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Inward FDI and innovation in Asian countries

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Summary

In many countries, FDI is considered an important component of development, therefore many developing countries have sought investment and designed policies to attract FDI. Countries seek FDI with the expectation that MNEs would bring new technology and know-how to their economy or spillovers. Evidence of this in existing research is contradictory; while some studies have proven the existence of positive spillovers, others have found no trace of such effects in the host country of FDI. Positive spillovers can be seen in, among others, technology and knowledge spillover in the form of innovation activities. Fagerberg et al (2010) suggest that innovation is not limited to high-tech activities; is an aspect in all aspects of economic activities, not only new products and process but also improvements in logistics and distribution, for example. Simple innovations in these areas may have large-scale economic effects. Therefore, innovation is important for developing countries, including the developing Asia. The present research aims to explain the relationship of FDI and innovation in selected Asian countries, and identify the condition in which FDI can have a positive effect on innovation activities.

Using the absorptive capacity theory with moderating variables human capacity, infrastructure and institutional environment, the result of statistical analysis is that evidence of this relationship exists, although it is rare and inconsistent across models. The relationship between FDI and innovation depends on the moderating variables and the type of investment. It is found that human capital positively determines the relationship between FDI and innovation. This finding is in line with previous research in this subject. For example, Hall and Mairesse (2006) found that firms with a greater share of highly educated employees are more likely to innovate. Education is necessary for the host country in order to absorb and internalize knowledge from foreign firms and apply it locally. Additionally, investment in the services sector is positive for innovation activities compared to investment sectors such as manufacturing and natural resources. FDI in the service sector may have a positive relationship with innovation activities because much of nature of the investment in this sector is high-tech.

Keywords

Foreign direct investment, greenfield, innovation, absorptive capacity, human capital, institutional environment, infrastructure, service sector, manufacturing sector, natural resources sector

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Abbreviations

IHS	Institute for Housing and Urban Development
FDI	Foreign direct invesmtent
MNE	Multinational enterprises
WIPO	World Intellectual Property Organization
GDP	Gross Domestic Product
Min.	Minimum
Max.	Maximum
Std Dev	Standard Deviation
OECD	Organization for Economic Cooperation and Development
WB	World Bank
GIS	Geographic Information System
UNCTAD	United Nations Conference on Trade and Development
ICRG	International Country Risk Guide
US$	US dollars
MNC	Multinational corporations
ASEAN	Association of Southeast Asian Nations
GNI	Gross national income

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Chapter 1: Introduction

1.1 Background

Over the past decade, foreign direct investment has steadily increased. In 2016, the OECD recorded a US$1.77 million of inward FDI worldwide, a significant recovery from the US$1.18 million in 2009, a year after the global economic crisis. Similarly, outward FDI flow reached US$1.4 million in 2016, an increase from US$1.09 million in 2009. Despite the blows in the global economy, multinational enterprises (MNE) continue to conduct cross-border investments.

There are four strategies which explain a firm's decision to invest in a foreign country, which are market-seeking, resource-seeking, efficiency-seeking and asset-seeking (Dunning, 1998). Therefore, a firm's decision to invest in a foreign highly depends on a host country's assets and which of the firm's strategies it can help fulfill.

Meanwhile, host countries seek foreign investment due to the possibility of positive spillovers. In many countries, FDI is considered as an important component of development, thus policies are designed to attract FDI (Crespo and Fontoura, 2005). Countries seek FDI with the expectation that MNEs would bring new technology and know-how to their economy (Javorcik and Spatareanu, 2005), or spillovers.

There are two types of spillovers from FDI, which are vertical and horizontal spillovers. A vertical spillover, also known as inter-industry spillover, occurs when domestic firms are affected by firms with foreign equity participation through backward or forward linkages, while a horizontal spillover, also known as intra-industry spillover, occurs when domestic firm productivity is positively affected by the existence of firms with foreign equity participation in the same sector (Du, Harrison and Jefferson. 2011). While vertical spillovers occur through contact between MNEs and their local suppliers, horizontal spillovers occur horizontal spillovers occur through a transfer of knowledge between MNEs and domestic firms in the same sector (Javorcik and Spatareanu, 2005).

An example of a horizontal spillover is innovation through technological diffusion. China, for example, is among the host countries with the largest FDI value and count. FDI in the country resulted in a positive and significant effect towards innovation in China's provinces (Cheung and Ping, 2004). In Argentina, Marin and Bell (2006) also found a similar positive spillover effect from FDI to local innovation capacity. However, Marin and Bell also found that there were preconditions in which a positive spillover from FDI could take place in a host country. They concluded that FDI by itself had no direct effect or positive spillovers. Marin and Bell concluded that absorptive capacity, among other factors, plays a large role in the existence of positive spillovers. Capacities which may induce positive spillovers include, among others, the qualities of human capital, infrastructure, and institutional environment; the better these capacities, the more likely FDI results in a positive spillover. Meanwhile, Feinberg and Majumdar (2001) found that MNEs operating in the pharmaceutical sector in India resulted in a technology spillover only to other MNEs, while Indian firms gained nothing. They suggested that the policy environment in India at the time did not make technology spillover from MNCs to local firms possible.

1.2 Problem statement

For developing countries, such as most of Southeast Asian and South Asian countries, FDI in knowledge- and technology-intensive industries are important to improve local knowledge, human capital, and productivity. FDI is generally perceived to bring economic benefits to the host country (Sjoholm, 2014). It is an important channel for technology transfers and knowledge spillovers (Fu, 2007). Advanced technology and knowledge from abroad can encourage innovation, as has been proven in China (Cheung and Ping, 2004; Fu, 2007).

Southeast Asia is an increasingly attractive regional market for foreign investors (Sjoholm, 2014). According to data from the UNCTAD, FDI in Southeast Asia began increasing rapidly in the 1980s. Although a number of ASEAN countries, such as Thailand, Indonesia and Malaysia, suffered due to the 1997 Asian Financial Crisis, FDI in Southeast Asia quickly increased after a temporary drop. A similar recovery can also be observed after the global financial crisis of 2008. According to Sjoholm 2014), Southeast Asia accounts for 8% of world FDI inflow. Southeast Asia's performance in FDI inflow has been discussed in many studies (Hsiao and Hsiao, 2006; Kang and Jiang, 2012; Sjoholm, 2014). However, few literatures have discussed the benefits of FDI in the form of spillover effects. Existing studies have discussed spillover effects in Thailand (Kohpaiboon, 2012), Vietnam (Nguyen and Nguyen, 2008), Indonesia (Takii, 2004; Salim and Bloch, 2009), and the Philippines, (Aldaba and Aldaba, 2010), among others. However, there is a lack of literature which discusses FDI and its effect on innovation in the host country in Southeast Asia.

Asian countries successfully attracted FDI in the past decade. However, have Asian countries enjoyed spillover effects from such economic activities from the countries? Has FDI proven to be a channel for technological transfers and knowledge spillover? One way to measure technological transfer and knowledge spillover is through innovation activities in the host country. According to data from the World Intellectual Property Organization (WIPO), Singapore as of 2015 is the best performer among Southeast Asian countries in terms of patent application, followed by Indonesia and Thailand. However, there is a high disparity. Countries such as Cambodia and Brunei Darussalam are lagging behind its Southeast Asian neighbors.

Compared to other Asian countries such as India and China, Southeast Asia is also left behind. In 2015, China, one of the countries with the largest FDI count and value in the world (Fu, 2007), is accountable for 1.1 million of the 1.7 million patent applications in Asia. Meanwhile, India in 2015 registered 45,658 patent applications. Southeast Asia has much lower figures compared to China and India. Even Singapore, the best performer in the region in terms of patent application, only registered 10,814 patent applications in 2015 while Indonesia, the second-best performer, registered 9,153 patent applications in the same year

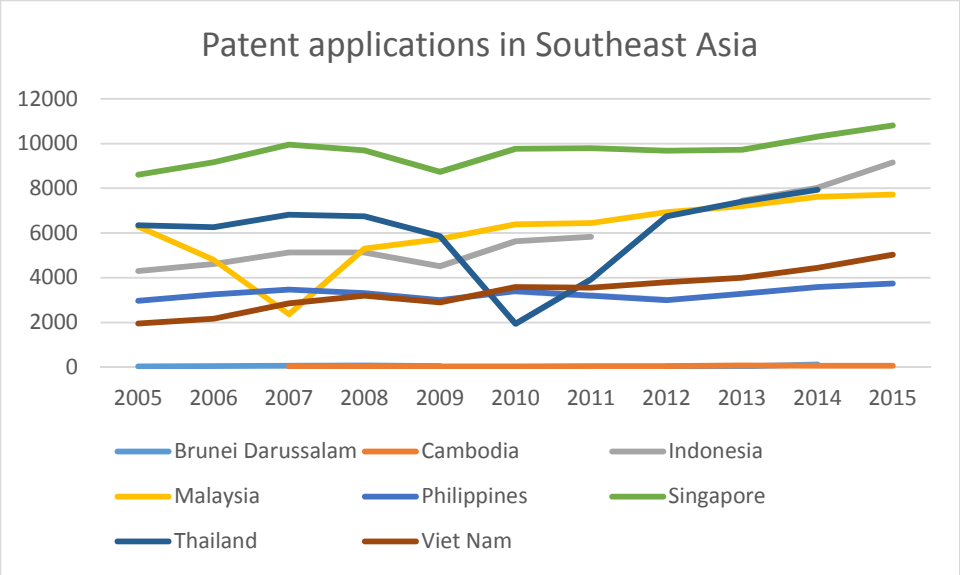

Figure 1: Patent application in Southeast Asia (Source: WIPO)

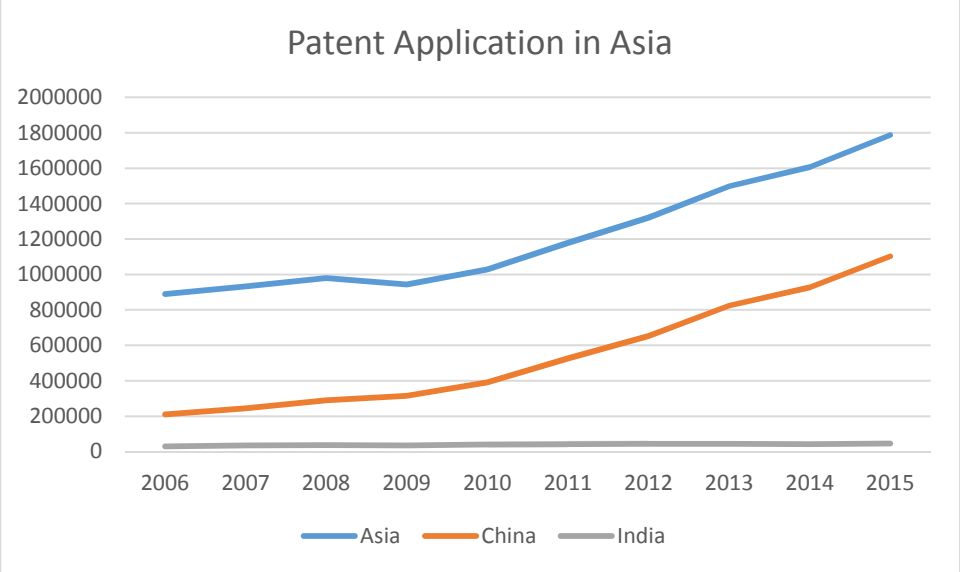

Figure 2: Patent application in Asia (Source: WIPO)

The level of education in a country are among the many factors which determine FDI inflow (Noorbakhsh, Paloni, and Youssef, 2001). In turn, multinational enterprises through FDI, with the help of sufficient education in the host country, can be an important agent to promote innovation activities with their advanced technology and their investment on research and development (Fu, 2007).

While the effect of FDI differs in every host country, many studies have explored and concluded with a positive relationship between inward FDI and technology spillover. This can be observed in a number of developing Asian countries (Erdal and Gocer, 2015). However, this positive spillover comes with some preconditions, such as a certain level of human capital.

Such studies have provided rich insights into the relationship between FDI and its spillovers. In Southeast Asia, studies on the relationship between FDI and productivity spillover have been explored, and the topic has been extensively researched. However, empirical studies on the relationship between FDI and innovation and the factors which determine their relationship the case of Asia has yet to be thoroughly explored.

1.3 Research objective

This research aims to explain the relationship between FDI and innovation in Southeast Asia and the factors which determine this relationship. Further, the research also attempts to identify which sectors promote a productivity spillover.

1.4 Research question

Main question:

What is the relationship between FDI and innovation in Asian countries?

Sub questions:

What is the effect of FDI on innovation activities in Asian countries?
Under what condition does FDI have a positive effect on innovation?
Which industries promote the most innovation?

1.5 Scope and Limitations

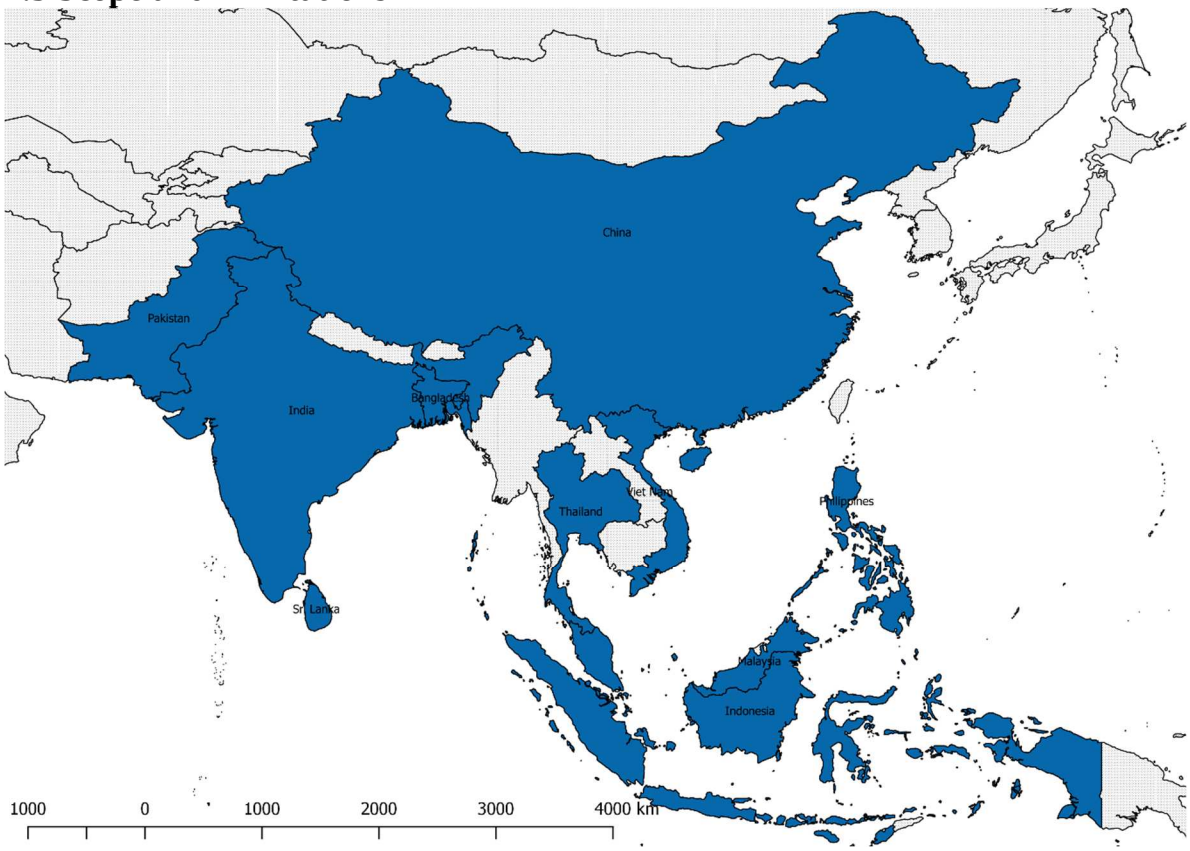

Figure 3: Research area, generated using QGIS

This research will explain the relationship between FDI and innovation in Asian at a country level. There are 10 countries which will be included in this research, which are Indonesia, Malaysia, the Philippines, Vietnam, Thailand, China, India, Bangladesh, Sri Lanka and Pakistan (Figure 3). While there are other Asian countries, such as Brunei, Myanmar, Laos, Iran, Saudi Arabia and so forth, these countries are not included due to availability of data. The study will focus on FDI and innovation in the ten countries in the span of 10 years from 2003 to 2012.

1.6 Significance of Study

In the knowledge economy, innovation is considered as one of the main drivers of economic growth (Fu, 2007). The development of innovation capabilities is crucial to ensure competitiveness, both for developed and developing countries. Thus, countries, such as those in Asia, seek FDI for the possibility of positive spillovers such as innovation. Many Asian countries are still lagging behind its neighbors. Countries such as China and India are excelling in terms of innovation, while others are still struggling. Therefore, it is relevant to explore the relationship between FDI and innovation to achieve an understanding of the channels of which Asia, or in other regions and countries, can develop its innovation capabilities. It is relevant to understand why such discrepancies in innovation, as previously mentioned, exist and what factors affect such differences. It is also relevant in order countries to understand how to shape policies to gain the most benefit from FDI.

This study can also contribute to the growing literature on the relatively new subject of FDI and the impact on innovation activities in host countries. Most existing research on the topic of FDI spillover discusses productivity spillover, wage spillover and knowledge spillover. Although the subject of FDI spillovers has been extensively and thoroughly discussed, the existing literature on the topic of innovation as a knowledge spillover is still at a phase of infancy, and most research in this topic focuses on China and developed countries.

Chapter 2: Literature Review/Theory

2.1 Literature Review

2.1.1 Foreign Direct Investment (FDI)

Although western explorers have sailed across seas centuries ago, the concept of globalization has become more relevant in the 21st century than ever before. The word "globalization" refers to various aspects – social, cultural, political. However, globalization is largely associated with global economic integration (Kali and Reyes, 2007). Jenkins (2004, p.2), who are among those who associate globalization with global economic integration, defines globalization as "*a process of greater integration within the world economy through movements of goods and services, capital, technology and labor, which lead increasingly to economic decisions being influenced by global conditions*".

Globalization has diminished barriers and countries are increasingly linked and interdependent through various activities, including foreign direct investment (FDI). The increasingly interlinked and interdependent globe is, in part, credited to the flow of FDI across seas. Lipsey (2003) defines FDI in both a macro and micro perspective. In the macro perspective, Lipsey defines FDI as "a particular form of the flow of capital across national borders, from home countries to host countries". Meanwhile, the micro perspective, Lipsey said, attempts to explain the motivations of the investment.

There are 2 types of FDI, which are greenfield investments and brownfield investments. According to Cheng (2006, p.203), greenfield FDI involves "an entry into a foreign market and the establishment of a new affiliate in the host country by another firm headquartered outside the country, alone or with one or more partners". Brownfield FDI, or merge and acquisitions, is "a new operation that entails the purchase of an existing firm by an acquirer headquartered outside the country, alone or with one or more partners in an amount sufficient to confer control" (Cheng, 2006. p.203). Cheng concluded that MNEs may choose greenfield or brownfield entry into a foreign market depending on the investor's resources, the host country's resources, and risks.

There are four strategies which explain a firm's decision to invest in a foreign country, which are market-seeking to find and serve new markets, resource-seeking to extract and process natural resources; efficiency-seeking to invest in production for the global market; and asset-seeking to establish partnerships with local firms for the benefit of the MNE (Dunning, 1998).

Fierce competition can be seen in, for example, Southeast Asia. The developing countries of ASEAN have been competing to attract FDI to secure potential benefits for host countries (Yussof and Ismail, 2002). Though academic literatures have extensively discussed both positive and negative impacts of FDI, empirical evidence, including those provided by Yussof and Ismail, indicate that FDI not only provides access to new technology and managerial skills, but also new capital.

Due to the positive externalities which can be gained from FDI, countries, both developing and developed, attempt to make their policies as business-friendly as possible, which is among the determinants of FDI (Alfaro et al, 2000). Other determinants of FDI include availability of labor and resources, as Chidlow, Salciuviene, and Young (2009) found in Poland. Further, Azam and Lukman (2010), found that market size and infrastructure were positive and significant variables in FDI inflow in India, Pakistan and Indonesia.

Although business-friendly policies may attract FDI, the benefits and positive spillovers which a host country can capture from FDI largely depends on the host country's characteristics. Local conditions may even limit the potential benefits of FDI (Alfaro et al., 2004).

2.1.1.1 FDI in Asia

Over the years, developing Asian countries have attracted much FDI, more than other regions. According to the UNCTAD World Investment Report published in 2017, developing Asia received US$443 billion in FDI inflows in 2016. This is much larger to other developing regions such as Latin America at $142 billion, and Africa at $59 billion. The 2017 World Investment Report found that developing Asia is the second largest FDI recipient, second to Europe. FDI inflows to China has contributed a great deal to the value; according to Chang and Lin (2003), China was the largest FDI recipient among developing countries in the 1990s. This trend seemed to stay until the 2000s (Poncet, 2010).

