analysis of the different ICT variables and IFDI in developed countries.

Bivariate analysis: Estimating relationships in developed countries

The following section presents the results obtained from a regression analysis using a model for relating IFDI and OFDI to all the individual ICT variables (internet users, mobile cellular subscriptions and telephone users) for developed countries. The goal was to understand the influence of individual ICT variables on IFDI and OFDI. Figure 23 summarised the bivariate analysis of IFDI and the various ICT variables for developed countries and figure 24 summarises the bivariate analysis of OFDI and the various ICT variables for developed countries.



Transformed Fit Log to Log

Log(IFDI) = -2.334382 + 0.8853377*Log(Internet users)

Summary of Fit

RSquare	0.783814
RSquare Adj	0.783134
Root Mean Square Error	0.866143
Mean of Response	10.92209
Observations (or Sum Wgts)	320

Lack Of Fit

Source	DF	Sum of Squares	Mean Square	F Ratio
Lack Of Fit	312	237.45490	0.761073	4.1146
Pure Error	6	1.10982	0.184970	Prob > F
Total Error	318	238.56472		0.0382*
				Max RSq
				0.9990

Analysis of Variance

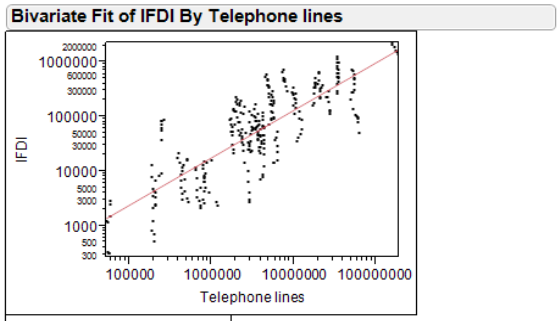
Source	DF	Sum of Squares	Mean Square	F Ratio
Model	1	864.9489	864.949	1152.952
Error	318	238.5647	0.750	Prob > F
C. Total	319	1103.5136		<.0001*

Parameter Estimates

Term	Estimate	Std Error	t Ratio	Prob>|t|	Std Beta
Intercept	-2.334382	0.393402	-5.93	<.0001*	0
Log(Internet users)	0.8853377	0.026074	33.96	<.0001*	0.885332

Fit Measured on Original Scale

Sum of Squared Error	1.242e+13
Root Mean Square Error	197658.33
RSquare	0.6342132
Sum of Residuals	2829245.2



Transformed Fit Log to Log

Log(IFDI) = -2.217299 + 0.8698188*Log(Telephone lines)

Summary of Fit

RSquare	0.679644
RSquare Adj	0.678637
Root Mean Square Error	1.054366
Mean of Response	10.92209
Observations (or Sum Wgts)	320

Lack Of Fit

Source	DF	Sum of Squares	Mean Square	F Ratio
Lack Of Fit	315	353.47517	1.12214	80.9318
Pure Error	3	0.04160	0.01387	Prob > F
Total Error	318	353.51676		0.0019*
				Max RSq
				1.0000

Analysis of Variance

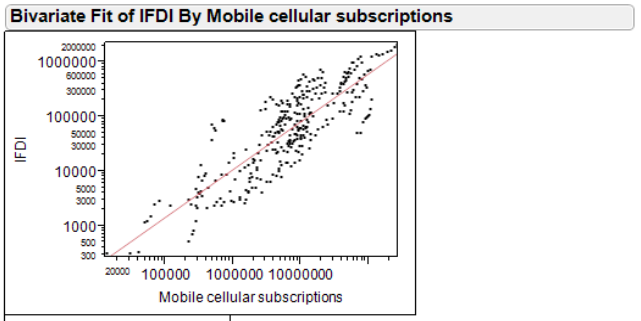
Source	DF	Sum of Squares	Mean Square	F Ratio
Model	1	749.9968	749.997	674.6469
Error	318	353.5168	1.112	Prob > F
C. Total	319	1103.5136		<.0001*

Parameter Estimates

Term	Estimate	Std Error	t Ratio	Prob>|t|	Std Beta
Intercept	-2.217299	0.50929	-4.35	<.0001*	0
Log(Telephone lines)	0.8698188	0.033488	25.97	<.0001*	0.824405

Fit Measured on Original Scale

Sum of Squared Error	1.157e+13
Root Mean Square Error	190738.83
RSquare	0.6593754
Sum of Residuals	10823893



Transformed Fit Log to Log

Log(IFDI) = -2.820645 + 0.8781065*Log(Mobile cellular subscriptions)

Summary of Fit

RSquare	0.730965
RSquare Adj	0.730119
Root Mean Square Error	0.966228
Mean of Response	10.92209
Observations (or Sum Wgts)	320

Analysis of Variance

Source	DF	Sum of Squares	Mean Square	F Ratio
Model	1	806.6298	806.630	864.0022
Error	318	296.8838	0.934	Prob > F
C. Total	319	1103.5136		<.0001*

Parameter Estimates

Term	Estimate	Std Error	t Ratio	Prob>|t|	Std Beta
Intercept	-2.820645	0.470647	-5.99	<.0001*	0
Log(Mobile cellular subscriptions)	0.8781065	0.029874	29.39	<.0001*	0.854965

Fit Measured on Original Scale

Sum of Squared Error	1.161e+13
Root Mean Square Error	191058.98
RSquare	0.658231
Sum of Residuals	14995054

Figure 23: The bivariate analysis of IFDI and the various ICT variables for developed countries

Relationship between IFDI and internet users in developed countries

The following equation expresses the bivariate fit of IFDI by internet users:

$$\log(\text{IFDI}) = -2.334382 + 0.8853377 \times \log(\text{internet users})$$

The R-squared value for Internet users and IFDI is 0.78. This would suggest that the model is a good fit and that most of the variation in IFDI can be explained by the independent variable in the model. The regression sum of square of the model is 864.9489 and the residual sum of squares is 238.5647 showing a good fit of the model and giving a total of 1103.5136. The variation among the observed values of IFDI could be attributed to random variation or attributed to some changes in internet users. The F statistic of 1152.952 derived from the ratio of the model to the error mean square and the associated p value of less than 0.0001 suggests that the coefficient of the variable is not zero. The strength of the relationship (effect size) between the two variables is 0.88.