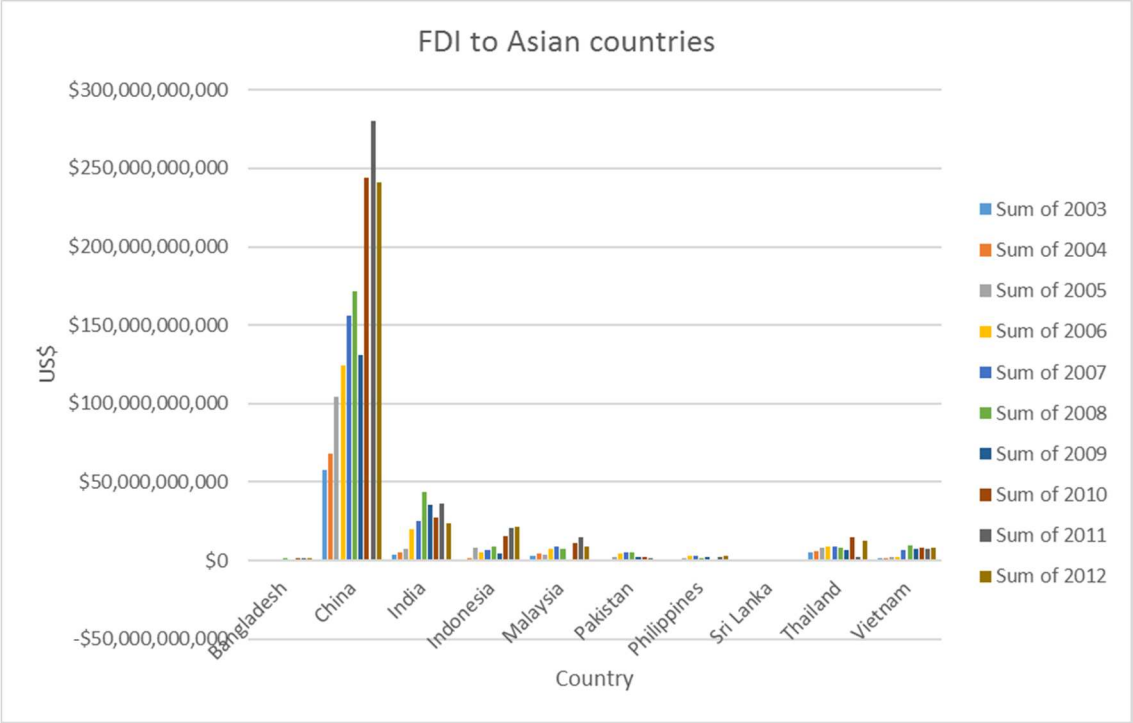

Figure 4: Foreign direct investment, net inflows (BoP, current US$) (Source: FDI markets)

According to Poncet (2010), international direct investment flows to China began increasing after a policy change in 1979, during which it became open to foreign multinationals. In the early stages after its policy change, China encouraged all flows of FDI into the country. However, in the mid 1980s, China encouraged more high-tech and capital-intensive FDI projects. The study on determinants of FDI inflow to China is extensive. However, Poncet (2010), who indicated that FDI inflow to China have been a result of a restructuring of the export-oriented production network, found that the most prevalent determinants in most studies are low labor cost, infrastructure development, agglomeration and the degree of openness. A large portion of FDI inflow to China are in the manufacturing industry (Poncet, 2010).

China is a large exporter of manufactured products. According to Liu and Daly (2007), China is still transitioning from low-tech FDI to high-tech investments.

Aside from China, Southeast Asian countries have also attracted the interest of multinationals. Through the globalization of production, multinationals have evolved Southeast Asian countries from a resource-based economy into exporters (Felker, 2003). According to Sjoholm (2014), Southeast Asia has largely succeeded in integrating into the global market through FDI and trade. Northeast Asian countries have contributed to this transition by investing in Southeast Asian countries for labor-intensive stages of manufacturing. Southeast Asia relies on the presence and activity of multinational corporation to maintain competitiveness and economic growth, according to Thangavelu, Wei Yong, and Chongvilaivan (2009).

Sjoholm (2014) found that FDI increase in Southeast Asia over the years is credited to two developments, which are technological changes and ideological changes in host countries.

Similarly, South Asian countries such as India, Pakistan, Bangladesh and Sri Lanka, have seen tremendous increase in FDI over the years (Thangamani, Xu, and Zhong, 2010). According to Athukorala (2013), FDI flows to the region have substantially increased due to market-oriented policy reforms. However, according to Thangamani, Xu, and Zhong (2010) FDI in South Asian countries remain lower compared to the rest of Asia. Compared to other regions, South Asia remains less attractive for multinationals. Bhavan, Xu and Zhong (2011) cited that poor infrastructure in South Asian countries may hamper FDI inflow. Further, the rate of domestic savings in many South Asian countries is “not sufficient to finance for enough fixed capital formation to accelerate growth in the region” (Bhavan, Xu and Zhong, 2011, p144).

Most FDI to South Asia goes to India. In fact, India accounts for up to 90 percent of FDI flow to the region (Athukorala, 2013). In India, its services sector contributed 60 percent to its GDP (Mandal, 2016). FDI in the services sector, which includes financial, banking, insurance, non-financial/business, outsourcing, research and development, courier, as well as technology testing and analysis, has seen sustainable growth in the past decades, according to Mandal (2016). With its large population, India attracts market-seeking FDI. However, FDI in India evidently seeks to sell goods instead of produce goods (Mandal, 2016). Recently, the Indian government launched an initiative to increase FDI in the manufacturing sector through Make in India.

2.1.1.2 FDI and Spillover

Countries seek FDI due to, among others, the possibility of positive spillovers. Positive spillovers include productivity (Koko, Tansini and Zejan, 1996; Arnold and Javorcik, 2009), (Barry and Gorg, 2005), and technology (Liu, 2008). As MNEs make their technology and managerial skills available to local firms, it is inevitable that local firms would learn and adopt.

Gorodnichenko, Svejnar, and Terrell (2007, p.3) define spillover as "*a transfer of managerial practices, production methods, mar keting techniques or any other knowledge embodied in a product or service*". There are two types of spillovers from FDI, which are vertical and horizontal spillovers. A vertical spillover, also known as inter-industry spillover, occurs when domestic firms are affected by firms with foreign equity participation through backward or forward linkages, while a horizontal spillover, also known as intra-industry spillover, occurs when domestic firm productivity is positively affected by the existence of firms with foreign equity

participation in the same sector (Du, Harrison and Jefferson. 2011). While vertical spillovers occur through contact between MNEs and their local suppliers, horizontal spillovers occur horizontal spillovers occur through a transfer of knowledge between MNEs and domestic firms in the same sector (Javorcik and Spatareanu, 2005).

The existence and extent of the spillovers varies. The causal relationship between FDI and spillovers is heterogenous across countries. While some studies argue that the existence of foreign firms foster competition which, with some preconditions, results to increased productivity and innovation in local firms (Arnold and Javorcik, 2009; Cheung and Ping, 2004), other studies have found that foreign firms can cause direct competition with local firms and result in crowding-out effects (Meyer and Sinani, 2009).

Further, there are also a number of channels in which the spillover effect of FDI can occur, which are through reverse engineering, by reproducing the foreign firm's technology; skilled labor turnovers, in which local firms obtain the technological know-how of FDI firms from the skilled workers; demonstration effect, where local firms demonstrate or imitate the technology in foreign firms; and vertically from foreign firms to local suppliers through transfer of know-how and training (Cheung and Lin, 2004).

There are few literatures which discuss the spillover effects of FDI in Southeast Asia. The more recent literature which discusses this subject focused on the effect of FDI to productivity in the chemical and pharmaceutical sectors in Indonesia by Salim and Bloch (2009), who found the existence of a horizontal spillover in the form of productivity spillover. They argued that FDI does not automatically result in a productivity spillover. They argued that there were three channels in which FDI could result in a productivity spillover. First, the entry of foreign firms results in competition and forces existing local firms to resort to efficiency. Second, spillover may occur via employee turnover. Third, through a demonstration effect, where local firms imitate technology introduced by foreign firms through research and development. The third channel, demonstration effect, is closely related to knowledge spillover, which is closely related to innovation activities in host countries.

Indeed, Salim and Bloch, who conducted a firm-level analysis, found that firms with a research and development (R&D) expenditure receive more productivity spillover than firms which do not spend on R&D.

A research by Aldaba and Aldaba (2010) discussed spillover effects of FDI to the Philippines. They found that FDI spillovers existed horizontally from MNEs to domestic firms in the same industry. Similar to Salim and Bloch, Aldaba and Aldaba also found that absorptive capacity is important to the existence of spillovers from FDI in the Philippines. They indicated that the Philippines attracted FDI mostly in industries which require less skills, and are labor-intensive and import dependent. This is mainly due to the absence of an efficient industry supply base. The country thus has limited participation in the production networks of MNCs in high-technology industries, therefore the Philippines only saw limited opportunities for spillovers (Aldaba and Aldaba, 2010).

Meanwhile, Kohpaiboon's (2006) study, which focused on technology spillovers from FDI in Thailand. Taking a different approach to most studies of FDI spillovers in Southeast Asia, Kohpaiboon tested whether technology spillover is unlikely to occur in highly trade-restricted

industry compared to industries which are export oriented. Kohpaiboon found evidence of such hypothesis and suggests that although the Philippines has liberalized the foreign investment regime, its trade-restrictive policy has attracted FDI which are unlikely to induce technological spillovers. Le and Pomfret (2011) studied technology spillovers from FDI in Vietnam and found that spillover effects depend on the quality of labor and technology gap, in addition to the type of investment and industry, among others.

Similarly, Takii (2004), who conducted a firm-level analysis of productivity spillover in Indonesia, found a positive productivity spillover in firms with specific characteristics. He indicated that the magnitude of spillovers is affected by technological gaps between locally and foreign-owned plants, size and capital intensity of each locally owned plant, and expenditures on employee training and research and development activity in locally owned plants. For example, Takii found that spillovers are relatively small, and even negative, in industries with large technological gaps in the initial year of the research, which implies that technological capability in some local firms were not enough to facilitate spillovers.

The subject of productivity and technology spillovers have been extensively discussed in existing literature, not only in Southeast Asia. However, there is a growing number of studies discussing the spillovers of FDI to innovation activities in the host country.

Cheung and Ping (2004, p.26), who conducted a research on spillover effects of FDI on innovation in China, stated that the presence of foreign firms with their foreign products and technologies can "stimulate local innovators to develop new products", which cuts the trial-and-error process and reduces risk for the manufacturers. Cheung and Ping also state that spillovers may occur vertically, from foreign firms to their local suppliers through knowledge transfer.

2.1.2 Innovation

In the knowledge economy, innovation is considered as one of the main drivers of economic growth (Fu, 2007). The development of innovation capabilities is crucial to ensure competitiveness, both for developed and developing countries. Thus, countries seek FDI for the possibility of positive spillovers such as innovation. Fagerberg et al (2010) suggest that innovation is not limited to high-tech activities; is an aspect in all aspects of economic activities, not only new products and process but also improvements in logistics and distribution, for example. Simple innovations in these areas may have large-scale economic effects. Therefore, innovation is important for developing countries, including the developing Asia.

The OECD's Oslo Manual for Measuring Innovation defines innovation as "the implementation of a new or significantly improved product (good or service), or process, a new marketing method, or a new organizational method in business practices, workplace organization or external relations". It further categorizes the definition into four types of innovation: Product innovation, a good or service that is new or significantly improved in technical specifications, components, and materials; process innovation, a new or significantly improved production or delivery method in terms of techniques, equipment, and/or software; marketing innovation, a new marketing method involving significant changes in product design or packaging, product placement, product promotion or pricing; and organizational innovation, a new organizational method in business practices, workplace organization or external relations.

Innovation and knowledge are tightly linked with location and geography. This link is highlighted in the concept of National Innovation Systems, which underlines the importance of "interactive learning and the r6le of nation-based institutions in explaining the difference in innovation performance and economic growth across various countries" (Asheim and Coenen. 2005, p.10).

Today, firms are faced with turbulence and uncertainty in the knowledge economy, thus firms are advised to invest in innovation to create and sustain competitive advantage (Johannessen, Olaisen, and Olsen. 1999). Knowledge is thus important in creating innovation and a sustainable competitive advantage. The human capital of a firm's employees is responsible for knowledge created within a firm; studies have confirmed that firms with a greater share of highly educated employees are more likely to innovate (Hall and Mairesse, 2006).

Studies have increasingly acknowledged that knowledge spillovers from external sources may impact innovation process and economic development (Fritsch and Franke, 2004). Liu and Zou (2007) agree that domestic innovative capacity is no longer based on domestic resources; knowledge from one country transcends to another through the activities of MNEs, among many others, and contributes to the development of technological capabilities. According to Narula and Zanfei (2005), MNEs use a variety of options through which innovation can develop and transcend through borders, such as FDI, trade, licensing, cross-patenting activities, and technological and science collaborations.

Fu (2007), has confirmed this hypothesis. He found that MNEs, through FDI, are an important agent to promote innovation activities with their advanced technology and their investment on research and development. Fu found that while FDI can have a positive effect on the host country's innovation capabilities through knowledge spillover, but asserted that such positive effect is determined by availability of absorptive capacity and the presence of innovation-complementary assets in the host region. Further, Fu underlined the importance of provincial capabilities, which affect the type of inward FDI. China's coastal regions, with top universities and research institutes, attract technology-intensive investment while the inland region have attracted investments which are mostly labor-, land- and resource-intensive. Thus, Fu found that knowledge spillover from FDI in inland areas are limited.

Other than Fu, a number of academic literatures have explored the relationship between FDI and innovation, by using patent applications as a measure of innovation as was done by Cheung and Ping (2004). Like Fu and Cheung and Ping, much of the study in this relatively new topic have focused on China.

To estimate spillover effects on innovation in China, Cheung and Ping used patent application to measure research and development output. FDI is measured per province per year. Further, as a measure of input to research and development activity, they included the human capital in the form of personnel for science and technical development, as well as expenditures on science and technical development. Cheung and Ping also tested the effect of foreign exposure on innovation by including the share of foreign funded enterprises export to its gross output. They finally included GDP per capita in each province to take into account the varying levels of economic growth, thus the difference in innovative capacity.

Cheung and Ping covered 26 provinces over the course of 6 years from 1995 to 2000. They argued that a provincial-level analysis was necessary, as spatial proximity is "of crucial importance

for technology and knowledge spillovers". For the data analysis, they used the OLS (ordinary least squares) model using the time-series and cross-section data. As a result, they found high correlation between science and technical development personnel as well as science and technical development expenditure.

While Cheung and Ping focused on the locational aspect of FDI, Liu and Zou (2008) focused on China's high-tech industry and differentiated FDI into the modes of entry, greenfield or mergers and acquisitions, to see how it would affect innovation in the country. Instead of using patent applications to measure innovation, Liu and Zou instead used the ratio of new product sales to the total sales of indigenous Chinese firms in a sub-sector. They found that both greenfield FDI and M&A activities positively affect innovation in local Chinese firms in different ways. While greenfield FDI has generates technology spillovers through R&D activities of foreign firms, M&A activities positively influence innovation of local firms only through inter-industry linkages.

Liu and Buck (2007) conducted a similar research on China's high-technology industry, but focused on the different channels for technology spillover. They found that R&D activities by multinational enterprises in the host country significantly affects the innovation performance of domestic firms, but only when absorptive capacity is in the equation. This finding is similar to that of Fu (2007), underlining the importance of absorptive capacity, who indicated that positive spillover effect of FDI were only observed in provinces with top universities and research institutes. Cheung and Ping also found that several factors significantly determined innovation output, which are science and technology personnel and science and technology output.

Such factors or preconditions have been thoroughly studied. Marin and Bell (2006), for example, found that FDI by itself had no direct effect or positive spillovers in the host country; that there were preconditions in which a positive spillover from FDI could take place in a host country. They concluded that absorptive capacity, among other factors, plays a large role in the existence of positive spillovers.

There are various factors or preconditions which could explain the effect of FDI on innovation activities in host countries. However, the variables generally fall into two main categories, which are absorptive capacity and FDI characteristics. These characteristics were also highlighted by Crespo and Fontoura (2007) in their review of studies of FDI spillovers.

Crespo and Fontoura found that one of the most important determinant of FDI spillover is absorptive capacity of the host country. In their paper, they conclude that despite the varying empirical findings related to the determinants of FDI spillover, absorptive capacity is robust and is a "fundamental precondition for enabling [the host country] to capture indirect benefits from FDI".

Absorptive capacity is also related to the technological gap between foreign and domestic firms, as the concept of absorptive capacity relates to a host country or firm's ability to internalize new technology brought by foreign firms. Thus, according to Crespo and Fontoura (2007), a technology gap must exist in order for spillovers to occur. Therefore, the characteristic of the investment itself is also taken into account, such as the sector of the investment itself, whether it is technology intensive or labor intensive. Further, Antonietti, Bronzini and Cainelli (2014) in their research also found a positive relationship between FDI and patenting activity only in the services industry in Italian provinces. They found that larger FDI in the service sector positively affects patenting in the knowledge intensive business service sector. In contrast, Antonietti, Bronzini and

Cainelli did not find a positive relationship between FDI and local patenting activities in the manufacturing sector.

Moreover, the entry mode of the FDI may also determine the existence of a spillover. Crespo and Fontoura (2007) found that a greenfield investment by a foreign firm, as opposed to a merger and acquisition of a local firm by a foreign firm, almost guarantees a spillover as completely new technology are introduced in the host country.

Crespo and Fontoura state that there are several channels in which FDI spillovers in the mode of technological diffusion can occur, which are demonstration effects, labor mobility, export, competition, and backward and forward linkages with domestic firms. However, they agree that the existence and magnitude of FDI spillovers depend on many factors, all of which are related to the characteristic of the investment itself, as well as characteristics related to host countries, sectors and firms.

2.1.3 FDI Spillover and Absorptive Capacity Theory

In 1990, Cohen and Levinthal's breakthrough research was able to measure a firm's innovative capabilities through the concept of absorptive capacity. Cohen and Levinthal (1990, p.128) define absorptive capacity as "the ability of a firm to recognize the value of new, external information, assimilate it, and apply it to commercial ends". In the context of innovation systems, Narula (2004, p.2) defines absorptive capacity as "the ability to absorb, internalize and utilize the knowledge potentially made available to them". Meanwhile, Meyer and Sinani (2009, p.1,078) state that absorptive capacity "captures firms' ability to utilize acquired knowledge, and thus to increase their realized spillovers". Thus, local firms which lack this capability may have a difficult time catching up, and will be crowded out by foreign firms.

Cohen and Levinthal's publication had provided a foundation for researchers to understand the impact of FDI in host countries. Since then, numerous studies have linked FDI and spillover effects in host country to the country's absorptive capacity (Kinoshita, 2000; Girma, 2005; Kolasa, 2007). Marin and Bell (2006) even indicated that FDI had no direct effect on the host country, and concluded that absorptive capacity plays an important role in technology spillover from FDI in the host country. Most of these studies, however, have focused their discussion at the firm-level, similar to Cohen and Levinthal's firm-level analysis.

A study by Criscuolo and Narula (2008) discussed national technological accumulation to absorptive capacity. It provided an understanding of applying the absorptive capacity theory to the national level. They found a relationship between a country's absorptive capacity to its level of technological development. Specifically, they found evidence that once a country achieves a certain level of absorptive capacity, absorption and catching-up processes occurs rapidly. This process explained the rapid growth of Asian NIEs in the 1970s and the 1980s (Criscuolo and Narula, 2008). They, however, highlight that once countries are able to absorb and imitate technological development created by others, they must have the ability to invent on their own.

Salim and Bloch (2009), who conducted a research to see the relationship between FDI and productivity growth in Indonesia's chemical and pharmaceutical sectors, took into account Indonesia's absorptive capacity by including research and development expenditure in their model. Prior to conducting the research, Salim and Bloch established a hypothesis stating that domestic

firms with research and development expenditure gain more productivity spillovers compared to firms without such expenditure. Their hypothesis was correct.

Studies have increasingly linked absorptive capacity to the innovation capacity of host countries. Fu (2007), for example, examined the role of absorptive capacity in determining innovation capabilities as a spillover from FDI. According to Fu, there are four ways in which FDI contributes to regional innovation. First is through R&D generated by foreign firms, which directly increases innovation outputs in the region. Second, it may affect the innovation performance in which they locate. Third, through a competition effect. And finally, through advanced practices and experiences in innovation management, resulting in more efficiency in innovation (Fu, 2007). However, Fu indicated that absorptive capacity is one of the main condition for a positive significant spillover.

There are a number of variables to measure absorptive capacity, which is through the quality of human capital, infrastructure, and institutional environment. These are discussed below:

2.1.3.1. Human capital

According to Becker (1964), human capital refers to the skills, knowledge and abilities of individuals. Human capital is conducive, not only for the development of knowledge but also for a firm's ability to absorb knowledge (van Uden, Knoben, and Vermeulen, 2014).

Absorptive capacity has been linked to the quality of human capital. For example, Narula and Marin's 2003 study on FDI spillovers and absorptive capacity in Argentina focused on the human capital aspect of absorptive capacity. Narula and Marin's study concluded that spillover effects from FDI must be internalized in order for it to benefit local firms. They indicated that local firms in Argentina were not equipped with the capacity to absorb and internalize spillovers (Narula and Marin, 2003). On the other hand, Vinding (2006) found in Denmark's manufacturing and services industry, the share of highly educated employees and application of human resource management practices is positively correlated with the ability to innovate.

Kwark and Shyn (2006) specifically chose human capital as an absorptive capacity for foreign technology through R&D spillover. They found that human capital stock is indeed a dominant factor in explaining the growth of total productivity through foreign R&D stock.

The research by van Uden, Knoben, and Vermeulen (2014), found positive relation between human capital and innovation in a firm-level environment. Their research focused on human capital and innovation in firms across Kenya, Tanzania and Uganda. Specifically, van Uden, Knoben, and Vermeulen found that the formal training and employee slack time, a practice conducted by firms, are activities which promote innovative output.

Thus, human capital is an important variable to capture absorptive capacity. The higher the quality of human capital, the more a country or a firm is able to internalize and adapt to foreign technology brought by MNEs through foreign direct investment. The quality of human capital can be measured through education, both formal education or training and work experience, or, in more recent literature, through total factor production (Elmawazini, Manga, and Saadi, 2008). Without

sufficient knowledge and know-how, a firm will thus lack the capacity to internalize foreign technology.

2.1.3.2 Infrastructure

Absorptive capacity can also be measured through infrastructure. Kinoshita and Lu (2006) proxied absorptive capacity using infrastructure to measure technological spillover from FDI. In a panel data analysis of 42 developing countries, Kinoshita and Lu found that technological spillovers via FDI only take place only take place when the host country has sufficient level of infrastructure. They indicated that such a result is even robust after controlling for a possible interaction effect between FDI and education. In terms of growth, Kinoshita and Lu also found that infrastructure attracts further investment, and in turn results in economic growth. Kinoshita and Lu argued that sufficient infrastructure is a pre-requisite for positive spillovers from FDI in a host country. The variables Kinoshita and Lu used to proxy infrastructure include telephone main lines per 1000 workers and power generation capacity, among others.

More recently, Tang and Zhang (2016) have also linked absorptive capacity with the quality of infrastructure. Their study focused on benefits of FDI in China while taking into account the absorptive capacity. They used a number of variables to proxy absorptive capacity, including infrastructure. Tang and Zhang found that "the capability and technology of domestic firms critically depend on the quality of physical infrastructure, ranging from roads and ports to energy and telecommunication". Further, they indicated that better infrastructure supported domestic firms to gain benefits from FDI.

Further, Nguyen et al (2009) describes physical infrastructure as a service system associated with energy, water supply, transport, telecommunications, sanitation and waste facilities, flood protection and drainage. Infrastructure formed by both physical and intangible constructs is considered an enabler of knowledge flow (Schutte and Snyman, 2006). According to Schutte and Snyman, a strong IT infrastructure can support a healthy knowledge flow and can promote rapid transfers of knowledge. Thus, strong infrastructure can ensure the flow of knowledge. On the other hand, weak infrastructure can hinder the flow of knowledge and mobility.

2.1.3.3. Institutional environment

The quality of institution in the host country is an important measure of absorptive capacity. Institutional quality as a measure of absorptive capacity is a relatively new concept, but has been an increasingly discussed in various studies. According to Levchenko (2007, p.2), institution usually "refers to a wide range of structures which affect economic outcomes: contract enforcement, property rights, investor protection, the political system, and the like".

Farole and Winkler (2012) indicate that weak institutions are linked to protectionism, and thus foreign investors may be constrained from fully exploiting their competitive advantages. This

may therefore influence the absorptive capacity of domestic firms. Weak institutions are those with high level of corruption and red tape. Weak institutional quality is generally associated with lower investment, slower productivity growth, lower per capita income, and slow output growth. Meanwhile, a good institutional quality can promote synergy and complementarity between FDI and local firms, thus promoting productivity spillovers, thus enhancing the benefits of FDI on economic growth (Jude and Levieuge, 2015).

2.2 Conceptual Framework

Based on the literature review, there are several important concepts which have been identified to answer the proposed research questions.

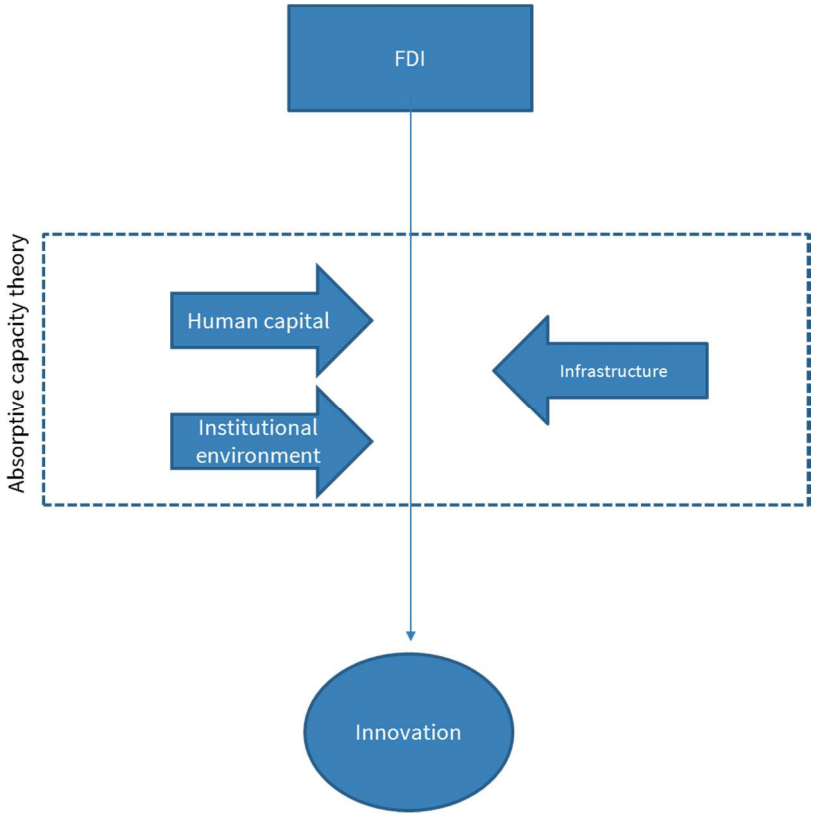

Figure 5: Conceptual framework

Innovation is a dependent variable while global integration measured as FDI is an independent variable. The relationship between the dependent and independent variable will be tested using the absorptive capacity theory. As previously discussed, knowledge from one country transcends to another through MNEs, among other channels, through activities such as FDI, trade, licensing, cross-patenting activities, and technological and science collaborations. This research will focus on FDI as a channel of knowledge spillover, while also taking into account the absorptive capacity of the host country.

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To moderate the effect of FDI on innovation, a number of variables will be taken into account. Taking note from previous literatures on the subject, the three moderating variables are human capital, infrastructure and institutional quality to proxy absorptive capacity. Absorptive capacity determines how well a country can internalize new technology introduced by MNEs. The capability of human capital is among the determinants for local firms to assimilate and utilize knowledge brought by foreign firms. Meanwhile, infrastructure is also an important factor in enabling the flow and transfer of knowledge. High quality infrastructure can promote the rapid transfer of knowledge, thus increasing the absorptive capacity. Further, institutional environment determines the quality of a government. Generally, strong institutions are associated with higher investment and higher productivity growth.

Chapter 3: Resarch Design and Methods

3.1 Operationalization: Variables and indicators

3.1.1 Definition of concepts

The definition of the most significant concepts based on literature are presented in the table below.

Concept	Definition
Global economic integration	"a process of greater integration within the world economy through movements of goods and services, capital, technology and labor, which lead increasingly to economic decisions being influenced by global conditions" (Jenkins, 2004)
Spillover	1) "a transfer of managerial practices, production methods, marketing techniques or any other knowledge embodied in a product or service" (Gorodnichenko, Svejnar, and Terrell, 2007); 2) "the impact of foreign firms' presence on domestic firms' economic performance" (Laenarts and Merlevede, 2011)
Innovation	1) "the implementation of a new or significantly improved product (good or service), or process, a new marketing method, or a new organizational method in business practices, workplace organization or external relations" (OECD, 2005); 2) "the application of new ideas to the products, processes, or other aspects of the activities of a firm that lead to increased value" (Greenhalgh and Rogers, 2010)
Absorptive capacity	1) "the ability of a firm to recognize the value of new, external information, assimilate it, and apply it to commercial ends" (Cohen and Levinthal, 1990); 2) "the ability to absorb, internalize and utilize the knowledge potentially made available to them" (Narula, 2004)
Human capital	"the skills, knowledge and abilities of individuals" (Becker, 1964"
Physical infrastructure	"as a service system associated with energy, water supply, transport, telecommunications, sanitation and waste facilities, flood protection and drainage" (Nguyen et al, 2009)

Institutional environment	“refers to a wide range of structures which affect economic outcomes: contract enforcement, property rights, investor protection, the political system, and the like” (Levchenko, 2007)
FDI characteristics	"FDI differs by the size and mode of entry; the nature of the (production) techniques chosen; the trade orientation of the parent company; the role of the affiliate in the global production network; the type of activity that takes place; and the aim with which the investment is made" (Fortainer, 2007)

Table 1: Concept definition

3.1.2 Operationalization of concepts

In this section, the concepts mentioned in the conceptual framework will be further discussed and unbundled into several variables. The variables are categorized into dependent variables, moderator variables, independent variables as well as the control variables. The first table consists of the dependent variable, which is innovation. The second table will compose of the moderator variables, which are absorptive capacity and FDI characteristics. The third table is the independent variable, FDI. And the fourth table is the control variables.

Concept	**Variable**	**Indicator**	**Source**	**Value**
Spillover	Innovation	Number of Patent Applications, residents and non-residents	World Bank World Development Indicators	The more patent applications, the more innovative
		Number of Industrial Design applications, residents and non-residents	World Bank	The more industrial design applications, the more innovative

Table 2: Dependent variables

	Concept	Variable	Indicator	Source	Value
			Gross enrolment ratio, tertiary, both sexes	World Bank World Development Indicators	The more share of tertiary-eduacated students, the higher the human capital
			Gross national income (GNI) per capita	World Bank	The higher the GNI, the higher the human capital
		Human Capital	Life expectancy	World Bank	The higher the life expectancy, the healthier the population, the higher the human capital
			Access to electricity (% of population)	World Bank	More access to electricity means better infrastructure
			Air transport, freight (million ton-km)	World Bank	More air transport, better infrastructure
		Infrastructure	Internet users (%of population)	World Bank	The more internet users, the better the infrastructrue
			Regulatory quality	International Country Risk Guide (ICRG)	The higher the regulatory quality, the better the institutional environment
Moderating	Absorptive Capacity of Host Country	Institutional environment	Investment profile	ICRG	The higher the investment profile, the better the institutional environment

Table 3: Moderating variables

Concept	Variable	Indicator	Source
Global economic integration	FDI	Total and sectoral FDI inflows (service, manufacturing, natural resources)	FDI Markets

Table 4: Independent variables

Variable	Indicator	Source
Per capita GDP growth	Annual growth rate of per capita GDP for year 2006	Euro Monitor Passport
Population	Total population (millions)	Euro Monitor Passport
Land area	Land area (square kilometers	Food and Agriculture Organization, UN
Inflation	% of rate of change	World Bank WDI

Table 5: Control variables

3.2 Research Strategy

To answer the research question, secondary data analysis using quantitative methods and statistical techniques will be the research strategy of choice. The nature of the research is deductive. It aims to explain the relationship between a dependent variable (innovation) and independent variable (FDI), using the absorptive capacity theory, which refers to the ability of a firm or a country to internalize foreign technology. Additionally, it has been assumed that FDI into different sectors have different effects on innovation. Therefore, FDI has been categorized into four sectors (high-tech, medium-high-tech, medium-low-tech, and low-tech). This study also aims to identify the conditions in which FDI inflow can positively affect innovation. The nature of the research questions are explanatory, and can be answered through secondary data analysis.

Further, the area of study consists of eight countries in Southeast Asia in the period of 10 years from 2006 to 2015, and thus aims at a broad understanding of the topic. In addition to the dependent and independent variables, moderator variables are also included in the research. The country-level scope of the study aims at gaining a broad understanding of topic, thus a secondary data analysis can best facilitate the research. The variables required cannot be obtained through primary data, thus a secondary data analysis will be employed.

3.3 Data collection method

Quantitative data will be obtained from secondary online data sources from international organizations. Eight Southeast Asian countries, namely Indonesia, Thailand, Malaysia, Singapore, the Philippines, Vietnam, Brunei and Cambodia, have been selected for the study. The required data for the study will be obtained from the secondary data sources which are listed below:

- **World Bank World Development Indicators**: The World Development Indicators is the World Bank's collection of development indicators compiled from officially recognized international sources. Data in the World Development Indicators are current and accurate, and are at the national, regional and global level. Data for indicators at the country level for the dependent variable (innovation) and the moderator variables (human capital, infrastructure and institutional environment) is obtained from the World Bank's World Development Indicators.
- **International Country Risk Guide (ICRG**): The ICRG is a commercial source for country risk analysis and ratings provided by The PRS Group. Two of the indicators in institutional quality are obtained from the ICRG.
- **FDI Markets**: FDI markets is a data service from the Financial Times, and is the most comprehensive online database for greenfield investments. FDI markets provides real-time monitoring of investment projects, capital investments, and job creation. Data on the independent variable (FDI inflow) is obtained from FDI Markets.
- **Euromonitor Passport**: Euromonitor Passport is a global market research database providing insights on industries, economies and consumers worldwide. Data for control variables is obtained from Euromonitor Passport.
- **FAO UN**: The Food and Agriculture Organization operates under the UN. The database within FAO cover a broad spectrum of topics related to food security and agriculture. Data for control variables is obtained from FAO UN.

3.4 Data analysis techniques

3.4.1 Descriptive statistics

In order to describe the data, dispersion methods in Stata have been used to understand the trends in the data. A summary of the data generated in Stata displays the number of observations, minimum and maximum value of the data as well as the mean and standard deviation value of the data. Further, graphs, trend lines and pie charts have been used to see the differences in trends in each country over the years. Moreover, thematic maps with graduated colors prepared in QGIS have also been prepared for some variables for a visual representation of the data.

3.4.2 Inferential statistics

Before progressing to inferential analysis in Stata, it is important to conduct assumption tests in order to confirm the validity of statistical analysis.

1) **Check for outliers**: Cooks distance test is applied to measure influence in the data. Based on this test, outliers are removed for the final regression.

2) **Test for normality**: A Shapiro-Wilk test is employed to test that the distribution is normal. The insignificant W value of the test confirms that the residuals are normally distributed. A geographical test is also applied for accuracy using a histogram and a Kernel density test. Variables which are not normally distributed are transformed into logarithm or square root.
3) **Test for multicollinearity**: This test is to confirm that independent variables are not perfectly multicollinear and that an independent variable should not be a linear function of another.
4) **Test for homoscedasticity**: The Breusch-Pagan test is to test whether or not residuals are homoscedastic..
5) **Test for model specification**: The Ramsey RESET tests whether or not a model specification is correct.
6) **Hausman test**: The Hausman test is to specify whether the regression will use a fixed effect or a random effect.
    - Fixed effect: According to Borenstein et al (2010), the fixed effect model assumes that there is one true effect size in the analysis, and that all differences in observed effects are due to sampling error. Therefore, all entities in the analysis share a common effect size. Based on the Hausman test, it is advised to use fixed effects as opposed to random effect. This research is conducted on developing Asian countries with a more or less similar level of development, and to analyze the impact of variables that vary over time. Therefore, the fixed effect model is fitting for the analysis.
    - Random effect: In contrast to fixed effect, random effect model allows effect sizes to differ (Borenstein et al, 2010). Therefore, there is a distribution in the true effects sizes.

3.4.2.1 Panel regression

To answer the research question, a regression analysis will be performed on the panel data of 10 Asian countries in the span of 10 years. A regression analysis tests whether the relation between a dependent variable and an independent variable is linear (van Thiel, 2015). An example of a positive linear relation indicates that an increase in the dependent variable leads to an increase in the dependent variable.

As previously mentioned, the dependent variable is innovation, proxied by patent applications and industrial design applications, while the independent variable is FDI. The regression analysis will be performed to explain the relationship between innovation and FDI. The panel regression will be performed using four independent variables separately. These variables are total FDI, FDI service, FDI manufacturing and FDI natural resources. There are also three dependent variables which will be tested separately, which are total innovation (total patent and industrial design application), as well as patent application and industrial design application.

In a regression result, the coefficient for a predictor variable shows the amount of change which can be expected in the dependent variable when the predictor variable changes by one unit. Other predictor variables in the model are held constant.

3.4.2 Panel regression with interaction terms

A number of studies have tested the relationship between FDI and innovation in host countries. However, many have concluded that there is no direct relationship between the two variables. Marin and Bell (2006) found that FDI by itself had no direct effect or positive spillovers in host countries. They indicated that there were preconditions in which a positive spillover from FDI could take place in a host country. Marin and Bell concluded that there are factors which determine the relationship between the two variables.

Therefore, a panel regression with interaction terms will be employed. This study will use moderator variables, derived from the absorptive capacity theory, to determine the relationship between FDI and innovation in Southeast Asian countries. The moderator variables are human capital, infrastructure and institutional environment.

3.5 Reliability and Validity

This research has a strong measurement validity. Secondary data is obtained from authentic data sources such as the World Bank, the World Economic Forum, FDI Markets, the WIPO. Euromonitor Passport, as well as UN's Food and Agriculture Organization. The indicators used in this study is derived from concepts and theories, specifically the absorptive capacity theory. To increase the robustness of the data analysis, two type of regressions will be used, namely panel regression, followed by panel regression with interaction terms. However, availability of data is a challenge in terms of reliability. For example, some indicators contain missing values. Moreover, while the scope of the research is country-level in Asia, not all Asian countries are included due to availability of data. The 10 Asian countries in the research are those which are the most complete in terms of data.

Chapter 4: Research Findings

4.1 Descriptive statistics

4.1.1 Innovation in Asian countries

Innovation is measured using patent and industrial design applications. Data on patent and industrial design applications is acquired from the World Intellectual Property Organization (WIPO). A patent, according to the WIPO, protects an invention that offers a new technical solution to a problem. This is different to that of industrial design, which protects only the aesthetic features of a product.

Table 6: Summary of Innovation (2003-2012)

	Obs	Mean	Std Dev.	Min	Max
Patent application	99	36200.51	105174.4	284	652777
Industrial design application	99	33189.53	108547.8	284	657582
Total patents & industrial design application	100	68696.13	212525.2	619	1310359
Observations	100				

A summary of the data is generated using Stata (Table 6). There are three indicators to measure innovation, namely patent application (patents_wipo), industrial design application (industrial_wipo), and total patent and industrial design application (wipo_total). From this summary, it can be seen that there is a discrepancy among Asian countries in terms of innovation. For example, for the variable of wipo_total, there is a large gap between the minimum and maximum value in the data. This means that while one country accumulated 619 patent and industrial design applications in a year, another country accumulated 1.3 million. Further investigation into the data reveals that Sri Lanka in 2004 produced 619 applications, while China in 2012 accumulated 1.3 million applications. Expectedly, China is also the country with the highest value for both patent and industrial design applications.

To visualize the differences in innovation in Asian countries, a distribution map of innovation activities in the form of accumulated patent and industrial design applications in graduated colors is generated using QGIS. In Figure 6, using a natural breaks, or Jenks, method of categorization in QGIS, the darker color indicates that there are more patent and industrial designs applications in the country. Natural breaks categorization is based on the natural groupings within the data. It groups similar values and attempts to maximize the differences between the groups.

In Figure 6, China, as expected, is the darkest color on the map. China is consistently the darkest color on the map in 2003 and 2012. This indicates that China is the most innovative among the countries studied. Comparing innovation activities in 2003 and 2012, it does not seem that there is much of a change among the countries. For example, countries such as India, Thailand, Indonesia, Vietnam, Pakistan, Bangladesh and the Philippines stay the same color in both 2003 and 2012. Meanwhile, Sri Lanka is the lightest color on the map, indicating it has less innovation activities compared to other countries in both 2003 and 2012.