Relationship between IFDI and telephone lines in developed countries

The following equation expresses the bivariate fit of IFDI by telephone lines:

$$\log(\text{IFDI}) = -2.820645 + 0.8781065 \times \log(\text{telephone lines})$$

The R-squared value for telephone users and IFDI is 0.73. This would suggest that the model is a relatively good fit and that most of the variation in IFDI can be explained by the independent variable in the model. The regression sum of square of the model is 806.6298

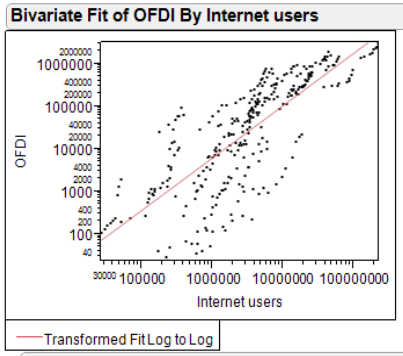
and the residual sum of squares is 296.8838 showing a good fit of the model and giving a total of 1103.5136. The variation among the observed values of IFDI could be attributed to random variation or attributed to some changes in telephone users. The F statistic of 864.0022 derived from the ratio of the model to the error mean square and the associated p value of less than 0.0001 suggests that the coefficient of variable is not zero. The strength of the relationship (effect size) between the two variables is 0.82.

Relationship between IFDI and mobile cellular subscriptions in developed countries

The following equation expresses the bivariate fit of IFDI by mobile cellular subscriptions:

$$\log(\text{IFDI}) = -2.217299 + 0.8698188 \times \log(\text{mobile cellular subscriptions})$$

The R-squared value for mobile cellular subscriptions and IFDI is 0.68. This would suggest that the model is a relatively good fit and that most of the variation in IFDI can be explained by the independent variable in the model; however, to a lesser extent when compared with internet users and telephone lines. The regression sum of square of the model is 749.9968 and the residual sum of squares is 353.5168 showing a good fit of the model and giving a total of 1103.5136. The variation among the observed values of IFDI could be attributed to random variation or attributed to some changes in mobile cellular subscriptions. The F statistic of 674.6469 derived from the ratio of the model to the error mean square and the associated p value of less than 0.0001 suggests that the coefficient of variable is not zero. The strength of the relationship (effect size) between the two variables is 0.85.



Transformed Fit Log to Log

Log(OFDI) = -8.225335 + 1.2282838*Log(Internet users)

Summary of Fit

RSquare	0.625794
RSquare Adj	0.624614
Root Mean Square Error	1.771407
Mean of Response	10.16984
Observations (or Sum Wgts)	319

Lack Of Fit

Source	DF	Sum of Squares	Mean Square	F Ratio
Lack Of Fit	311	976.25390	3.13908	1.0206
Pure Error	6	18.45457	3.07576	Prob > F
Total Error	317	994.70847		0.5611
				Max RSq
				0.9931

Analysis of Variance

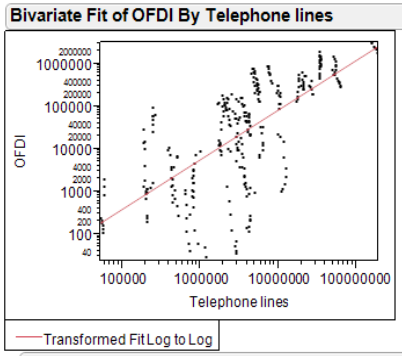
Source	DF	Sum of Squares	Mean Square	F Ratio
Model	1	1663.4773	1663.48	530.1275
Error	317	994.7085	3.14	Prob > F
C. Total	318	2658.1857		<.0001*

Parameter Estimates

Term	Estimate	Std Error	t Ratio	Prob>|t|	Std Beta
Intercept	-8.225335	0.805072	-10.22	<.0001*	0
Log(Internet users)	1.2282838	0.053347	23.02	<.0001*	0.791072

Fit Measured on Original Scale

Sum of Squared Error	5.103e+13
Root Mean Square Error	401211.32
RSquare	0.248662
Sum of Residuals	6793244.6



Transformed Fit Log to Log

Log(OFDI) = -7.408842 + 1.1636271*Log(Telephone lines)

Summary of Fit

RSquare	0.504903
RSquare Adj	0.503341
Root Mean Square Error	2.03755
Mean of Response	10.16984
Observations (or Sum Wgts)	319

Lack Of Fit

Source	DF	Sum of Squares	Mean Square	F Ratio
Lack Of Fit	314	1315.9029	4.19077	80.0521
Pure Error	3	0.1571	0.05235	Prob > F
Total Error	317	1316.0600		0.0019*
				Max RSq
				0.9999