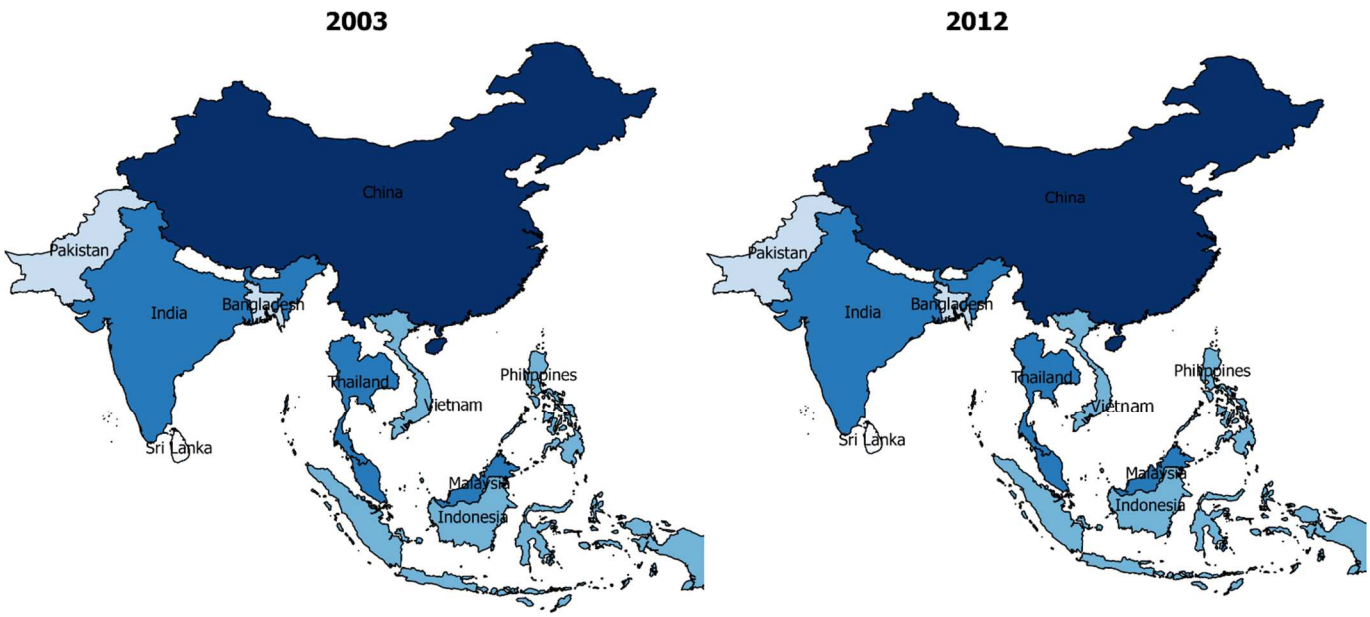

Figure 6: Distribution map of innovation in Asia (Source: WIPO, generated using QGIS)

To understand the trends in each country over the years, a line graph is further generated of total innovation, or total patent and industrial design applications, in Asian countries. Due to the disparity between regions, two separate graphs, Figure 6 and Figure 7, have been generated, to see the difference in trends between Southeast Asian countries and South Asian countries.

In Southeast Asia (Figure 7), Thailand, Malaysia and Indonesia have competed for the most patent and industrial design applications. However, while the leading countries experienced highs and lows in in innovation, over the years, Vietnam and the Philippines have steadily increased the number of patent and industrial design applications. The steady progress of Vietnam, for example, has surpassed Indonesia in 2012. Indonesia, Malaysia, the Philippines, Thailand and Vietnam are countries with similar development level, in terms of economic growth and human capital. This may explain the similar and competing trends in innovation between the Southeast Asian countries.

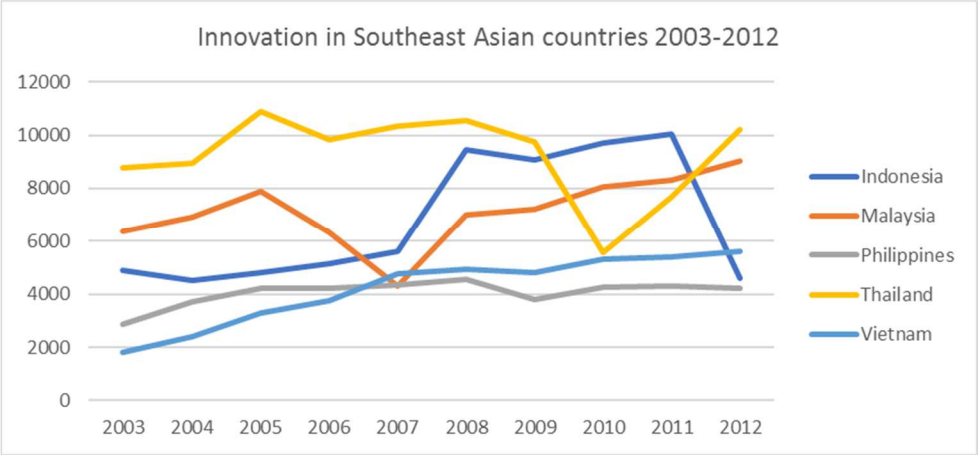

Figure 7: Innovation in Southeast Asian countries (Source: WIPO)

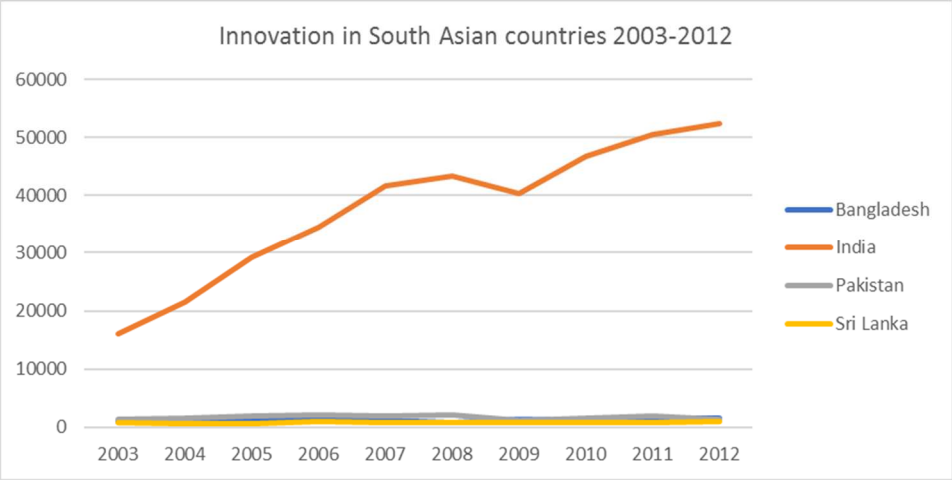

Figure 8: Innovation in South Asian countries (Source:WIPO)

Meanwhile, South Asian countries (Figure 8) shows a different case as opposed to the collective progress in Southeast Asia. India is at the forefront of innovation, not only in South Asia but in also continent. There is visible disparity between India and other South Asian countries. India leads innovation in South Asia, with an overwhelming lead compared to Bangladesh, Pakistan and Sri Lanka. Compared to Southeast Asian countries, South Asian countries is still lacking. India is now among the leaders of technology and innovation in Asia. In 2007, the Indian government, in cooperation with the private sector, launched an initiative called the India Innovation Growth Program, which aims at accelerating and introducing innovative Indian technology to the global market.

4.1.2 Greenfield FDI in Asian countries

Data on greenfield FDI is obtained from FDI Markets. FDI is the independent variable, and it will be further categorized into four types: total FDI (am_invested), FDI in the service sector (inv_services), FDI in the manufacturing sector (inv_manufacturing), and FDI in the natural resources sector (inv_natural). A summary of FDI data is generated using Stata (Table 7).

Table 7: Summary of FDI, in million US$

	Obs	Mean	Std Dev.	Min	Max
Total investment	100	2736.863	4015.922	0	19219.84
FDI Service	100	1609.946	2516.48	0	16450.62
FDI Manufacturing	100	717.8742	1472.659	0	7595.466
FDI natural resources	100	388.2821	1161.845	0	9546.581
Observations	100				

From this summary, it can be seen that the maximum sectoral investment is in the service sector, at US$16 billion. This is much higher compared to the maximum investment in the manufacturing and natural resources sector. It seems that most investment by foreign multinationals in Asian countries are spent in the service sector, as opposed to the manufacturing and natural resources sector. Further investigation into the data shows that India in 2007 received

the US$16 billion in FDI in the service sector. In 2011, India also attracted US$19 billion in total greenfield FDI.

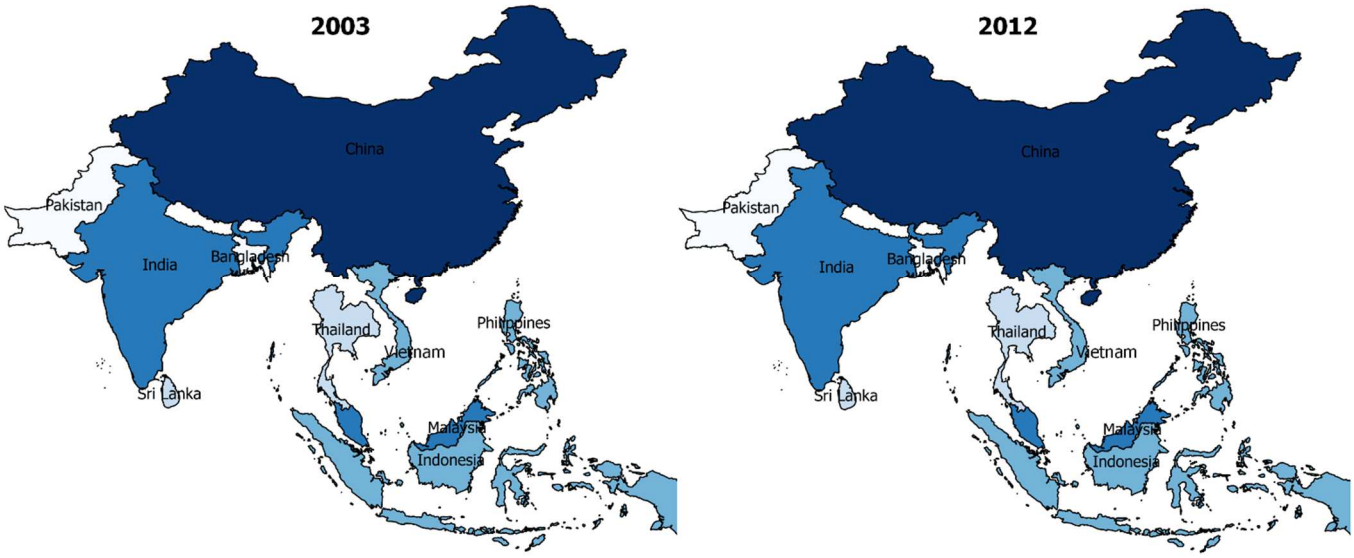

Figure 9: Total FDI in 2003 and 2012 (Source: FDI markets, generated using QGIS)

A graduated colors map of total FDI in 2003 and 2012 was generated in QGIS to visualize FDI inflow to Asian countries. Similar to the map generated for innovation (Figure 9), the categorization uses natural breaks. Countries with darker colors receive more FDI. It seems that the distribution of FDI in terms of value is the same in 2003 and 2012. All countries stay the same color in 2003 and 2012.

Similar to innovation activities, China is consistently the darkest color on both maps in Figure 9, thus indicating that it received the highest FDI both in 2003 and 2012. The large population in China may explain the large amount of FDI inflow into the country.

In terms of population, China has passed the one-billion mark, making it a large market for multinationals. Aside from market-seeking multinationals, the activity of seeking and serving new markets, there may also be many efficiency-seeking multinationals in China. Efficiency-seeking invest in production for the global market, according to Dunning (1998). Many activities of manufacturing by multinationals are conducted in China. This may further explain China's overwhelming lead in attracting FDI compared to other Asian countries.

Although India attracted the maximum amount of total FDI and FDI in the service sector, as previously mentioned, it seems FDI inflow to India consistently large like China's. FDI inflow into India may be more dynamic compared to the steady inflow into China.

Meanwhile, smaller countries such as Pakistan and Bangladesh have consistently attracted lower FDI inflow compared to other countries in the study.

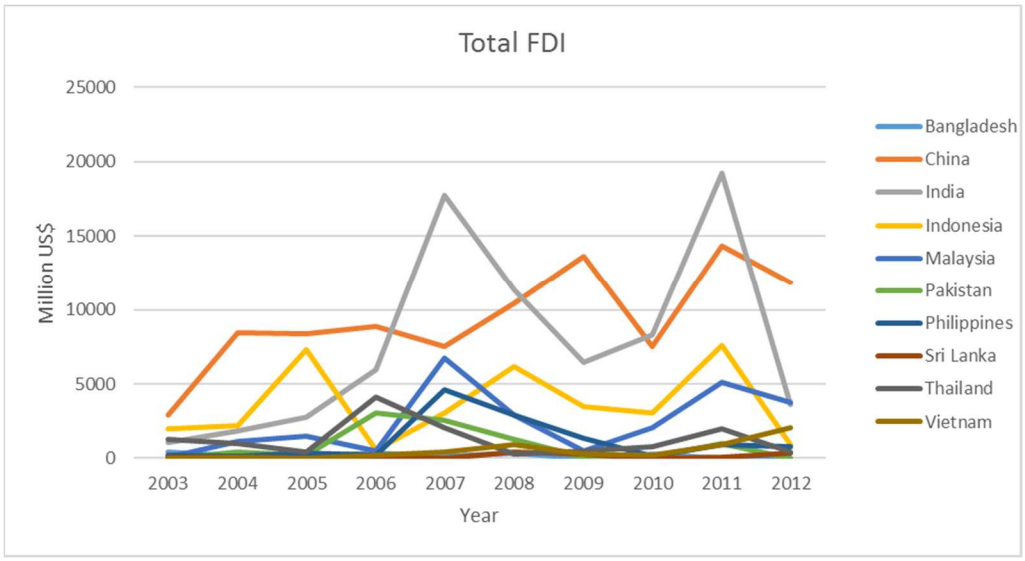

Figure 10: Total FDI 2003-2012 in million US$ (Source: FDI markets)

It can be seen in Figure 10 that FDI inflow to China has been more consistent compared to India. This explains why India attracted the maximum value of total FDI and FDI in the service sector, but is still lower than China in Figure 9. India's jump in FDI inflow in 2007 is caused by the sharp increase in FDI in the service sector. Although both China and India offer a large market for investors, China may be more attractive to investors for a number of reasons. For example, Poncet (2007) found that infrastructure development is among the determinants of FDI inflow to China. Further, low labor cost and agglomeration are also found to be important determinants (Poncet, 2007). It may be that China has a higher level of connectivity -- both in terms of physical infrastructure and linkages between companies -- compared to India, thus attracting more FDI.

Data on foreign direct investment is obtained from FDI Markets, which mainly tracks cross-border greenfield investment. FDI markets classifies investment into a number of sectors. In the manufacturing sector, as can be seen in Figure 11, China consistently received to most FDI in this sector both in 2003 and 2012.

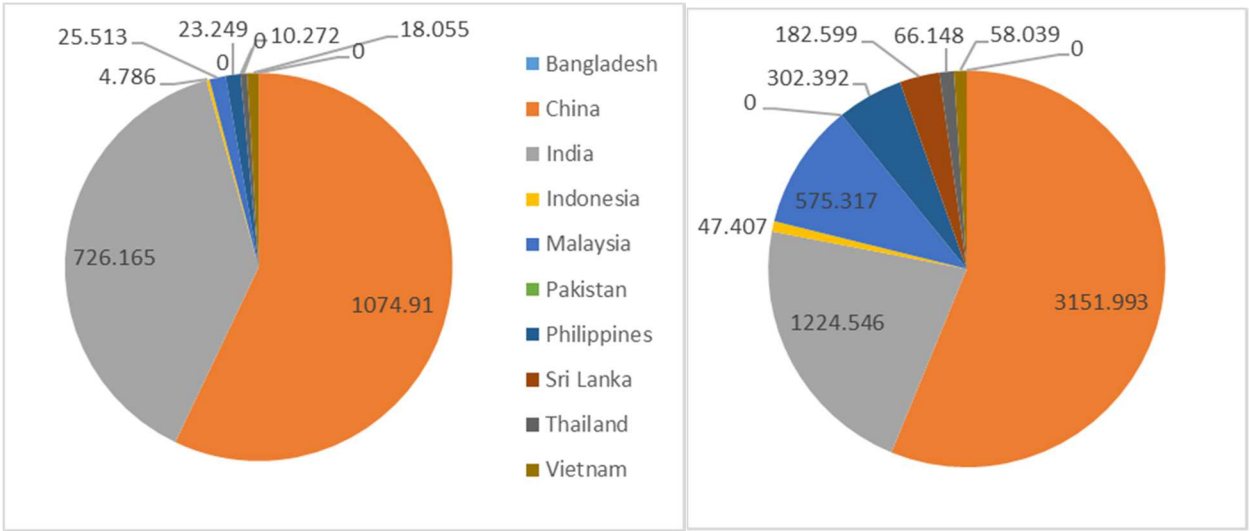

Figure 11: FDI in manufacturing sector in 2003 (left) and 2012 (right), in million US$ (Source: FDI markets)

A large portion of FDI inflow to China are in the manufacturing industry (Poncet, 2007), thus explaining why China is the most prominent country in the manufacturing sector. Indonesia is also a notable country in the manufacturing sector, trailing behind China and India. The manufacturing sector consists of various industries, such as clothing and textile, to household appliances and motor vehicles. Countries such as China, India and Indonesia may attract much FDI in the manufacturing sector due to their large domestic market. Goods manufactured in the country by foreign multinationals can be sold to the large domestic market.

In the service sector (Figure 12), China has again attracted the most foreign investments. As previously mentioned, China population may attract market-seeking multinationals, moreso in the services sector. FDI in the service sector in India and Malaysia have increased in 2012 compared to 2003. In India, the service sector in India make up of 60 percent of its GDP, according to Mandal (2016). This may explain the large increase in FDI in the services sector in India in 2012 compared to 2012. Overall, FDI in the service sector increased significantly in Asian countries over the years.

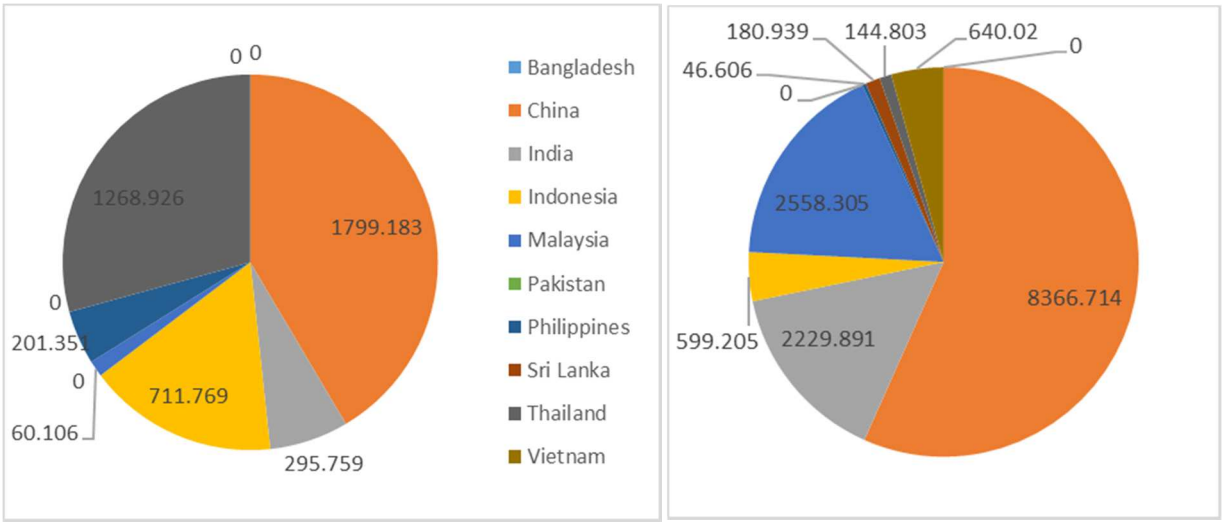

Figure 12: FDI in service sector in 2003 (left) and 2012 (right) in million US$ (Source: FDI markets)

In Figure 13, Indonesia is arguably the most prominent receiver of FDI in natural resources in 2003. In fact, Indonesia accounted for almost 75 percent of the total FDI inflow in natural resources in the countries studied. Indonesia is a vast archipelago and is rich in resources – this may explain the high amount of investment in natural resources in Indonesia. Indonesia was among the countries affected by the 1997 Financial Crisis. Many subsectors suffered and collapse, except for farm crop, fishery, and oil and gas mining (Khaliq and Noy, 2007). Farm crop, fishery, and oil and gas mining, along with electricity, water and communication sectors, continued to grow despite the crisis. According to Khaliq and Noy (2007), sectors hit the hardest include construction, transport, hotel and restaurants, and services and finance.

However, in 2012, Vietnam is the largest receiver of FDI in this sector, while Indonesia only accounted for a small portion of investment among the countries studied. Similar to Indonesia, Vietnam is blessed with abundant natural resources, thus making it a suitable country for agricultural activities (Trung and Cuong, 2010). Further, according to Trung and Cuong (2010),

Hanoi especially has moderate weather, fertile land, abundant water, and irrigation and drainage system, in addition to skilled workforce, a favorable condition for agricultural investment.

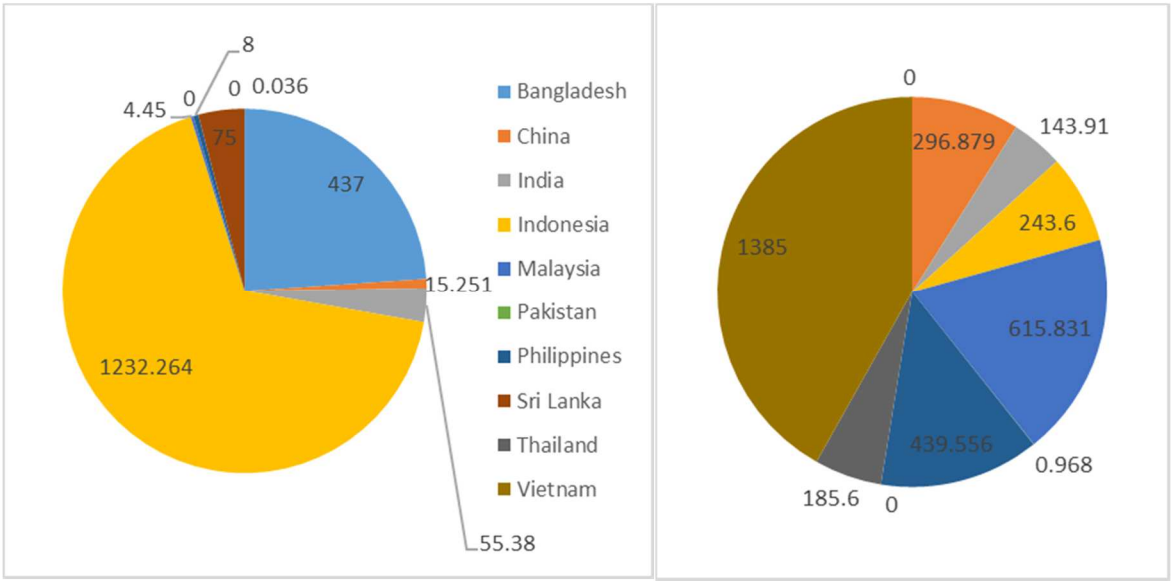

Figure 13: FDI in natural resources 2003 (left) and 2012 (right) in million US$ (Source: FDI markets)

4.1.3 Local conditions in Asian countries

To understand the relationship between FDI and innovation, it is also important to consider the local conditions in Asian countries, which may moderate the relationship between the two variables. There are three variables to represent local conditions within countries, which are human capital, infrastructure, and institutional quality. Human capital consists of three variables which are tertiary education enrollment (tertiary_edu), GNI per capita (gni), and life expectancy; infrastructure is proxied by access to electricity (electricity), internet users (internet_users), and air freight (air_freight); institutional quality is represented by investment profile (investment) and regulatory quality (wgi_regul).

Table 8: Summary of moderating variables

	Obs	Mean	Std Dev.	Min	Max
Tertiary education enrollment	90	22.18614	12.41231	2.73015	52.74705
GNI per capita	100	2318.5	2043.113	450	10150
Life expectancy	100	70.40494	3.849219	63.45834	75.39293
Access to electricity	100	84.87137	15.27556	38.40781	100
Internet users	100	.1566114	.1606602	.0016388	.658
Air freight	100	1909.446	3466.099	.013	17193.88
Investment profile	100	7.895583	1.154843	4	9.75
Regulatory quality	100	-.2648	.416623	-1.1	.61
Observations	100				

It should be noted that there are only 90 observations out of the possible 100 observations in tertiary education because some countries have missing values. The trends in conditions of human capital, infrastructure and institutional quality in Asian countries is further discussed below.

4.1.3.1 Human capital

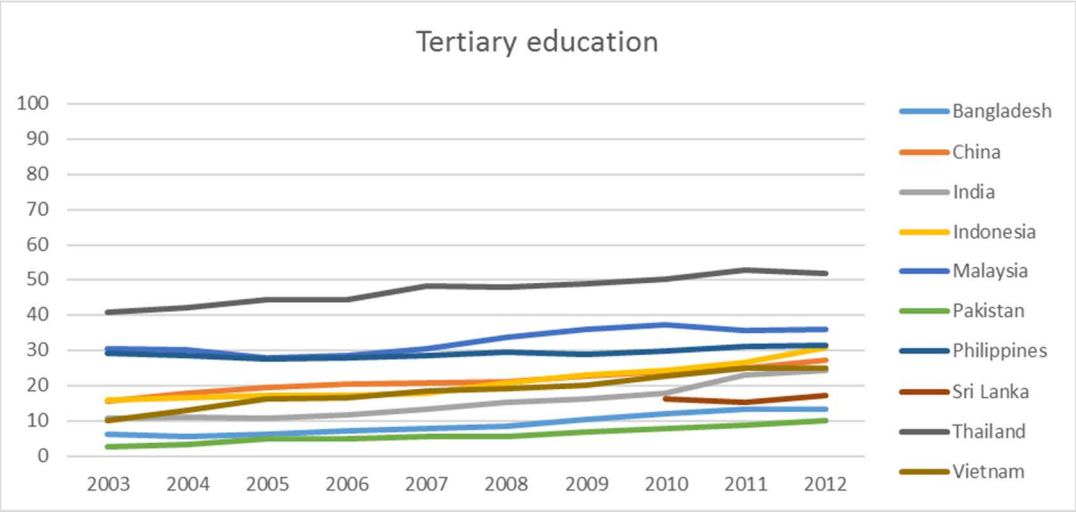

Figure 14: Total enrollment in tertiary education (in percentage of population) (Source: World Bank World Development Indicators)

Education is among the most important quality which can improve human capital because education is also important to increase knowledge and skills. As previously mentioned, without sufficient knowledge and know-how, a country may lack the capacity to internalize foreign technology. Tertiary education enrollment varies across Asian countries, but is steadily growing (Figure 14). The World Bank World Development Indicators measures tertiary education enrollment regardless of age, and is measured as a percentage of the total population. In percentage, As of 2012, more than 50 percent of Thailand's population are enrolled in tertiary education. Meanwhile, other countries are significantly behind Thailand, including China and India. However, it is important to note that this data is measured in percentage of population, thus highly populated countries such as China and India, which are inhabited by over 1 billion people, may have smaller value in percentage but higher value in real count compared to Vietnam, which has a population of less than 100 million people. In Figure 14 it can be seen that there are missing values for tertiary enrollment in education for Sri Lanka.

Similarly, all countries have progressed in GNI (gross national income) per capita over the years (Figure 15). Data for GNI per capita, measured in current US$, is obtained from World Bank World Development Indicators. The higher the income indicates the higher quality of human capital. For example, countries with higher income may be able to spend more on education compared to countries with higher income. In Figure 15, Malaysia is seen as the country with a significantly higher per capita GNI compared to others. Malaysia's GNI per capita has managed to increase consistently in the last 10 years. In 2009, Malaysia's GNI stagnated, which may be gue to the aftermath of the global financial crisis in 2008. In 2012, however, Malaysia's GNI reached over US$10,000. Thailand and China have also growth steadily and consistently over the years. Although initially Thailand has seen higher GNI per capita. China has managed to overtake the former in 2011 and 2012. However, countries such as Bangladesh and Pakistan have progressed

slowly. In Bangladesh, this may be due to its high poverty rate. It may be that in countries such as Bangladesh and Pakistan have lower human capital compared to countries with higher income such as Malaysia, as well as China and Thailand.

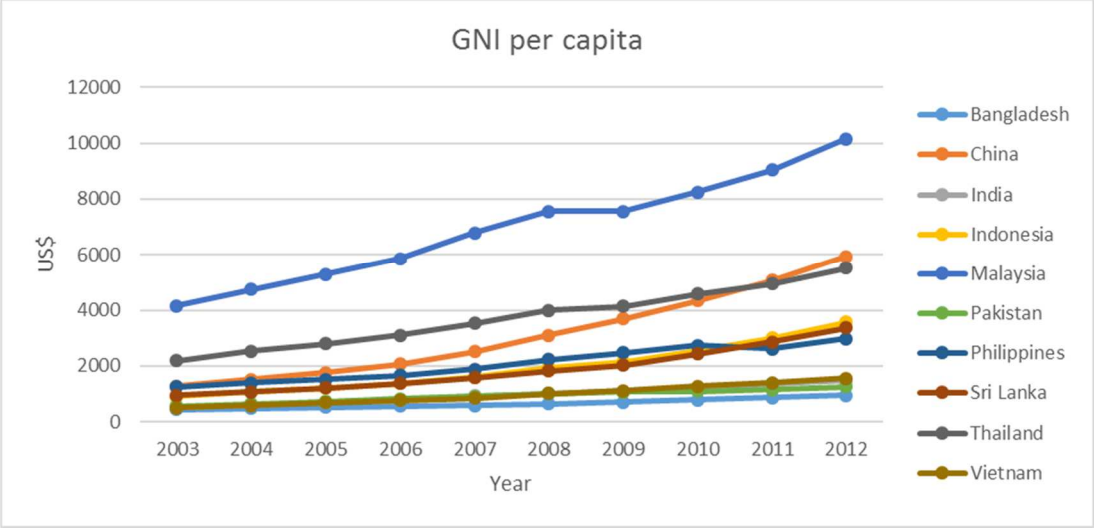

Figure 15: GNI per capita (Source: World Development Indicators)

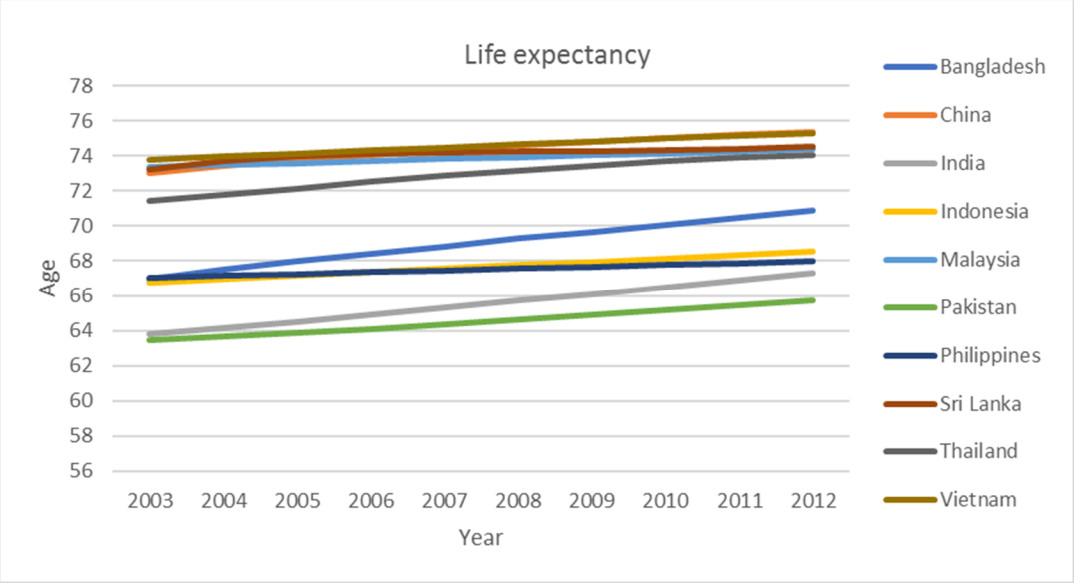

Figure 16: Life expectancy in Asian countries(Source: World Development Indicators)

Another variable to represent human capital is life expectancy. Life expectancy, measured by the World Bank World Development Indicators, indicates the health of a population. The longer the life expectancy, the longer a population is able to produce goods and services. According to (de la Croix and Ricando, 1997, p.1), life expectancy may proxy for good health that "reflect desirable performance of a society". Life expectancy in Asian countries have steadily increased over the years (Figure 16). Although life expectancy varies across countries, most have shown a similar growth rate. Countries with higher life expectancy include Vietnam, China, Malaysia and

Thailand. Meanwhile, countries such as Pakistan and India have seen lower life expectancy, ranging from about 60 to 70.

4.1.3.2 Infrastructure

Infrastructure is an important variable to measure absorptive capacity. The higher the quality of infrastructure, whether physical public infrastructure or digital infrastructure indicate the higher the capacity of a host country to absorb knowledge from foreign firms. Kinoshita and Lu (2006) in their paper even argue that sufficient infrastructure is a pre-requisite for positive spillovers from FDI in a host country.

Access to electricity is one way to measure the quality of infrastructure in a country (Figure 15). Most Asian countries have sufficient access to electricity. Up to 100 percent of the population in countries such as China, Malaysia, Thailand and Vietnam have access to electricity. Meanwhile, the majority of the population in Indonesia, Pakistan, Sri Lanka and the Philippines also have access to electricity. Bangladesh, however, is trailing behind other Asian countries, although its numbers have steadily grown over the years. While countries such as China, Malaysia, Thailand and Vietnam are more urbanized with populated metropolitans, it may be that Bangladesh is less urbanized. Thus, percentage of population with access to electricity is still low. However, the percentage continues to increase. In 2003, only about 40 percent of Bangladesh's population have access to electricity. In 2012, the number increased to 60 percent.

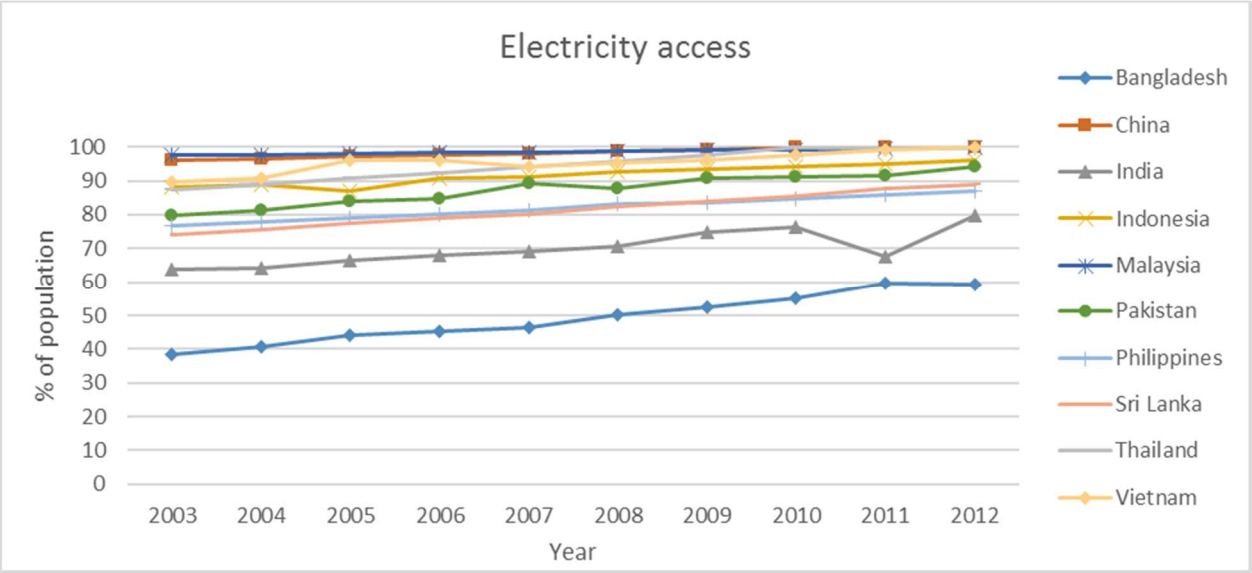

Figure 17: Percentage of population with access to electricity (Source: World Development Indicators)

Digital infrastructure can be measured through the percentage of population using the Internet. Further, the more connected a population is to the Internet, the more knowledge it can acquire by accessing the Internet. The percentage of internet users in Asian countries vary, but most show growth over the years. In Figure 18, Malaysia is the country with the highest percentage of population using the internet. As of 2012, over 60 percent of Malaysia's population use the Internet. Meanwhile, China has seen significant growth over the years, reaching about 40 percent in 2012.

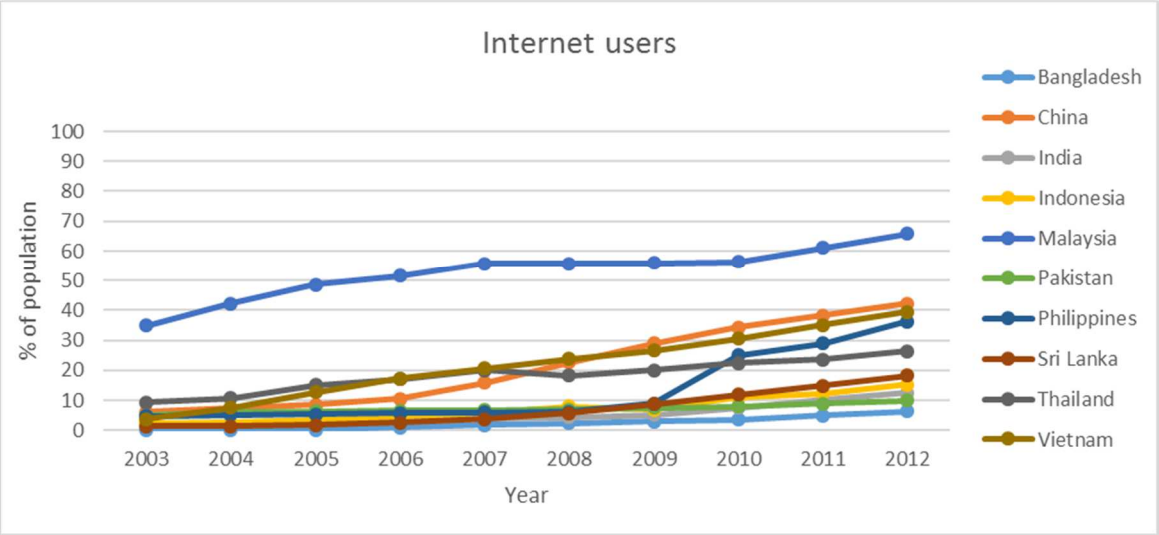

Figure 18: Percentage of population using the internet(Source: World Development Indicators)

4.1.3.3 Institutional quality

The World Bank Worldwide Governance Indicators measures regulatory quality using an index, with a score of -2.5 to 2.5, with higher numbers corresponding to better governance. Regulatory quality is measured using a number of concepts, such as investment freedom, ease of starting a business, burden of government regulation, trade policy, competition policy and investment climate for rural businesses. Overall, the trend among Asia countries seem to be stable, thus a graph of the annual average of the index is generated. (Figure 19). In the last 10 years, regulatory quality in Asian countries have ranged from -0.35 to about -0.25. It is important to note that regulatory quality some countries such as Malaysia and Thailand is higher compared to others such as Bangladesh, Pakistan and Indonesia. Malaysia and Thailand are the only countries which consistently score above 0.

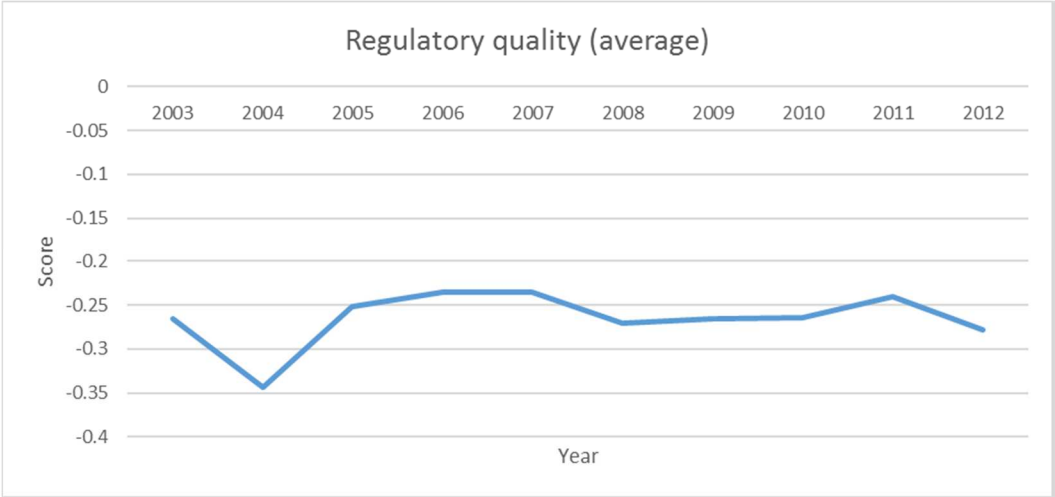

Figure 19: Regulatory quality (average) (Source: World Bank World Governance Indicators)

Meanwhile, investment profile varies in each country (Figure 20). The International Country Risk Guide (ICRG) in its index assesses factors which affect the risk to investment categorized into three subcomponents, which are contract viability/expropriation, profit repatriation, and payment delays. Each subcomponent is scored with a minimum of 0 as Very High Risk, and a maximum of 4 as Very Low Risk. Therefore, the higher total of a country's total score of the subcomponents means the lower risk to investment, while the lower the score, means the higher the risk to investment in the country.

Countries with higher score in investment profile include the Philippines, Thailand and Malaysia. These countries are those with less risk to investment. Meanwhile, countries with more risk to investment include Pakistan and Bangladesh.

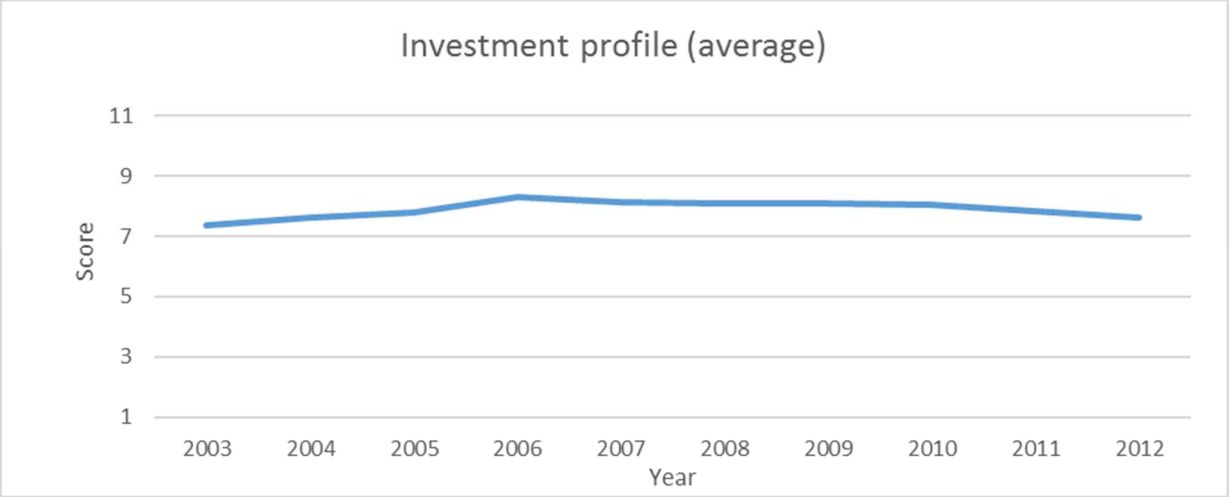

Figure 20: Investment profile in Asian countries(Source: World Bank World Governance Indicators)

4.1.3.4 Control variables

There are several control variables which will be included in the analysis to control for growth and development in the country. These are GDP growth, inflation and population. A summary of these three variables are generated using Stata (Table 9). In GDP growth, the minimum growth from 2003 to 2012 among the countries studied is -2%, while the highest is a 14% growth. A similar disparity can be seen in inflation, where the minimum value is about -5.9 percent while the highest is 22 percent inflation.