Analysis of Variance

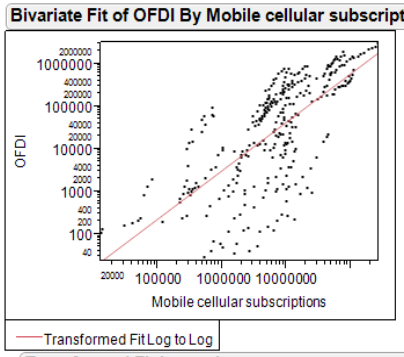
Source	DF	Sum of Squares	Mean Square	F Ratio
Model	1	1342.1258	1342.13	323.2785
Error	317	1316.0600	4.15	Prob > F
C. Total	318	2658.1857		<.0001*

Parameter Estimates

Term	Estimate	Std Error	t Ratio	Prob>|t|	Std Beta
Intercept	-7.408842	0.984316	-7.53	<.0001*	0
Log(Telephone lines)	1.1636271	0.064718	17.98	<.0001*	0.710565

Fit Measured on Original Scale

Sum of Squared Error	2.825e+13
Root Mean Square Error	298507.77
RSquare	0.5840891
Sum of Residuals	29731931



Transformed Fit Log to Log

Log(OFDI) = -7.621943 + 1.1367602*Log(Mobile cellular subscriptions)

Summary of Fit

RSquare	0.50851
RSquare Adj	0.506959
Root Mean Square Error	2.030114
Mean of Response	10.16984
Observations (or Sum Wgts)	319

Analysis of Variance

Source	DF	Sum of Squares	Mean Square	F Ratio
Model	1	1351.7137	1351.71	327.9773
Error	317	1306.4721	4.12	Prob > F
C. Total	318	2658.1857		<.0001*

Parameter Estimates

Term	Estimate	Std Error	t Ratio	Prob>|t|	Std Beta
Intercept	-7.621943	0.988974	-7.71	<.0001*	0
Log(Mobile cellular subscriptions)	1.1367602	0.062769	18.11	<.0001*	0.713099

Fit Measured on Original Scale

Sum of Squared Error	2.937e+13
Root Mean Square Error	304398.99
RSquare	0.5675106
Sum of Residuals	41722633

Figure 24: The bivariate analysis of OFDI and the various ICT variables for developed countries

Relationship between OFDI and internet users in developed countries

The following equation expresses the bivariate fit of OFDI by internet users:

$$\log(\text{OFDI}) = -8.225335 + 1.2282838 \times \log(\text{internet users})$$

The R-squared value for Internet users and OFDI is 0.63. This would suggest that the model is a relatively good fit; however, when compared with the IFDI this is a lesser of a fit and some of the variation in OFDI can be explained by the independent variable in the model. The regression sum of square of the model is 1663.4773 and the residual sum of squares is 994.7085 giving a total of 2658.1857. The variation among the observed values of OFDI could be attributed to random variation or attributed some changes in internet users. The F statistic of 530.1275 derived from the ratio of the model to the error mean square and the associated p value of less than 0.0001 suggests that the coefficient of the variable is not zero. The strength of the relationship (effect size) between the two variables is 0.79.

Relationship between OFDI and telephone lines in developed countries

The following equation expresses the bivariate fit of OFDI by telephone lines:

$$\log(\text{OFDI}) = -7.621943 + 1.1367602 \times \log(\text{telephone lines})$$

The R-squared value for telephone lines and OFDI is 0.51. This would suggest that the model is weak fit and only some variation in OFDI can be explained by the independent variable in the model. The regression sum of square of the model is 1351.7137 and the

residual sum of squares is 1306.4721 giving a total of 2658.1857. The F statistic of 327.9773 derived from the ratio of the model to the error mean square and the associated p value of less than 0.0001 suggests that the coefficient of the variable is not zero. The strength of the relationship (effect size) between the two variables is 0.71.

Relationship between OFDI and mobile cellular subscriptions in developed countries

The following equation expresses the bivariate fit of OFDI by mobile cellular subscriptions:

log(OFDI)=-7.408842 + 1.1636271 x log(mobile cellular subscriptions)

The R-squared value for telephone lines and OFDI is 0.5. This would suggest that the model is a weak fit and some variation in OFDI can be explained by the independent variable in the model. The regression sum of square of the model is 1342.1258 and the residual sum of squares is 1316.0600 giving a total of 2658.1857.The F statistic of 323.2785 derived from the ratio of the model to the error mean square and the associated p value of less than 0.0001 suggests that the coefficient of the variable is not zero. The strength of the relationship (effect size) between the two variables is 0.71.

Multivariate analysis: Refining relationships in developed countries

The following figure presents the results obtained from a regression analysis conducted on a model for relating the IFDI to all the ICT variables and the control variables.

Response IFDI

Summary of Fit

RSquare	0.749943
RSquare Adj	0.745948
Root Mean Square Error	164643
Mean of Response	194436.4
Observations (or Sum Wgts)	319

Analysis of Variance

Source	DF	Sum of Squares	Mean Square	F Ratio
Model	5	2.5446e+13	5.089e+12	187.7426
Error	313	8.4846e+12	2.711e+10	Prob > F
C. Total	318	3.3931e+13		<.0001*

Parameter Estimates

Term	Estimate	Std Error	t Ratio	Prob>|t|	Std Beta	VIF
Intercept	-117487.3	51688.97	-2.27	0.0237*	0	.
Internet users (per 100 people)	1636.9313	663.8898	2.47	0.0142*	0.110357	2.5074724
Telephone lines (per 100 people)	1342.3024	898.718	1.49	0.1363	0.058143	1.8968766
Mobile cellular subscriptions (per 100 people)	871.05266	408.5929	2.13	0.0338*	0.077988	1.6751472
GDP (current US$)	1.2757e-7	4.562e-9	27.96	<.0001*	0.829135	1.100486
GDP per capita (current US$)	-0.613072	0.802179	-0.76	0.4453	-0.03713	2.9550159

Effect Tests

Source	Nparm	DF	Sum of Squares	F Ratio	Prob > F
Internet users (per 100 people)	1	1	1.648e+11	6.0795	0.0142*
Telephone lines (per 100 people)	1	1	6.047e+10	2.2308	0.1363
Mobile cellular subscriptions (per 100 people)	1	1	1.232e+11	4.5447	0.0338*
GDP (current US$)	1	1	2.1196e+13	781.9348	<.0001*
GDP per capita (current US$)	1	1	1.5833e+10	0.5841	0.4453

Figure 25: The multivariate analysis of IFDI to various ICT variables and control variables in developed countries

The R-squared value of 0.74 for the model suggests that a major portion of the variation of IFDI can be explained by all the independent variables in the model. However, when comparing with the bivariate analysis the adjusted R-squared value is much better alternative and again the adjusted R-squared value of 0.74 would suggest that a major

portion of the variation of cost could be explained by the independent variables. The p value associated with internet users (per 100 people) is 0.01 indicating that there is a variation in IFDI due to internet users (per 100 people) that is not due to telephone lines (per 100 people), mobile cellular subscriptions (per 100 people), GDP per capita and GDP. The p values and the associated t statistic for mobile cellular subscriptions (per 100 people) and GDP shows that there is variations in IFDI due to that specific variable and not due to the other variables in the model. The p value associated with telephone lines (per 100 people) is 0.13 which is greater than the significance level, suggesting that the reverse is true. This is also the case for GDP per capita. The F statistic of 187.74 derived from the ratio of the model to the error mean square indicates that at least one of the coefficients is not zero. There is significant evidence to conclude that the included variables in the model contribute significantly to the model.

A standardised beta value of 0.82 suggests that GDP has a modest effect on the model in the relation to all the other variables in the model. The standardised beta for GDP per capita is - 0.03 and this would suggest that this variable has a weak effect on the model. The negative value would also suggest a negative association with FDI. All the other variables have effect on the model in relation to all the other variables. The VIF statistics displayed in the parameter estimates vary from 1.1 and 2.95 and this suggests that there is a low probability of a multicollinearity problem.

The following figure presents the results obtained from a regression analysis conducted on a model for relating the OFDI to all the ICT variables and the control variables.

Response OFDI

Summary of Fit

RSquare	0.772702
RSquare Adj	0.769059
Root Mean Square Error	222333
Mean of Response	253080
Observations (or Sum Wgts)	318

Analysis of Variance

Source	DF	Sum of Squares	Mean Square	F Ratio
Model	5	5.243e+13	1.049e+13	212.1294
Error	312	1.5423e+13	4.943e+10	Prob > F
C. Total	317	6.7853e+13		<.0001*

Parameter Estimates

Term	Estimate	Std Error	t Ratio	Prob>|t|	Std Beta	VIF
Intercept	-291403.3	69917.77	-4.17	<.0001*	0	.
Internet users (per 100 people)	2800.3088	896.8892	3.12	0.0020*	0.133081	2.4937627
Telephone lines (per 100 people)	4043.5475	1213.802	3.33	0.0010*	0.12369	1.8923301
Mobile cellular subscriptions (per 100 people)	1270.3183	551.8377	2.30	0.0220*	0.080335	1.6717505
GDP per capita (current US$)	-1.77074	1.083306	-1.63	0.1031	-0.07564	2.9394554
GDP (current US$)	1.7962e-7	6.161e-9	29.16	<.0001*	0.825356	1.0999705

Effect Tests

Source	Nparm	DF	Sum of Squares	F Ratio	Prob > F
Internet users (per 100 people)	1	1	4.8188e+11	9.7484	0.0020*
Telephone lines (per 100 people)	1	1	5.4858e+11	11.0976	0.0010*
Mobile cellular subscriptions (per 100 people)	1	1	2.6194e+11	5.2991	0.0220*
GDP per capita (current US$)	1	1	1.3207e+11	2.6718	0.1031
GDP (current US$)	1	1	4.2021e+13	850.0811	<.0001*

Figure 26: The multivariate analysis of OFDI to various ICT variables and control variables in developed countries

The R-squared value of 0.77 for the model suggests that a larger portion of the variation of OFDI can be explained by all the independent variables in the model as compared to the variation of IFDI. The adjusted R-squared value is a better alternative and again the

adjusted R-squared value of 0.76 would suggest that a huge portion of the variation of cost could be explained by the independent variables. The p value associated with internet users (per 100 people) is 0.002 indicating that there is a variation in OFDI due to internet users (per 100 people) that is not due to telephone lines (per 100 people), mobile cellular subscriptions (per 100 people), GDP per capita and GDP. The p values associated with telephone lines (per 100 people), mobile cellular subscriptions (per 100 people) and GDP shows that there is a variation in IFDI due to that specific variable and not due to the other variables in the model. The p value associated with GDP per capita is 0.10 which is greater than the significance level, suggesting that the reverse is true.

The F statistic of 212.129 derived from the ratio of the model to the error mean square suggests that at least one of the coefficients is not zero. Therefore, there is significant evidence to conclude that one or more of the included variables in the model contribute significantly to the model. A standardised beta value of 0.82 suggests that GDP has a modest effect on the model in the relation to all the other variables in the model. The standardised beta for GDP per capita is - 0.07 and this would suggest that this variable has a weak effect on the model. The negative value would also suggest a negative association with FDI. All the other variables have effect on the model in relation to all the other variables. The VIF statistics displayed in the parameter estimates vary from 1.09 and 2.93 and this suggests that there is a low probability of a multicollinearity problem.