Table 9: Summary of control variables

	Obs	Mean	Std Dev.	Min	Max
GDP growth	100	6.200514	2.52573	-2.329849	14.2
Inflation	100	(7.242157	4.71103	-5.991932	22.67332
Population	100	(3.32e+08	4.64e+08	1.92e+07	1.35e+09
Observations	100				

A line graph is generated to further understand the trends in GDP growth, inflation and population in Asian countries.

Asian countries have observed different trends in GDP growth (Figure 21). China, despite its highs and lows, continue to be the country with the highest growth in GDP. Its highest year was 2007, where it touched the 14% mark. However, China's GDP growth continued to decrease in the following years. Meanwhile, countries such as Malaysia and Thailand, have even hit subzero in GDP growth in 2009. This may be due to the effects and aftermath of the global economic crisis in 2008-2009.

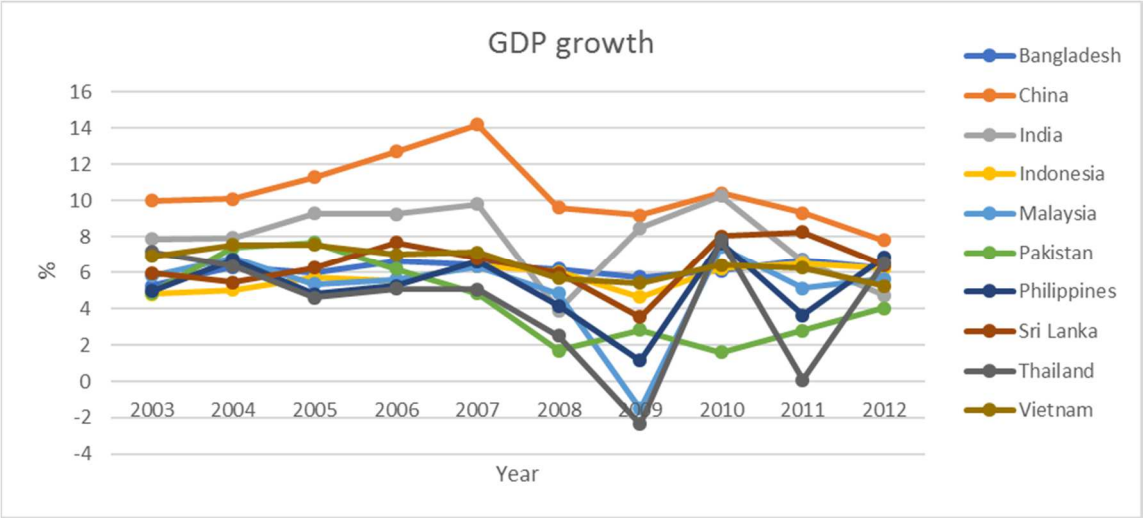

Figure 21: GDP Growth (Source: World Development Indicators)

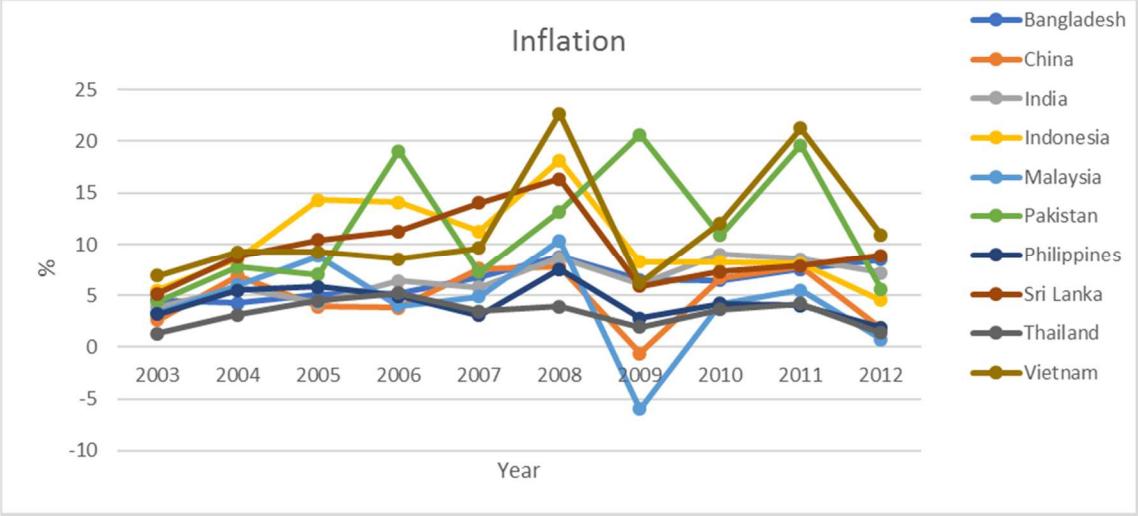

Figure 22: Inflation in Asian countries (Source: World Development Indicators)

Similarly, the countries have also seen different trends in inflation (Figure 22). For example, Pakistan's inflation rate would decrease in one year, but sharply increase in the next, before significantly decreasing again the following year. Other countries such as Thailand has a more consistent inflation rate over the years. Meanwhile, Malaysia's inflation rate observed a similar pattern to its GDP growth rate, sharply decreasing in 2009.

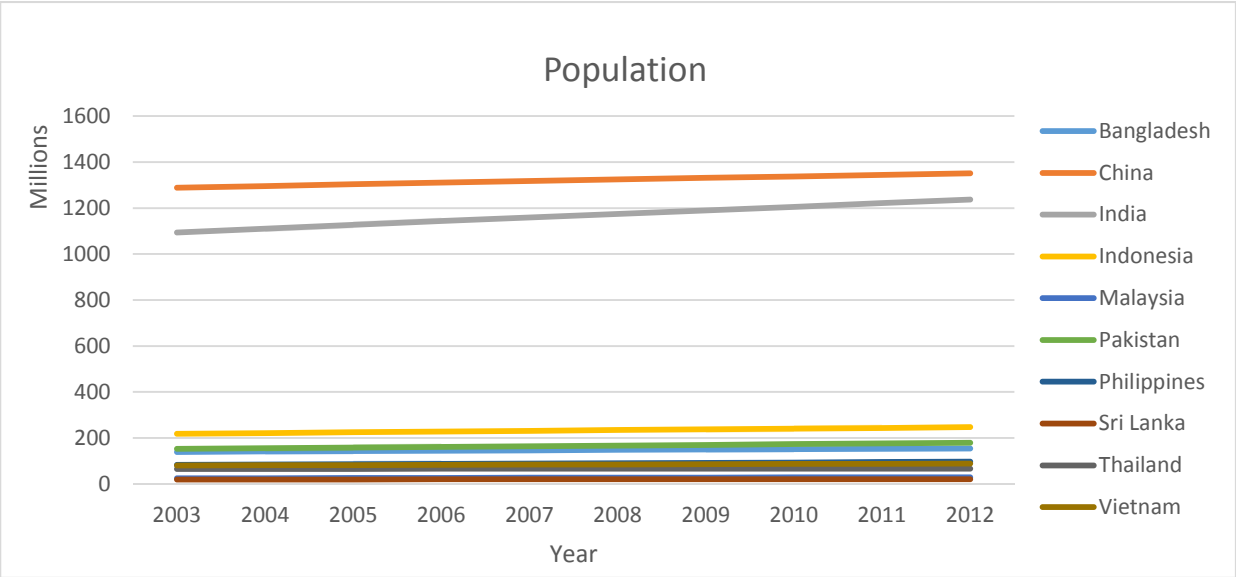

Figure 23: Population (in millions) (Source: World Development Indicators)

In terms of population, China and India are expectedly the highest populated countries, with over a billion inhabitants. The two countries are significantly more populated compared to other countries in this study. While there are other highly populated countries in Asia such as Indonesia, its population is just above 200 million in 2012, far below both China and India.

4.2 Empirical Analysis

To answer the research question and sub-questions, inferential statistics is conducted with the available data. Before performing a regression, assumption and diagnostic tests are conducted before running a regression and interpreting its results to increase the validity of statistical analysis:

7) **Check for outliers**: Cooks distance test is applied to measure influence in the data. Based on this test, outliers are removed for the final regression.
8) **Test for normality**: A Shapiro-Wilk test is employed to test that the distribution is normal. The insignificant W value of the test confirms that the residuals are normally distributed. A geographical test is also applied for accuracy using a histogram and a Kernel density test. Variables which are not normally distributed are transformed into logarithm or square root. In most models included in this study, logarithms are created for variables which are skewed. For example, the histogram test for total FDI (*aminvested*) indicates that the variable is not normally distributed (Figure 24). After a log transformation (*ln_invested*) the variable seems more normally distributed.

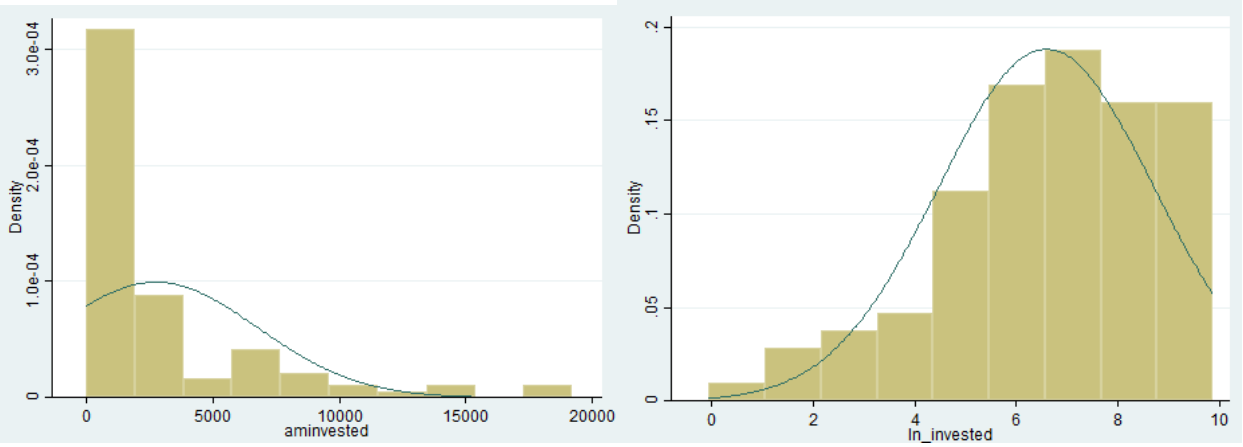

*Figure 24: Histogram test for total FDI (*aminvested*) to check for normality before transformation (left) and after log transformation (right)*

9) **Test for multicollinearity**: This test is to confirm that independent variables are not perfectly multicollinear and that an independent variable should not be a linear function of another. Variables which values over 10 in this test are removed.

Table 10: Example of VIF in regression of patent applications as a dependent variable

	VIF
lninv_ser	2.228183
tertiary_edu/100	4.2984
life expectancy	3.285321
ln_gni	10.96002
ln_electricity	7.688935
ln_internet	10.16672
sqrt_airfreight	20.58443
wgi_regul	9.094079
investment	2.965746
wdi_area	27.35576
gdp_growth	2.165122
population	11.13818
inflation	1.802482
Constant	
Observations	87

For example in Table 10, the VIF of the variables of land area (wdi_area), air freight (sqrt_airfreight), GNI per capita (gni), internet users (internet_users) and population are above 10. Air freight, GNI per capita and internet users are important moderating variables, therefore, land area and population were removed from the final model.

10) **Test for homoscedasticity**: The Breusch-Pagan test is to test whether or not residuals are homoscedastic. An insignificant result of the test confirms that the residuals is homoscedastic and thus does not need a robust command during a regression.
11) **Test for model specification**: The Ramsey RESET tests whether or not a model specification is correct. A significant value of the test indicates that the model specification is incorrect. A link test is further conducted to confirm that the error term and the independent variables are not correlated. An insignificant value of the P statistics confirm that the model specification is correct.
12) **Hausman test**: The Hausman test is to specify whether the regression will use a fixed effect or a random effect. In a fixed effect model, it is estimated that the correlation in each observation is the same. Meanwhile, a random effect accepts that there is variation in the correlation in each observation. A significant result of the test indicates that a fixed effect model shall be used for a regression.

After running assumption tests and transforming necessary variables, there are two steps for inferential statistics, which is 1) panel regression, and 2) panel regression with interaction terms. A panel regression and panel regression with interaction terms is conducted with three different dependent variables (total patent, total industrial design, and total patent and industrial design) and four different independent variables (total FDI, FDI services, FDI natural resources and FDI manufacturing). However, the discussion below are only results of pairings with significant findings, which are total FDI, FDI services, FDI natural resources and FDI manufacturing towards total patent and industrial design application, and total FDI and FDI services towards patent application. Other pairings showed insignificant results.

4.2.1 Total FDI towards total patent and industrial design application

4.2.1.1 Panel regression

A panel regression is employed in order to understand the relationship between FDI and innovation in Asian countries. After removing outliers, creating logarithm for the variables based on normality and linearity tests, a fixed effect is applied. The dependent variable is total Innovation, measured by the total amount of patent and industrial design application, and the independent variable is Total FDI. There are also several moderating variables to proxy the absorptive capacity theory. Three variables represent human capital, which are Tertiary education enrollment, Life expectancy and GNI per capita. Further, infrastructure is measured by Access to electricity, Internet users and Air freight. Regulatory quality and Investment profile represent institutional quality. GDP growth and Inflation rate is included in the model as control variables.

Some variables are log transformed to fix variables with distribution which is not normal. These variables are Innovation, Total FDI, GNI per capita, Access to electricity, Internet users and Air freight. The log transform affects the data interpretation. Model 1 of Table 11 show a panel regression, including the independent variable and moderating variables, as well as a control variable. The coefficients for the variables indicates the amount of change in total innovation given a change in the variables by one unit, or, if the variables are log transformed, by 10 percent. Other variables are held constant.

A panel regression with fixed effect is employed in Model 1 of Table 6. The p-value of the F test for the model is 0.000 (not included in Table 6), indicating that the model is highly significant. The R-squared for fixed effects is .507, meaning that approximately 50 percent of the variability of the dependent variable, total Innovation, is accounted for by the model, even while taking into account other variables in the model. In Model 1, it can be seen that FDI has a positive and significant effect towards innovation with a coefficient of 0.0506. Because both Total FDI and Innovation are log transformed, this means that a 0.5 percent increase in Innovation, or total patent and industrial design applications, can be expected when Total FDI increases by 10 percent. However, it should be noted that the significance level is just below 0.1. Meanwhile, other variables included in the regression do not show a significant sign.

Table 11: Panel regression and panel regression with interaction terms of total FDI towards innovation (total patent and industrial design)

Model	**(1)**	**(2)**	**(3)**	**(4)**	**(5)**	**(6)**	**(7)**	**(8)**	**(9)**
VARIABLES	Innovation	Innovation	Innovation	Innovation	Innovation	Innovation	Innovation	Innovation	Innovation
Total FDI	0.0506*	0.109**	0.548	0.246	0.0998**	0.0524	-0.0620	0.0241	0.255
	(0.03)	(0.05)	(0.49)	(0.23)	(0.04)	(0.07)	(0.13)	(0.03)	(0.20)
Tertiary edu	-1.482	0.322	-1.194	-1.890	-1.970	-1.475	-1.145	-2.076	-1.729
	(1.87)	(2.22)	(1.89)	(1.93)	(1.85)	(1.90)	(1.91)	(1.88)	(1.88)
Life exp	0.153	0.171	0.171	0.176	0.211	0.152	0.105	0.159	0.140
	(0.13)	(0.13)	(0.13)	(0.14)	(0.13)	(0.14)	(0.14)	(0.13)	(0.13)
GNI per capita	0.400	0.459*	0.462*	0.644*	0.307	0.398	0.342	0.525**	0.463*
	(0.24)	(0.25)	(0.25)	(0.38)	(0.24)	(0.26)	(0.25)	(0.25)	(0.25)
Electricity access	-1.735	-1.809	-1.820	-1.859	-4.471**	-1.728	-1.367	-1.514	-1.442
	(1.13)	(1.12)	(1.13)	(1.14)	(1.83)	(1.16)	(1.20)	(1.12)	(1.16)
Internet users	0.104	0.0867	0.111	0.0867	0.129	0.0996	0.103	0.0682	0.0838
	(0.10)	(0.10)	(0.10)	(0.10)	(0.09)	(0.17)	(0.10)	(0.10)	(0.10)
Air freight	0.000991	-0.00835	-3.44e-06	-0.00647	0.0398	0.00120	-0.0376	-0.0168	-0.00587
	(0.03)	(0.03)	(0.03)	(0.03)	(0.04)	(0.03)	(0.05)	(0.03)	(0.03)
Regulatory quality	0.292	0.225	0.197	0.284	0.425	0.293	0.323	0.878*	0.341
	(0.37)	(0.37)	(0.38)	(0.37)	(0.37)	(0.37)	(0.37)	(0.51)	(0.37)
Investment profile	-0.0108	-0.0103	-0.00967	-0.0125	-0.0126	-0.0109	-0.00225	-0.00280	0.156
	(0.05)	(0.05)	(0.05)	(0.05)	(0.04)	(0.05)	(0.05)	(0.05)	(0.17)
GDP growth	0.00501	0.00534	0.00408	0.00601	-0.000116	0.00497	0.000332	0.0100	0.00707
	(0.02)	(0.02)	(0.02)	(0.02)	(0.02)	(0.02)	(0.02)	(0.02)	(0.02)
inflation	0.00522	0.00523	0.00740	0.00436	0.00405	0.00522	0.00461	0.00443	0.00485
	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)

Total FDI * Tertiary education enrollment		-0.303							
		(0.21)							
Total FDI * Life expectancy			-0.00720						
			(0.01)						
Total FDI * GNI per capita				-0.0266					
				(0.03)					
Total FDI * Access to electricity					0.311*				
					(0.17)				
Total FDI * Internet users						0.000756			
						(0.02)			
Total FDI * Air freight							0.0182		
							(0.02)		
Total FDI * Regulatory quality								-0.0991	
								(0.06)	
Total FDI * Investment profile									-0.0254
									(0.02)
Constant	-4.729	-6.778	-6.517	-8.043	-8.560	-4.664	-0.763	-5.782	-5.501
	(8.84)	(8.87)	(9.01)	(9.70)	(8.90)	(9.17)	(9.90)	(8.74)	(8.86)
Observations	82	82	82	82	82	82	82	82	82
R-squared	0.507	0.524	0.516	0.513	0.534	0.507	0.514	0.529	0.516
Number of countryid	10	10	10	10	10	10	10	10	10
Standard errors in parentheses									
*** p<0.01, ** p<0.05, * p<0.1									

4.2.1.2 Panel regression with interaction terms

Models 2 to 8 in Table 11 shows the changes of value in Total FDI towards total Innovation when the former interacts with different variables. For example, Model 2, in which an interaction

between Total FDI and Tertiary education enrollment is included, the coefficient for Total FDI towards Innovation changes. Total FDI becomes more significant towards Innovation when an interaction term between FDI and Tertiary education enrollment is included compared to when an interaction term is not included. In Model 2, in which the R-squared is 52 percent with a statistically significant p-value, the coefficient for Total FDI is 0.109. This means that a 1.1 percent increase in Innovation can be expected when Total FDI increases by 10 percent when an interaction between Total FDI and Tertiary education enrollment is included in the model. The coefficient for Total FDI is more statistically significant in Model 2 ($p<0.05$) compared to Model 1 ($p<0.01$).

In Model 5, Total FDI also becomes statistically significant with a coefficient of 0.998 when an interaction between Total FDI and Access to electricity is included in the model. This indicates that a 1 percent increase in Innovation can be expected when Total FDI increases by 10 percent in this model. Other variables in the models in Table 6 do not indicate a highly statistically significant coefficient.

4.2.2 FDI in service towards total patent and industrial design application

4.2.2.1 Panel regression

Model 1 in Table 12 shows results of a panel regression. The dependent variable is innovation, measured by the total amount of patent and industrial design application, and the independent variable is the value of FDI in the service sector. There are also other variables included to proxy the absorptive capacity theory. Three variables represent human capital, which are tertiary education enrollment, life expectancy, and GNI per capita. Further, infrastructure is measured by access to electricity, internet users and air freight. Regulatory quality and investment profile represent institutional quality. GDP growth is included in the model as a control variable.