Chapter 6: Discussion of Results

The previous chapter documented the statistical findings of the four hypotheses that intended to examine the relationship between FDI and ICT readiness at a macro level. An initial assessment suggests that the statistical results are in agreement with the hypotheses. In this chapter, the results will be discussed in greater detail and assessed in relation to the literature and in terms of the research question.

Hypothesis 1: Least developed countries

Hypothesis one intended to test the relationship between IFDI and ICT readiness in least developed countries, with the expectation that there would be no relationship in the case of these countries.

The results from the bivariate analysis tend to support the hypothesis. The bivariate analysis showed that the relationship between the ICT variables and IFDI was weak. Contrary to expectation, internet users had the strongest relationship with IFDI as opposed to telephone users and mobile cellular subscribers. In least developed countries, one would expect that the number of internet users would be relatively lower than telephone and mobile cellular subscribers. The correlation coefficient of internet users was nearly double of that for telephone users and mobile cellular subscribers.

The low R-squared value obtained in the bivariate analysis confirms the lack of relationship and "goodness of fit". Although, the multivariate analysis showed some significance, this could have been attributed to the addition of the control variables – GDP per capita and GDP as this variables had a modest effect on the model. The F value and the associated p values were used to test the null hypothesis H0: $\beta1 = \beta2 = \beta3 = \beta4 = 0$. The associated p value, shown as < 0.0001 under Prob > F, leads to the rejection of this hypothesis and indicates that at least one of the coefficients is not zero. As mentioned above, the low R-squared value would suggest that there is a lack of fit. The lack of fit and correlation could be attributed to a number of reasons. As found in existing literature, the IDP is less significant in resource rich countries and these countries typically attract investments that are focused on exploiting the natural resources (Vavilov, 2006; Dunning, 2000) and this would require minimal use of ICT infrastructure. Additionally, existing literature also suggests that the main determinants of FDI are very difficult to quantify and model (Vailov, 2006); however, the literature review suggests that the availability of natural resources is the main determinant of FDI for countries in stage 1 and stage 2. It could also be argued that the diffusion of ICT takes a significant number of years and the full potential of ICT is not realised in least developed countries. Hence, the independent ICT variables do not have an immediate impact on the dependent variables because of this time lag. As the time progresses, the effect of ICT are seen in these countries.

Another reason could be related to outdated perceptions that exist about some countries. Aseidu (2002) suggested that countries in the sub-Saharan Africa region, still find it very

difficult to attract foreign direct investment even though the countries have progressed significantly in terms of development.

Hence, based on the evidence from this study, it can be concluded that hypothesis one holds and that there is not a significant relationship between ICT readiness and IFDI in least developed countries.

Hypothesis 2: Developing countries

After demonstrating that the relationship between IFDI and the ICT variables are relatively weak and not significant in least developed countries, the question arises whether this phenomenon will be evident in developing countries. Thus, the objective of hypothesis two is to test the relationship between (1) IFDI and ICT readiness and (2) OFDI and ICT readiness in developing countries. The expectation is that there would be a significant relationship in the case of these countries.

The results obtained tend to support the hypothesis on the relationship between IFDI and ICT. The bivariate analysis showed that the relationship between the ICT variables and IFDI was positive and relatively strong. The relationship between internet users and IFDI is relatively strong and the direction of the clustering would suggest a positive relationship. This is confirmed by the relatively high R-squared value of 0.66 which suggests that internet users explain 66% of the variation in IFDI. The relationship between OFDI and internet users is not as strong as the IFDI. The R-squared value for Internet users and OFDI

is 0.46 which suggested that the model only explained 48% of variation in OFDI. This is expected for developing countries as these countries are in the early stages of internationalising. These countries are still net recipients of FDI and most of these FDI are still focused on resources and labour intensive industries. Additionally, there is a very high correlation between IFDI and OFDI; given that the inflowing FDI also contributes to the development of the country and enables OFDI activities (Fonseca, 2007). All the IFDI bivariate equations showed sufficient variations to suggest that all these variables, by itself, were useful in estimating the impact it had on IFDI.

Additionally, the relationship between the ICT variables and OFDI was not as strong as the relationship between ICT variables and IFDI. Specifically, in the case of telephone users and OFDI, only 40% of the variations OFDI could be explained by telephone lines. This could be linked to the fact that internet is a common business tool for multinationals. It is also known to reduce geographical distance effects; can reduce coordination costs; increase foreign production and increases the mobility of MNCs (Ko, 2007). Furthermore, the weak relationship between OFDI and the different ICT variables could also be linked to the fact that these countries are in the early stages of outward FDI and still heavy recipients of IFDI.

The high R-squared value and the adjusted R-squared value in the multivariate analysis would suggest that a major portion of the variation of IFDI could be explained by the ICT variables. The analysis of variance would suggest that variables are statistically significant.

The F value and the associated p value, shown as < 0.0001 under Prob > F, leads to the rejection of the null hypothesis (H0: β1 = β2 = β3 = β4 = 0) and indicates that at least one of the coefficients is not zero. As expected in the case of IFDI, the variations in IFDI could be explained by internet users (per 100 people), GDP per capita and GDP when these individual variables were evaluated on its own. GDP had a moderate effect on the IFDI model; whilst internet users (per 100 people) had a modest effect on the IFDI model and GDP per capita has a weak effect on the IFDI model, in the context of all the other variables in the model. Telephone lines (per 100 people) and mobile cellular subscriptions (per 100 people) are negatively correlated in the IFDI model. This is contrary to expectation, especially for mobile cellular subscription as developing countries as improved ICT infrastructure should increase IFDI. This would suggest that more rigorous tests need to be conducted and more telephone and mobile specific variables need to be considered, as the current measure seems to contrary to the current body of literature.

Similar results were obtained for OFDI. The R-squared value and the adjusted R-squared value in the multivariate analysis would suggest that some of the variation of OFDI could be explained by the ICT variables. The analysis of variance would suggest that variables are statistically significant. The F value and the associated p value, shown as < 0.0001 under Prob > F, leads to the rejection of the null hypothesis (H0: β1 = β2 = β3 = β4 = 0) and indicates that at least one of the coefficients is not zero. GDP and internet users (per 100 people) have a modest effect on the OFDI model, in the relation to all the other variables in the model. GDP per capita has a weak effect on the OFDI model; whilst all the other

variables are negatively associated in relation to all the other variables in the model. As echoed in the previous paragraphs, the lower R-squared values seen in the analysis of OFDI and the individual ICT variables could be attributed to the fact that there is relatively small amount of OFDI and IFDI is still focused on primary commodities, natural resources and industries that are intensive in physical and low qualified work. Furthermore, there is an improvement in the country's assets such as infrastructure, ICT and education (Fonseca, 2007).

Hence, based on the evidence from this study, it can be concluded that hypothesis 2(a) and 2(b) holds and that there is a significant relationship between ICT readiness and IFDI in developing countries and to a lesser extent in the case of OFDI and ICT readiness.

Hypothesis 3: Developed countries

After demonstrating that the relationship between the ICT readiness and IFDI is relatively strong and to a lesser extent in the case the ICT readiness and OFDI, the next question that arises is whether this phenomenon will be evident in developed countries. Thus, the objective of hypothesis two is to test the relationship between (1) IFDI and ICT readiness and (2) OFDI and ICT readiness in developed countries. The expectation is that there would be a significant relationship in the case of these countries.

As in the case of developing countries, the bivariate analysis showed that the relationship between the ICT variables and IFDI was positive and very strong. This would suggest that

ICT plays a key role in IFDI activities. The R-squared values for internet users and mobile cellular subscriptions was relatively higher than telephone lines; suggesting that these technologies facilitate IFDI activities in a much better manner. As mentioned previously, these technologies are known for reducing the economic distance between nations and reducing the transaction costs. Furthermore, developed countries are likely to have less of a problem adopting ICT as a GPT as compared with developing countries, since the potential mismatches between technology, the facilitating structure and the policy structure may be weaker in the case of developed countries and stronger in the case of developing countries (Guerrieri & Padoan, 2007). This would explain why the result from the bivariate analysis is a better fit for the developed countries.

By the same token, the bivariate analysis of the individual ICT variables against the OFDI showed a relatively good fit, with the best fit obtained between internet users and OFDI. This could be linked to the fact that developed countries are heavily involved in the services industry. Additionally, investment by these countries is motivated by the search for new markets and cheap labour in countries that are in the lower stages of development. The services sector such as finance, insurance and communication services are potentially major users of ICT and furthermore, the interaction with its affiliates and even more interactions between the industry sectors are hugely dependent on ICT. Hence, the best fit was obtained between internet users and OFDI.

The high R-squared value and the adjusted R-squared value in the multivariate analysis would suggest that a major portion of the variation of IFDI could be explained by the ICT variables. The analysis of variance would suggest that variables are statistically significant. The F value and the associated p value, shown as < 0.0001 under Prob > F, leads to the rejection of the null hypothesis (H0: $\beta1 = \beta2 = \beta3 = \beta4 = 0$) and indicates that at least one of the coefficients is not zero. The p values and the associated t statistics show that the variation in IFDI could be explained by internet users (per 100 people), mobile cellular subscriptions and GDP. The p value associated with the t statistic 1.49 for telephone lines (per 100 people) is 0.13 which is greater than the significance level, suggesting that the reverse is true. This could be attributed to the fact that telephone lines are not necessarily considered to be main line technology in ICT in developed countries. Previous studies such as the one done by Aseidu (2002) also obtained similar results and suggested that telephone lines seemed to be an inadequate measure of infrastructure.

Similar results were obtained for OFDI. The R-squared value and the adjusted R-squared value in the multivariate analysis would suggest that a major portion of the variation of OFDI could be explained by the ICT variables. The analysis of variance would suggest that variables are statistically significant. The F value and the associated p value, shown as < 0.0001 under Prob > F, leads to the rejection of the null hypothesis (H0: $\beta1 = \beta2 = \beta3 = \beta4 = 0$) and indicates that at least one of the coefficients is not zero. This could be attributed to the fact that countries in stage 4 and stage 5 of the IDP participate heavily in OFDI activities and there is an exponential growth in OFDI. Secondly, countries at this stage of

development have a "developed" country profile in terms of the level of infrastructure development including ICT, economic and social infrastructure.

Hence, based on the evidence from this study, it can be concluded that hypothesis 3 holds and that there is a significant relationship between ICT readiness, inward FDI and outward FDI in developed countries.

Implications of findings

This study was developed on the argument that there exists a link between ICT readiness and FDI of a country by relating it to the IDP, a framework which postulates the relationship of FDI and economic development of countries and categorises the evolution of these countries through five different stages. According to the results obtained from the study, there exists a relationship between ICT readiness and the FDI activities of a country, specifically in developing and developed countries. In the case of least developed countries, no significant relationship was established between ICT readiness and the FDI activities of these countries. Previous studies such as the study done by Gholami *et al*. (2005) just focused on developing and developed countries without relating these country groups to the IDP. The findings of this study supports those of similar studies done by Gholami *et al*. (2005); but this study also took into consideration the least developed countries and also used the IDP as a context to analyse the relationship between ICT readiness and FDI activites of a country.