Similar to the previous regression, several variables are log transformed, which are Innovation, FDI Services, GNI per capita, Access to electricity, Internet users and Air freight. The log transform variables are generated to fix variables which are not normal.

The panel regression result in Model 1 of Table 12 has an R-squared of 0.533 or 53 percent, meaning that approximately 53 percent of the variability of the dependent variable, which is total innovation, is accounted for by the model, even while taking into account all other variables in the model. Further, the p-value of the F test is statistically significant (not shown), indicating that the model is highly significant. The panel regression results in Model 1 indicates that FDI in the services sector is statistically significant and positive for Innovation with a coefficient of .0391. This means that a 0.4 percent increase in Innovation can be expected when Total FDI increases by 10 percent, while other variables are held constant. FDI in the services sector may positively affect the growth of innovation in Asian countries due to the high competition in the sector. Competition forces local companies to innovate in order to stay relevant in the market.

4.2.2.2 Panel regression with interaction terms

Models 2 to 9 in Table 12 shows the changes in FDI services when it interacts with different variables. In Model 2, an interaction term between FDI in the services sector and Tertiary education enrollment is included. The R-squared for this model is 53% with a statistically significant p-value for the F test (not shown). The result for Model 2 indicates a statistically significant coefficient for Total FDI; a 0.5 increase in Innovation can be expected when FDI Services increases by 10 percent.

The coefficient for FDI Services in Model 1 and Model 2 are equally significant ($p<0.05$). However, Model 2 shows a larger coefficient for FDI Service (0.0484), compared to Model 1 (0.0391)

Table 12: FDI Service towards total patent and industrial design application

Model VARIABLES	**1** Innovation	**2** Innovation	**3** Innovation	**4** Innovation	**5** Innovation	**6** Innovation	**7** Innovation	**8** Innovation	**9** Innovation
FDI Service	0.0391**	0.0484**	0.204	0.0593	0.0541***	0.0452	-0.0388	0.0359	-0.0110
	(0.01)	(0.02)	(0.25)	(0.14)	(0.02)	(0.04)	(0.10)	(0.02)	(0.07)
Tertiary edu	-1.798	-1.320	-1.658	-1.837	-2.096	-1.802	-1.451	-1.828	-1.823
	(1.73)	(1.97)	(1.75)	(1.76)	(1.75)	(1.74)	(1.79)	(1.75)	(1.74)
Life expectancy	0.155	0.162	0.159	0.159	0.171	0.153	0.120	0.156	0.159
	(0.12)	(0.12)	(0.12)	(0.12)	(0.12)	(0.12)	(0.13)	(0.12)	(0.12)
GNI per capita	0.406*	0.414*	0.426*	0.433	0.385*	0.395*	0.358	0.413*	0.400*
	(0.22)	(0.22)	(0.22)	(0.29)	(0.22)	(0.23)	(0.23)	(0.22)	(0.22)
Access to electricity	-1.712*	-1.841*	-1.852*	-1.756	-1.978*	-1.641	-1.438	-1.717*	-1.657
	(1.01)	(1.05)	(1.04)	(1.06)	(1.04)	(1.10)	(1.07)	(1.02)	(1.02)
Internet users	0.114	0.113	0.124	0.112	0.113	0.104	0.116	0.113	0.110
	(0.09)	(0.09)	(0.09)	(0.09)	(0.09)	(0.11)	(0.09)	(0.09)	(0.09)
Air freight	0.0161	0.0150	0.0155	0.0156	0.0166	0.0162	-0.0252	0.0160	0.0151
	(0.03)	(0.03)	(0.03)	(0.03)	(0.03)	(0.03)	(0.06)	(0.03)	(0.03)
Regulatory quality	0.380	0.389	0.368	0.388	0.324	0.369	0.359	0.426	0.331
	(0.34)	(0.34)	(0.34)	(0.35)	(0.34)	(0.35)	(0.34)	(0.44)	(0.35)
investment profile	-0.0296	-0.0324	-0.0326	-0.0309	-0.0221	-0.0279	-0.0209	-0.0303	-0.0679
	(0.04)	(0.04)	(0.04)	(0.04)	(0.04)	(0.04)	(0.04)	(0.04)	(0.06)
GDP growth	-0.00280	-0.00284	-0.00368	-0.00264	-0.00206	-0.00271	-0.00526	-0.00250	-0.00295
	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)
FDI Services * Tertiary		-0.0714							

education enrollment									
		(0.14)							
FDI Services * Life expectancy			-0.00240						
			(0.00)						
FDI Services * GNI per capita				-0.00296					
				(0.02)					
FDI Services * Access to electricity					0.0566				
					(0.05)				
FDI Services * Internet users						0.00206			
						(0.01)			
FDI Services * Air freight							0.0136		
							(0.02)		
FDI Services * Regulatory quality								-0.00612	
								(0.04)	
FDI Services * Investment profile									0.00695
									(0.01)
Constant	-4.615	-5.194	-5.020	-5.025	-5.689	-4.408	-1.700	-4.666	-4.596
	(8.11)	(8.23)	(8.17)	(8.61)	(8.15)	(8.26)	(8.88)	(8.17)	(8.13)
Observations	86	86	86	86	86	86	86	86	86
R-squared	0.533	0.535	0.536	0.533	0.542	0.533	0.538	0.533	0.537
Number of countryid	10	10	10	10	10	10	10	10	10
Standard errors in parentheses									
*** p<0.01, ** p<0.05, * p<0.1									

Further, Model 5 in Table 12, in which an interaction term between FDI Services and Access to electricity is included, also shows a statistically significant coefficient for FDI Services. The R-squared in this model is 0.542, meaning that approximately 54 percent of the variability of the dependent variable, which is total innovation, is accounted for by the model. In this model, Innovation can be expected to increase by 0.5 percent when FDI Services increases by 10 percent in this model. The coefficient for FDI Services in Model 5 is more statistically significant ($p<0.01$) compared to the coefficient in Model 1 and Model 2.

4.2.3 FDI in natural resources towards total patent and industrial design application

Table 13: FDI natural resources towards total patent and industrial design application

Model	**(1)**	**(2)**	**(3)**	**(4)**	**(5)**	**(6)**	**(7)**	**(8)**	**(9)**
VARIABLES	Innovation	Innovation	Innovation	Innovation	Innovation	Innovation	Innovation	Innovation	Innovation
FDI in natural resources	0.00480	0.0479*	0.269	0.131	0.00873	-0.00238	0.0696	-0.00605	0.0288
	(0.01)	(0.02)	(0.25)	(0.11)	(0.02)	(0.03)	(0.07)	(0.02)	(0.06)
Tertiary education enrollment	-1.723	-0.876	-1.484	-1.694	-1.749	-1.697	-1.967	-1.689	-1.731
	(1.90)	(1.89)	(1.91)	(1.89)	(1.91)	(1.91)	(1.92)	(1.88)	(1.91)
Life expectancy	0.107	0.154	0.144	0.138	0.112	0.107	0.150	0.138	0.109
	(0.17)	(0.16)	(0.17)	(0.17)	(0.17)	(0.17)	(0.17)	(0.17)	(0.17)
GNI per capita	0.715**	0.703**	0.722**	0.769**	0.701**	0.720**	0.766**	0.690**	0.707**
	(0.33)	(0.32)	(0.33)	(0.33)	(0.33)	(0.33)	(0.33)	(0.32)	(0.33)
Access to electricity	-1.629	-1.654	-2.042	-1.814	-1.832	-1.619	-1.855	-1.656	-1.632
	(1.52)	(1.48)	(1.57)	(1.53)	(1.62)	(1.54)	(1.55)	(1.51)	(1.54)
Internet users	0.144	0.114	0.148	0.131	0.145	0.154	0.136	0.122	0.145
	(0.10)	(0.10)	(0.10)	(0.10)	(0.10)	(0.10)	(0.10)	(0.10)	(0.10)
Air freight	0.0136	0.00802	0.0116	0.00904	0.0154	0.0129	0.0113	0.00803	0.0131
	(0.03)	(0.03)	(0.03)	(0.03)	(0.03)	(0.03)	(0.03)	(0.03)	(0.03)
Regulatory quality	0.140	0.0846	0.0973	0.131	0.161	0.129	0.136	0.242	0.138
	(0.37)	(0.36)	(0.37)	(0.37)	(0.38)	(0.38)	(0.37)	(0.38)	(0.38)
Investment profile	0.0219	0.0289	0.0218	0.0249	0.0201	0.0230	0.0198	0.0295	0.0332
	(0.05)	(0.04)	(0.05)	(0.05)	(0.05)	(0.05)	(0.05)	(0.05)	(0.05)
GDP growth	0.00107	0.00633	0.00226	0.00568	-0.000117	0.00181	0.00518	0.00629	0.00167
	(0.02)	(0.02)	(0.02)	(0.02)	(0.02)	(0.02)	(0.02)	(0.02)	(0.02)
Population	-2.362	-2.156	-2.160	-1.995	-2.310	-2.286	-2.438	-1.901	-2.290
	(1.73)	(1.68)	(1.73)	(1.75)	(1.74)	(1.75)	(1.73)	(1.74)	(1.75)

FDI nat * Tertiary education enrollment		-0.195**							
		(0.09)							
FDI nat * Life expectancy			-0.00381						
			(0.00)						
FDI nat * GNI per capita				-0.0172					
				(0.01)					
FDI nat * Access to electricity					0.0208				
					(0.05)				
FDI nat * Internet users						-0.00298			
						(0.01)			
FDI nat * Air freight							-0.0103		
							(0.01)		
FDI nat * Regulatory quality								-0.0370	
								(0.03)	
FDI nat * Investment profile									-0.00306
									(0.01)
Constant	40.82	33.37	34.25	31.24	39.53	39.33	38.86	30.02	39.24
	(36.60)	(35.77)	(37.06)	(37.37)	(36.98)	(37.13)	(36.72)	(37.04)	(37.08)
Observations	84	84	84	84	84	84	84	84	84
R-squared	0.492	0.527	0.502	0.503	0.494	0.493	0.499	0.509	0.493
Number of countryid	10	10	10	10	10	10	10	10	10
Standard errors in parentheses									
*** p<0.01, ** p<0.05, * p<0.1									

4.2.3.1 Panel regression

Model 1 in Table 13 shows results of a panel regression of FDI in natural resources towards total patent and industrial design. Model 1 has an R-squared of 0.492, meaning that approximately 50

percent of the variability of the dependent variable, total innovation, is accounted for by the model. Several variables are log transformed to fix normality problem. These variables are Innovation, FDI natural resources, GNI per capita, Access to electricity, Internet users and Air freight. The result of a panel regression indicates that FDI in natural resources is not significant towards innovation. Other variables are also not significant. However, it is noted that GNI per capita is positive and statistically significant ($p<0.05$) in this model with a coefficient of 0.715. GNI per capita is statistically significant with consistent coefficients in other models as well.

4.2.3.2 Panel regression with interaction terms

The results panel regression with interactions terms are shown in Models 2 to 9 in Table 13. The coefficient of FDI in natural resources shows the changes when interaction terms are included in the model. In Model 2, in which an interaction term between FDI natural resources and Tertiary education enrollment are included, the coefficient for FDI natural resources becomes positive and statistically significant. This means that in this model, a 0.5 percent increase in Innovation can be expected when FDI natural resources increases by 10 percent. However, the level of the significance ($p<0.1$) should be noted. However, for FDI in natural resources as an independent variable, only Model 2 shows a significant and positive coefficient.

4.2.4 FDI in manufacturing towards total patent and industrial design application

Table 14: FDI manufacturing towards total patent and industrial design application

Model	**(1)**	**(2)**	**(3)**	**(4)**	**(5)**	**(6)**	**(7)**	**(8)**	**(9)**
VARIABLES	Innovation	Innovation	Innovation	Innovation	Innovation	Innovation	Innovation	Innovation	Innovation
FDI in manufacturing	0.00334	0.00292	-0.274	-0.119	0.0129	0.0704*	-0.117	-0.0130	0.00931
	(0.02)	(0.03)	(0.31)	(0.17)	(0.03)	(0.04)	(0.10)	(0.02)	(0.09)
Tertiary education enrollment	-1.467	-1.477	-1.576	-1.253	-1.528	-1.265	-1.062	-1.788	-1.472
	(1.89)	(2.02)	(1.89)	(1.92)	(1.90)	(1.86)	(1.91)	(1.91)	(1.90)
Life expectancy	0.123	0.123	0.103	0.105	0.124	0.0863	0.0571	0.131	0.122
	(0.13)	(0.13)	(0.13)	(0.13)	(0.13)	(0.13)	(0.14)	(0.13)	(0.13)
GNI per capita	0.467*	0.467*	0.443*	0.343	0.419	0.264	0.402	0.528**	0.469*
	(0.24)	(0.24)	(0.24)	(0.29)	(0.26)	(0.26)	(0.25)	(0.25)	(0.24)
Access to electricity	-1.893*	-1.887	-1.607	-1.562	-1.869*	-0.890	-1.159	-2.072*	-1.896*
	(1.08)	(1.15)	(1.13)	(1.18)	(1.09)	(1.21)	(1.24)	(1.10)	(1.09)
Internet users	0.129	0.129	0.119	0.130	0.136	0.0644	0.108	0.122	0.129
	(0.09)	(0.09)	(0.09)	(0.09)	(0.09)	(0.10)	(0.09)	(0.09)	(0.09)
Air freight	0.0152	0.0153	0.0148	0.0172	0.0170	0.0117	0.0134	0.0124	0.0151
	(0.03)	(0.03)	(0.03)	(0.03)	(0.03)	(0.03)	(0.03)	(0.03)	(0.03)
Regulatory quality	0.194	0.195	0.236	0.231	0.253	0.368	0.303	0.292	0.192

	(0.37)	(0.37)	(0.37)	(0.37)	(0.39)	(0.37)	(0.38)	(0.38)	(0.37)
Investment profile	0.00245	0.00254	0.0125	0.00803	0.000650	0.00913	0.00704	-0.00123	0.00453
	(0.04)	(0.04)	(0.04)	(0.04)	(0.04)	(0.04)	(0.04)	(0.04)	(0.05)
GDP growth	0.00142	0.00138	0.000573	-0.000481	0.000768	-0.00201	-0.00299	0.00438	0.00164
	(0.02)	(0.02)	(0.02)	(0.02)	(0.02)	(0.02)	(0.02)	(0.02)	(0.02)
Population		0.00215							
		(0.14)							
FDI manu * Tertiary education enrollment			0.00402						
			(0.00)						
FDI manu * Life expectancy				0.0168					
				(0.02)					
FDI manu * GNI per capita					0.0684				
					(0.13)				
FDI manu * Access to electricity						0.0285*			
						(0.02)			
FDI manu * Internet users							0.0199		
							(0.02)		
FDI manu * Air freight								-0.0466	
								(0.05)	
FDI manu * Regulatory quality									-0.000756
									(0.01)
Constant	-2.995	-2.969	-1.484	-0.855	-2.652	1.071	2.034	-3.847	-2.963
	(8.81)	(9.05)	(8.99)	(9.30)	(8.89)	(8.98)	(9.75)	(8.85)	(8.90)
Observations	84	84	84	84	84	84	84	84	84
R-squared	0.463	0.463	0.469	0.467	0.465	0.488	0.475	0.471	0.463
Number of countryid	10	10	10	10	10	10	10	10	10
Standard errors in parentheses									

*** p<0.01,
** p<0.05,
* p<0.1

4.2.3.1 Panel regression and panel regression with interaction terms

Table 14 shows panel regression, both with and without interaction terms of FDI in manufacturing as an independent variable towards total patent and industrial design, or Innovation, as a dependent variable. Model 1 has an R-squared of 0.463, meaning that about 50 percent of the variability of the dependent variable, total innovation/patent and industrial design application, is accounted for by the model. The R-squared in all models are similar. Several variables are log transformed for normality. These variables are Innovation, FDI manufacturing, GNI per capita, Access to electricity, Internet users and Air freight.

FDI in the manufacturing sector, both with and without interaction terms, do not indicate a significant and positive correspondence towards total innovation. This shows different results compare to total FDI and, especially FDI in the services sector. In previous regressions, an interaction term between the independent variable and tertiary education enrollment would have a positive effect for the statistics of the independent variable. The only significance can be seen in Model 6, in which an interaction term between FDI manufacturing and Access to electricity is included, the coefficient for FDI manufacturing becomes statistically significant with a coefficient of 0.704. However, the level of significance ($p<0.1$) should also be noted.

While FDI in the manufacturing sector may increase productivity and wage in the host country, it may not necessarily increase innovation. This may be because FDI in the manufacturing sector in Asian countries are labor-intensive, thus chances of a technological spillover are low. Many Asian countries are known for labor-intensive manufacturing industries. Countries such as Indonesia, Vietnam, and Bangladesh are home to many labor-intensive manufacturing industries, such as textile and clothing apparel.

4.2.5 Total FDI towards patent application

4.2.4.1 Panel regression

The result of a panel regression of Total FDI towards patent is shown in Model 1 of Table 15. Model 1 has an R-squared of 0.492, meaning that approximately 50 percent of the variability of the dependent variable, patents, is accounted for by the model. A patent, according to the WIPO, protects an invention that offers a new technical solution to a problem. This is different to that of industrial design, which protects only the aesthetic features of a product. Further, patents are territorial rights, according to the WIPO. Therefore, the rights are only applicable in the country in which it was filed and granted. Model 1 does not show a statistically significant coefficient for all variables.

4.2.4.2 Panel regression with interaction terms

The panel regression with interaction terms is shown in Models 2 through 8 in Table 15. Similar to the panel regression in Total FDI towards total Innovation (Table 11), an interaction between total FDI and Tertiary education enrollment as shown in Model 2 results in a positive and

significant coefficient for total FDI towards Patents at 0.109. This means that an increase by 1 percent in patents can be expected when Total FDI increases by 10 percent. While Model 1 is insignificant, Model 2 statistically significant with a p-value of under 0.05. Interaction between total FDI and GNI per capita (Model 4) also results in a significant and positive value for total FDI towards patents at 0.532.

Table 15: Total FDI towards patent applications

Model	**(1)**	**(2)**	**(3)**	**(4)**	**(5)**	**(6)**	**(7)**	**(8)**	**(9)**
VARIABLES	Patent	Patent	Patent	Patent	Patent	Patent	Patent	Patent	Patent
Total FDI	0.0334	0.109**	0.732	0.532**	0.0303	-0.0505	0.0459	-0.00200	0.413*
	(0.03)	(0.05)	(0.51)	(0.23)	(0.04)	(0.07)	(0.04)	(0.04)	(0.23)
Tertiary education enrollment	0.521	2.802	0.965	-0.491	0.549	0.292	0.268	-0.643	-0.579
	(2.19)	(2.45)	(2.20)	(2.17)	(2.23)	(2.19)	(2.29)	(2.24)	(2.26)
Life expectancy	-0.0301	0.00612	-0.00680	0.0265	-0.0333	-0.00329	-0.0132	0.00996	-0.00564
	(0.16)	(0.15)	(0.16)	(0.15)	(0.16)	(0.16)	(0.16)	(0.15)	(0.15)
GNI per capita	0.283	0.379	0.369	0.898**	0.286	0.372	0.290	0.462	0.509
	(0.29)	(0.28)	(0.29)	(0.39)	(0.29)	(0.29)	(0.29)	(0.30)	(0.31)
Access to electricity	-1.118	-1.350	-1.228	-1.418	-0.975	-1.344	-1.235	-1.169	-1.164
	(1.35)	(1.33)	(1.35)	(1.32)	(1.89)	(1.36)	(1.39)	(1.33)	(1.33)
Internet users	0.120	0.105	0.130	0.0863	0.119	0.310*	0.123	0.0930	0.0946
	(0.10)	(0.10)	(0.10)	(0.10)	(0.10)	(0.17)	(0.10)	(0.10)	(0.10)
Air freight	0.0124*	0.0106	0.0124*	0.0121*	0.0124	0.0137*	0.0174	0.00860	0.00524
	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)
Regulatory quality	0.459	0.383	0.333	0.474	0.455	0.394	0.462	1.148**	0.562
	(0.40)	(0.39)	(0.40)	(0.38)	(0.40)	(0.40)	(0.40)	(0.53)	(0.39)
Investment profile	-0.00591	-0.00903	-0.00450	-0.0108	-0.00588	0.000171	-0.00522	-0.00365	0.293
	(0.05)	(0.05)	(0.05)	(0.05)	(0.05)	(0.05)	(0.05)	(0.05)	(0.18)
GDP growth	-0.0137	-0.0132	-0.0151	-0.0122	-0.0135	-0.0129	-0.0138	-0.00735	-0.00697
	(0.02)	(0.02)	(0.02)	(0.02)	(0.02)	(0.02)	(0.02)	(0.02)	(0.02)
inflation	0.00974	0.00997	0.0127	0.00720	0.00977	0.00930	0.00956	0.00961	0.0104
	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)
Total FDI * Tertiary education enrollment		-0.410*							
		(0.21)							
Total FDI * Life expectancy			-0.0101						
			(0.01)						

Total FDI * GNI per capita				-0.0687**					
				(0.03)					
Total FDI * Access to electricity					-0.0161				
					(0.15)				
Total FDI * Internet users						-0.0340			
						(0.03)			
Total FDI * Air freight							-0.000569		
							(0.00)		
Total FDI * Regulatory quality								-0.115*	
								(0.06)	
Total FDI * Investment profile									-0.0481*
									(0.03)
Constant	7.994	4.345	5.642	-0.280	8.213	5.837	6.689	4.361	2.655
	(10.57)	(10.51)	(10.63)	(10.90)	(10.85)	(10.62)	(11.11)	(10.53)	(10.87)
Observations	81	81	81	81	81	81	81	81	81
R-squared	0.492	0.523	0.508	0.532	0.492	0.507	0.494	0.521	0.516
Number of countryid	10	10	10	10	10	10	10	10	10
Standard errors in parentheses									
*** p<0.01, ** p<0.05, * p<0.1									

4.2.6 FDI service towards patents

In the panel regression and panel regression with interaction terms conducted for the dependent variable of patents and the independent variable of FDI in the services sector (Table 16), the results do not indicate statistical significance of below 0.05 for any of the variables in any of the models. However, it is important to note that interaction between FDI in the services sector and tertiary education enrollment has a similar positive effect for the coefficient of FDI services, as can be seen in Model 2 of Table 16. The coefficient for FDI Services in Model 2 is 0.0487, which means that a 0.5 percent increase in patent applications can be expected when FDI increases by 10 percent.