The existing IDP models do not fully capture the complex mechanisms through which ICT influences the FDI activities of a countries. However, some of these models make use of ICT as a proxy to measure the economic development of a country and how the economic development influences FDI at a macro level. In order to capture the impact of ICTs on FDI activities in the models considered, some modification was required and the intention of this study was to capture these effects at a macro level. Based on the results obtained, this study presents the ICT readiness of countries relative to the economic development and different stages of IDP in a graphical manner (depicted in figure 27). The model depicted below is an adaption of the IDP model that was initially proposed by Duran and Ubeda (2001).

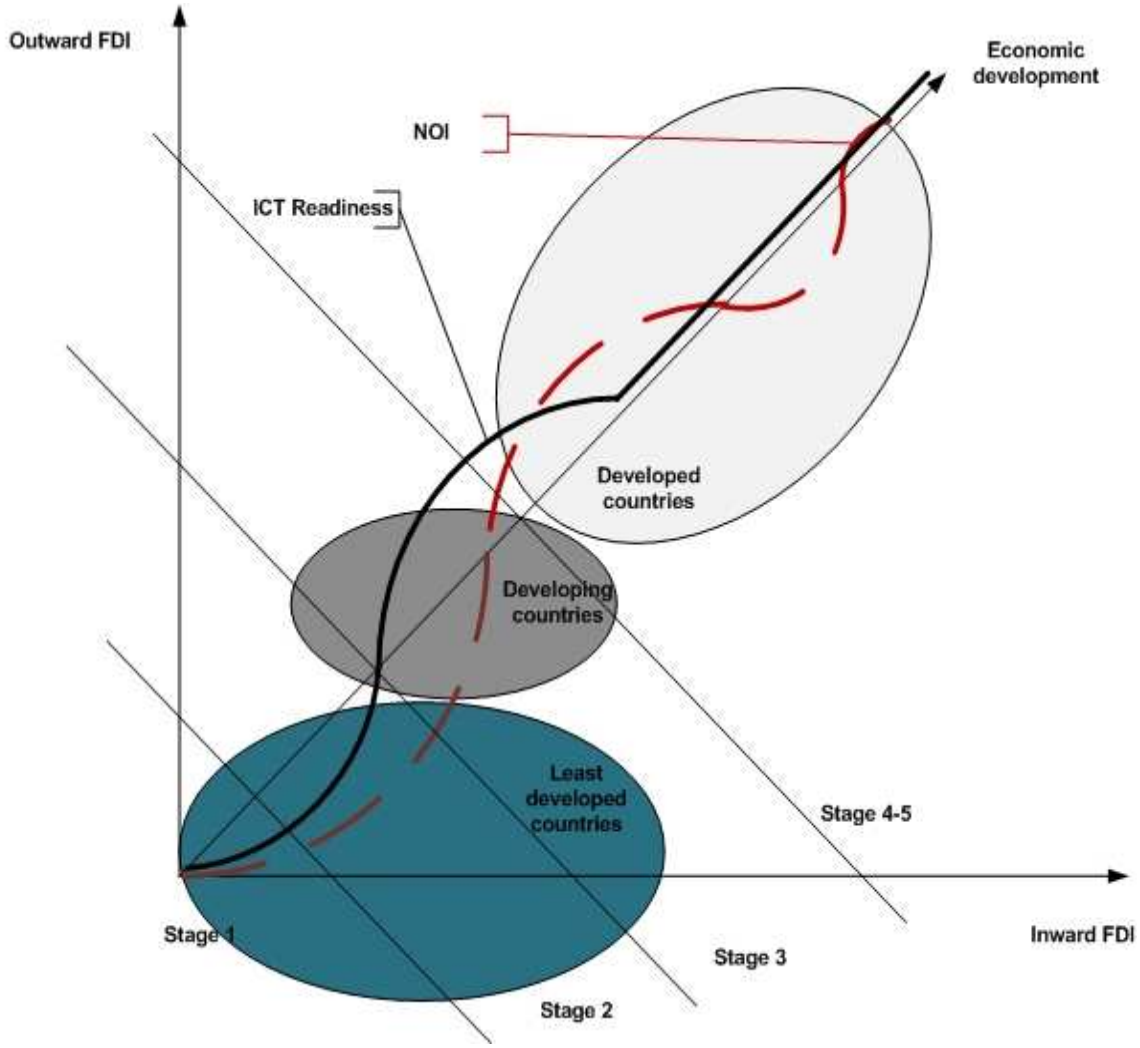


Figure 27: The figure depicts the ICT readiness of countries relative to the economic development and different stages of IDP.

As discussed in literature review, the IDP model proposed by Duran and Ubeda tried to show the position of the countries in the different stages of IDP based on the results obtained from their study. This study agrees with the positioning of the countries in terms of least developed and developed countries; however, in addition, this study also adds the positioning for developing countries into the model (depicted in grey in the figure above).

The countries in the first and second stages are situated along the axis; whilst countries in the third stage are characterised by increased volumes of OFDI. The countries in stages four and five are represented around the bisection. As depicted in figure 27, the net position of stock (NOI) fluctuates to zero as countries reach stage five of the IDP.

As depicted in figure 27, the early stages of the IDP refer to the least developed countries and these countries face a negative NOI. As mentioned in the literature review, least developed countries attract FDI that take advantage of the country's natural resources. The results obtained from the study show no relationship between ICT readiness and FDI in the case of least developed countries and based on these results, this study posits that these countries face a negative ICT readiness position relative to the economic development of these countries. As expected, these countries are predominantly resource focused, with minimal and inappropriate infrastructure and major component of the economic and social objectives of these countries is strongly dependent on these specific resources (Dunning, 2000). Therefore, they attract a different kind of FDI, and this FDI is not heavily reliant on ICT. Based on this, the focus on ICT is relative low in these countries relative to the level of development in these countries.

Based on the results, this study suggests that the gap between the ICT readiness and level of development narrows as countries proceed to the third stage of IDP. Countries in this stage are mainly characterised by incoming FDI and increasing volumes of outward FDI. The study agrees with previous studies such as Gholami *et al*.(2005), on the relationship

between between ICT and the IFDI in developing countries. Many studies (Jalava & Pohjola, 2007; Osei-Bryson & Samoilenko, 2008; Morawczynski & Ngwenyama, 2009) suggest that a certain threshold needs to be reached in terms of ICT investment before economic growth can be achieved; however, very little is known about these important levels of threshold. One such inflection point is the point where ICT readiness of a country moves from a negative position to a positive position. The concept of "leapfrogging" in terms of developing economies deploying next generation technologies could be applicable here. This study suggests that developing countries invest heavily in ICT activities during the third stage of the IDP.

In the case of developed countries, the results show that the inward and outward FDI is strongly related ICT readiness. The ICT readiness is expected to be in line with the economic development of these countries. In these economies ICT is strongly integrated into the economy and ICT is generally considered a General Purpose Technology.

Chapter 7: Conclusions

All the studies undertaken thus far have focused on understanding the relationship between ICT and FDI, predominantly focusing on developing and developed countries. This study adds to the current body of literature on the role of ICT in FDI activities, whilst also focusing on least developed, developing and developed countries. As mentioned in the previous chapter, this study applied the IDP as a context to analyse the relationship between ICT readiness and FDI activites of a country.

Key findings

The results from this study show that there is indeed a link between ICT and FDI and this is closely associated with the investment development path of a country. Additionally, the study also shows that ICT plays a more significant role in promoting FDI activities as a country progresses through the five stages in a country's investment development path. Countries in the first stage of IDP are net receivers of FDI stocks and the study show that there is no significant relationship between ICT and FDI and attribute this to the fact that these countries are mainly focused on natural resources. Typically, these are the least developed countries. In the middle stages of IDP, countries are still net receivers of FDI stocks, albeit at a greater rate; and there is a significant relationship between ICT, inward and outward FDI. This study mainly attributes the relationship to the fact that most of these countries attract FDI that promotes country development. This leads to the improvement in infrastructure and technology capabilities of the country. Finally, the study also found that there is a strong significant relationship between ICT, IFDI and OFDI

in developed countries. Developed countries in the fourth and fifth stages of IDP, invest abroad mainly in search for new markets and better efficiency and hence, these countries are technologically very capable. Countries at these stages are heavily service oriented and are very much dependent on ICT and hence resulting in the strong relationship.

Recommendations to stakeholders

The study provides critical insight for both policy makers in different countries (macro level view) and also business decision makers of firms looking to internationalise (firm level view). The following section provides a brief summary of key recommendations for these stakeholders.

Macro level view

At a macro level, the study shows that ICT plays a key role in a country's ability to compete effectively in the international market. Based on the current body of literature and the results obtained from this study, countries that focus on ICT as an enabler tend to globalise more rapidly. This would also suggest that the government plays a pivotal role in developing and creating ICT infrastructure at a macro level. As such, policy makers need to facilitate this process by ensuring that the correct policy and incentives are in place to ensure that the technology capability building process takes place in an efficient manner. On this front, governments might also need to put additional effort to attract ICT related investments into the country; especially in least developed countries where ICT related investment could help build skills and move the country to the next stage of investment

development. With respect to developing countries, ICT plays a more critical role in helping the countries to expand its investment abroad. Previous literature has already shown that ICT creates a more supportive environment for business by creating better efficiencies. This study recommends that developing countries take a techno-centric view and deploy technology such that the benefits of that specific technology can be used to move from a natural resources based or agrarian economy to one that of a services oriented economy. Furthermore, developing countries should create an environment such that emerging multinational firms can enjoy certain short term competitive advantages during their early stages of internationalisation, using ICT as a home-country specific advantage.

Firm level view

This study did not conduct a firm level analysis; however, it is possible to make some inferences based on results and information gathered from the literature study. Firstly, it is very important to note that it is very difficult to quantify firm specific advantages; however, previous studies such as the one by Ramamurti and Singh (2009) identified support from the home government in the form of preferred access to markets, preferential regulations, or preferred access to capital as some of the firm specific advantages (FSAs) that some firms enjoyed. This study recommends firms to take advantage of ICT to improve productivity and also lower transaction costs. Furthermore, most developing countries tend to leap frog in terms of technology and multinationals can

make use of the latest technologies to gain cost advantages in creative ways such that these companies can deliver high technology, variety and customisation.

Future research

Despite the findings, there are some limitations that could be addressed in order to improve the results in this area of research. Firstly, the lack of historical data was one of the biggest limitations of this study and this probably had an impact on the R-squared values obtained in this study. Additionally, the lack of data also implied that only certain explanatory variables could be used in the study. Future research should look at limiting these effects by focusing on certain countries or country classifications. This would give researchers with quality data and also result in richer findings.

Furthermore, this study focused on a macro level analysis of different countries that were classified according to categories used by the UNCTAD FDI database. Future studies can look on expanding this area of research by focusing on an industry level analysis or a firm level analysis or a combination there of.

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