Model 2 has an R-squared of .523, which means that the 52 percent of the variability of patent applications as the dependent variable is accounted for by the model.

Table 16: FDI services towards patent application

Model	**(1)**	**(2)**	**(3)**	**(4)**	**(5)**	**(6)**	**(7)**	**(8)**	**(9)**
VARIABLES	Patents	Patents	Patents	Patents	Patents	Patents	Patents	Patents	Patents
FDI Services	0.0264	0.0487*	0.176	0.254*	0.0249	-0.00496	0.00412	0.0407	0.0290
	(0.02)	(0.03)	(0.29)	(0.15)	(0.02)	(0.04)	(0.03)	(0.03)	(0.07)
Tertiary education enrollment	0.526	1.786	0.697	0.230	0.564	0.668	0.314	0.182	0.527
	(2.15)	(2.39)	(2.19)	(2.14)	(2.21)	(2.17)	(2.17)	(2.23)	(2.17)
Life expectancy	-0.0336	-0.0206	-0.0341	-0.00542	-0.0357	-0.0309	-0.0272	-0.0137	-0.0336
	(0.15)	(0.15)	(0.15)	(0.15)	(0.15)	(0.15)	(0.15)	(0.15)	(0.15)
GNI per capita	0.294	0.331	0.323	0.603*	0.298	0.351	0.360	0.314	0.296
	(0.26)	(0.26)	(0.27)	(0.32)	(0.26)	(0.27)	(0.27)	(0.26)	(0.26)
Access to electricity	-1.108	-1.482	-1.251	-1.584	-1.085	-1.443	-1.236	-1.261	-1.116
	(1.25)	(1.29)	(1.29)	(1.27)	(1.29)	(1.33)	(1.26)	(1.28)	(1.28)
Internet users	0.118	0.119	0.129	0.100	0.118	0.169	0.113	0.120	0.118
	(0.09)	(0.09)	(0.10)	(0.09)	(0.10)	(0.12)	(0.09)	(0.09)	(0.10)
Air freight	0.0125*	0.0115	0.0121*	0.0122*	0.0125*	0.0125*	0.0111	0.0191	0.0124*
	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)
Regulatory quality	0.549	0.554	0.528	0.629	0.554	0.603	0.840*	0.579	0.551
	(0.39)	(0.39)	(0.40)	(0.39)	(0.40)	(0.40)	(0.49)	(0.40)	(0.40)
Investment profile	-0.0273	-0.0356	-0.0310	-0.0408	-0.0283	-0.0357	-0.0343	-0.0299	-0.0254
	(0.05)	(0.05)	(0.05)	(0.05)	(0.05)	(0.05)	(0.05)	(0.05)	(0.07)
GDP growth	-0.0166	-0.0175	-0.0177	-0.0164	-0.0166	-0.0176	-0.0147	-0.0168	-0.0166
	(0.02)	(0.02)	(0.02)	(0.02)	(0.02)	(0.02)	(0.02)	(0.02)	(0.02)
inflation	0.00955	0.0109	0.0106	0.00902	0.00965	0.0104	0.0103	0.00980	0.00955
	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)
FDI Services * Tertiary education enrollment		-0.181							
		(0.15)							
FDI Services * Life expectancy			-0.00219						
			(0.00)						

FDI Services * GNI per capita				-0.0334					
				(0.02)					
FDI Services * Access to electricity					-0.00519				
					(0.06)				
FDI Services * Internet users						-0.0104			
						(0.01)			
FDI Services * Air freight							-0.0404		
							(0.04)		
FDI Services * Regulatory quality								-0.000779	
								(0.00)	
FDI Services * Investment profile									-0.000373
									(0.01)
Constant	8.359	7.061	8.213	4.328	8.497	7.910	7.692	6.782	8.338
	(10.21)	(10.23)	(10.28)	(10.41)	(10.41)	(10.26)	(10.24)	(10.56)	(10.31)
Observations	83	83	83	83	83	83	83	83	83
R-squared	0.514	0.525	0.516	0.533	0.514	0.518	0.521	0.517	0.514
Number of countryid	10	10	10	10	10	10	10	10	10
Standard errors in parentheses									
*** p<0.01, ** p<0.05, * p<0.1									

4.3 Factors which moderate the relationship between FDI and innovation

Based on the research findings from the panel regression and panel regression with interaction terms, evidence which proves that FDI is positively and statistically significant for innovation is rare. Generally, an increase FDI is not found to have a positive effect towards the growth of innovation in Asian countries, as can be observed in the empirical analysis. Variables to

represent the absorptive capacity theory, such as infrastructure and institutional quality, do not prove to have a positive effect. However, an interaction between FDI and Tertiary education enrollment, a variable to proxy human capital, often results in a positive and statistically significant coefficient for FDI (Model 2 Tables 11, 12, 13, 15 and 16). Further, FDI in the services sector also seem to have a more positive effect on innovation compared to FDI in other sectors (as seen in Tables 7 and 10). This will be further discussed below.

4.3.1 Education

The interaction between FDI and tertiary education enrollment often results in a statistically significant and positive coefficient for FDI. This can be seen in the results of panel regression with interaction terms in Tables 11, 12, 13, 15 and 16. Tertiary education is those conducted in a university or college, or similar institutions. Tertiary education is an important means for the population to improve their skills. It is thus also an important channel for knowledge spillover; the more educated a worker, the easier for the worker to absorb knowledge and know-how from foreign multinationals. Education proves to result in a positive effect for total FDI as well as FDI in the services and natural resources sectors. However, tertiary education has little to no effect for FDI in the manufacturing sector. This may be because FDI in the manufacturing sector in Asian countries are mostly labor-intensive, thus an increase educated workforce would have little to no effect.

This finding is in line with previous research in this subject. For example, Hall and Mairesse (2006) found that firms with a greater share of highly educated employees are more likely to innovate. This firm-level research is also relevant at a country level in Asia. Further, Fu ‘s (2007) provincial-level research in China also confirmed a similar finding to that of Mairesse. Fu found that FDI can have a positive effect on the host’s innovation capabilities through knowledge spillover. However, this effect is determined by several important variables, such as provincial capabilities. China’s coastal regions is home to top universities and research institutes, thus it attracts technology-intensive investment which in turn increases the innovation capabilities of the province. Meanwhile in China’s inland areas, where the quality of educational institutions is lower compared to those in coastal regions, knowledge spillover from FDI is limited.

4.3.2 FDI sector

Differences in regression results can be seen among FDI sectors. For example, FDI in the service sector (Tables 12 and 15) have a positive effect towards patents and total innovation when an interaction term between selected variables are included, such as tertiary education enrollment and electricity. FDI in the service sector may have a positive relationship with innovation activities because much of nature of the investment in this sector is high-tech. For example, FDI in the service sector in India include, among others, financial, banking, insurance, non-financial/business, outsourcing, research and development, courier, as well as technology testing and analysis (Mandal, 2016). Such subsectors are knowledge- and technology-intensive, thus it is possible that a knowledge spillover occurs in this sector. Further, FDI in the service sector is more statistically significant towards innovation when tertiary education enrollment is included in the

model, as seen in Table 7. This is expected, because an educated population is more likely to absorb knowledge and technology brought by a foreign firm.

Meanwhile, the effect of FDI in the manufacturing sector towards innovation remains unchanged (Table 8). Such a result also persists when the dependent variable is changed. This may be because most FDI in the manufacturing sector in Asian countries are labor intensive, as opposed to the knowledge-intensive service sector. It has been previously mentioned that Asian countries have transitioned from a resource-based economy to exporters, thanks to the globalization of production (Felker, 2003). According to Sjoholm (2014), Northeast Asian countries have contributed to this transition by investing in Southeast Asian countries for labor-intensive stages of manufacturing.

Previous research in this subject have also found similar results. For example, Antonietti, Bronzini and Cainelli (2014) found a positive relationship between FDI and patenting activity only in the services industry in Italian provinces. They found that larger FDI in the service sector positively affects patenting in the knowledge intensive business service sector. In contrast, they did not find a positive relationship between FDI and local patenting activities in the manufacturing sector.

Chapter 5: Conclusion and Recommendations

5.1 Conclusion

Global economic integration has diminished barriers and countries are increasingly linked and interdependent through various activities, including foreign direct investment (FDI). Lipsey (2003) defines FDI as "a particular form of the flow of capital across national borders, from home countries to host countries". There have been extensive studies on both positive and negative impacts of FDI in host countries. Positive spillovers include, for example, productivity (Koko, Tansini and Zejan, 1996; Arnold and Javorcik, 2009), (Barry and Gorg, 2005), and technology (Liu, 2008). As MNEs make their technology and managerial skills available to local firms, it is inevitable that local firms would learn and adopt.

Due to the possibility of positive spillovers which can be gained from FDI, countries are competing to attract FDI, through policies, among others. Although business-friendly policies may attract FDI, the benefits and positive spillovers which a host country can capture from FDI largely depends on the host country's characteristics. Local conditions may even limit the potential benefits of FDI (Alfaro et al., 2004). This research aims to explain the relationship between FDI and innovation in Asian countries and the factors which moderate the relationship, using the absorptive capacity theory. Cohen and Levinthal (1990, p.128) define absorptive capacity as "the ability of a firm to recognize the value of new, external information, assimilate it, and apply it to commercial ends". In the context of innovation systems, Narula (2004, p.2) defines absorptive capacity as "the ability to absorb, internalize and utilize the knowledge potentially made available to them". In the present research, there are three variables to represent absorptive capacity, which are human capital, infrastructure and institutional environment.

Fu (2007) found that MNEs through FDI are an important agent to promote innovation activities with their advanced technology and their investment on research and development. Fu found that while FDI can have a positive effect on the host country's innovation capabilities through knowledge spillover, but asserted that such positive effect is determined by availability of absorptive capacity and the presence of innovation-complementary assets in the host region. However, studies which link FDI and innovation in host countries is limited and evidence varies.

To answer the first sub-question of the research, based on statistical analysis, evidence which proves that FDI has a direct relationship towards innovation is rare. Further, evidence which proves that FDI is positively and statistically significant for innovation is also rare. Generally, an increase FDI is not found to have a positive effect towards the growth of innovation in Asian countries. However, to answer the second sub-question, there are two factors which are found to moderate this relationship, namely education and FDI sector.

First, an interaction between FDI and tertiary education enrollment, an indicator for human capital, often results in a statistically significant and positive coefficient for FDI. In other words, FDI, when supported by tertiary education enrollment, may increase innovation activities in the host country. This finding is in line with previous research in this subject. For example, Hall and Mairesse (2006) found that firms with a greater share of highly educated employees are more likely to innovate. Education is necessary for the host country in order to absorb and internalize knowledge from foreign firms and apply it locally.

However, this also varies across sector. An interaction with tertiary education enrollment results in a positive and significant coefficient for total FDI and sectors such as services and natural resources. In the manufacturing sector, however, tertiary education has little to no effect. FDI in the service sector may have a positive relationship with innovation activities because much of nature of the investment in this sector is high-tech. For example, FDI in the service sector in India include, among others, financial, banking, insurance, non-financial/business, outsourcing, research and development, courier, as well as technology testing and analysis (Mandal, 2016). Such subsectors are knowledge- and technology-intensive, thus it is possible that a knowledge spillover occurs in this sector. Meanwhile, the effect of FDI in the manufacturing sector towards innovation remains unchanged (Table 8). Such a result also persists when the dependent variable is changed. This may be because most FDI in the manufacturing sector in Asian countries are labor intensive, as opposed to the knowledge-intensive service sector. Further, to answer the third sub-question, the service sector promotes the most innovation in Asian countries. As previously mentioned, the nature of FDI in the service sector in Asia may be high-tech, thus enabling knowledge spillover to occur.

5.2 Limitations of research

As with other studies, this research is not without its limitations. The limitations of the present study are listed below:

1. Due to the unavailability of data in other Asian countries, the research Area is limited to 10 countries in the span of 10 years. The limited number of observations may affect the statistical analysis in Stata.
2. In the 10 countries included in the research, there are missing values for several countries. This may affect the calculation and analysis of the research.
3. There are many indicators which were selected to represent moderating variables. However, based on assumption tests conducted in Stata, many of these variables were eventually not included in the empirical analysis. The exclusion of some of these important variables may affect the analysis and results.
4. A lack of data in the provincial level in Indonesia has also limited the research. The research originally aimed to analyze the relationship between FDI and innovation in the provincial level in Indonesia. However, due to a lack of data, the research is conducted at a country level in Asia.
5. The FDI sectors in the research is not categorized based on technology and R&D intensity of the sector, thus the research is unable to see the difference in the impact of high-tech FDI compared to medium-high tech and low-tech FDI, for example.
6. The research only conducts analysis in the host country of FDI and does not include an analysis on the source country of FDI. This also applies to the characteristics of the FDI itself; not only the sector of investment but also the motivation of the investment (market-seeking, resource-seeking, efficiency-seeking, and asset-seeking) and the type of FDI (greenfield or brownfield). An analysis into the characteristics of the source FDI country and the characteristics of the investment itself may help understand the different effects of FDI.

7. The present research does not yet include the serial correlation test in Stata. Serial correlation is the relationship between a variable and itself over time (Drukker, 2003). This test may be important, and not utilizing the test may lead to inefficient estimates and biased standard errors (Born and Breitung, 2016).

5.3 Recommendations for future research

1. A comparative analysis between high-tech FDI and low-tech FDI can be done to see whether high-tech FDI increases innovation in host countries as compared to low-tech FDI.
2. An analysis at the provincial level can be conducted, as has been done in China, to see the discrepancy and disparity between regions of the same country.
3. A serial correlation test can be utilized for a more efficient and unbiased calculation.
4. This research only uses three moderating variables which are human capital, institutional environment and infrastructure. Further research can additionally include other moderating variables related to, for example, firm-level capacity (R&D and exposure to international market, size of firms and MNE presence).
5. The point of view in this research is from the receiving end of the investment, as it analyzes the absorptive capacity of the host country. Future research can analyze from the giving end, or the source country of investment. The characteristic and type of FDI can also be discussed.

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Annex 1

Description of indicators			
Variable	**Indicators**	**Unit of measurement**	**Source**
Dependent variable	Total patent and industrial design application	Number of applications filed	WIPO
	Patent application	Number of applications filed	WIPO
	Industrial design application	Number of applications filed	WIPO
Independent variable	Total FDI	million US$	FDI Markets
	FDI Service	million US$	FDI Markets
	FDI Natural resource	million US$	FDI Markets
	FDI manufacturing	million US$	FDI Markets
Human capital	Tertiary education enrollment	% of population	World Bank World Development Indicators
	Life expectancy	Age	World Bank WDI
	GNI per capita	US$	World Bank WDI
Infrastructure	Access to electricity	% of population	World Bank WDI
	Internet users	% of population	World Bank WDI
	Air transport, freight	million tons-km	World Bank WDI
Institutional quality	Regulatory quality	Score of -2.5 to 2.5	World Bank WDI
	Investment profile	Score of 0 to 12	ICRG
Control variables	GDP growth	Percentage	World Bank WDI
	Inflation	Percentage	World Bank WDI

Annex 2: Trend of total FDI, FDI service, FDI manufacturing and FDI natural resources in Asian countries (in million US$)

Country name	Year	Total FDI	FDI Service	FDI Manufacturing	FDI Natural resource
Bangladesh	2003	437	0	0	437
	2004	135	60	0	75
	2005	142.5	142.5	0	0
	2006	330.115	330.115	0	0
	2007	114.5	1	0	113.5
	2008	350	350	0	0
	2009	9.861	9.861	0	0
	2010	309.551	300	9.551	0
	2011	10.481	0	10.481	0
	2012	0	0	0	0
China	2003	2889.344	1799.183	1074.91	15.251
	2004	8452.243	4215.088	4206.792	18.642
	2005	8381.15	6789.635	1421.464	170.051
	2006	8892.004	6032.703	2385.943	473.358
	2007	7513.121	5314.318	1702.399	447.453
	2008	10397.791	6257.491	2711.264	1425.862
	2009	13601.894	4838.167	7595.466	1168.261
	2010	7528.787	4444.511	2810.498	264.487
	2011	14333.035	7803.723	6228.782	217.929
	2012	11825.309	8366.714	3151.993	296.879
India	2003	1077.304	295.759	726.165	55.38
	2004	1809.015	1239.055	434.139	77.735
	2005	2762.623	2412.72	319.987	29.916
	2006	5983.722	4239.241	1010.175	701.806
	2007	17774.592	16450.62	1206.639	99.639
	2008	11335.847	4808.52	6000.775	526.552
	2009	6483.189	4678.428	1687.454	100.544
	2010	8323.093	2430.367	5488.623	283.573
	2011	19219.843	6072.171	2179.204	9546.581
	2012	3598.347	2229.891	1224.546	143.91
Indonesia	2003	1948.819	711.769	4.786	1232.264
	2004	2180.936	1452.076	4.055	724.805
	2005	7286.624	2015.343	5133.928	127.303
	2006	554.717	264.816	18.601	271.3
	2007	3066.395	762.576	19.009	2284.81
	2008	6149.145	5918.042	137.599	93.504
	2009	3469.803	2228.494	995.622	245.687
	2010	3071.296	1627.409	689.898	753.989
	2011	7587.327	1873.862	680.551	5020.758
	2012	890.212	599.205	47.407	243.6
Malaysia	2003	90.069	60.106	25.513	4.45
	2004	1116.671	400.939	715.318	0.414

	2005	1458.846	1219.763	239.083	0
	2006	490.617	419.158	56.614	0
	2007	6752.922	4723.671	1919.922	109.329
	2008	2900.833	2226.109	438.361	53.591
	2009	508.635	264.193	244.442	0
	2010	2055.904	1509.786	440.232	101.575
	2011	5090.982	4324.158	566.824	200
	2012	3749.453	2558.305	575.317	615.831
Pakistan	2003	0	0	0	0
	2004	398.082	398.082	0	0
	2005	207.107	57.107	0	150
	2006	3049.369	3049.369	0	0
	2007	2538.847	1949.813	339.034	250
	2008	1236.303	1102.911	133.392	0
	2009	36.708	0	36.708	0
	2010	50.462	50.462	0	0
	2011	995.59	228.677	17.771	749.142
	2012	0.968	0	0	0.968
Philippines	2003	232.6	201.351	23.249	8
	2004	141.027	103.19	4.65	33.187
	2005	339.136	234.268	4.868	100
	2006	191.905	38.648	34.56	118.697
	2007	4641.141	596.619	605.272	3439.25
	2008	2899.857	991.717	26.788	1881.352
	2009	1353.811	28.75	1325.061	0
	2010	144.29	43.932	100.358	0
	2011	895.5	221.36	0	674.14
	2012	788.554	46.606	302.392	439.556
Sri Lanka	2003	75	0	0	75
	2004	83.326	83.326	0	0
	2005	5	0	5	0
	2006	3.15	3.15	0	0
	2007	5.229	5.229	0	0
	2008	384.135	303.744	80.391	0
	2009	248.468	238.055	10.413	0
	2010	11.633	5.456	6.177	0
	2011	46.751	46.751	0	0
	2012	363.538	180.939	182.599	0
Thailand	2003	1279.198	1268.926	10.272	0
	2004	959.93	826.061	124.669	9.2
	2005	409.534	343.718	23.317	42.499
	2006	4076.916	3885.914	191.002	0
	2007	2061.692	1747.026	314.666	0
	2008	301.106	280.68	20.426	0
	2009	505.836	457.435	28.364	20.037
	2010	778.834	569.224	31.302	178.308

	2011	2004.596	1684.622	303.442	16.532
	2012	396.551	144.803	66.148	185.6
Vietnam	2003	18.091	0	18.055	0.036
	2004	77.629	2.88	1.954	72.795
	2005	0	0	0	0
	2006	180.561	160.078	20.483	0
	2007	436.552	420.724	10.828	5
	2008	921.87	675.038	246.832	0
	2009	260.366	131.365	35.641	82
	2010	186.036	88.259	70.76	19.391
	2011	938.991	386.786	432.205	120
	2012	2083.059	640.02	58.039	1385

Annex 3: Human capital in Asian countries

Country name	Year	Tertiary education enrollment	Life expectancy	GNI
Bangladesh	2003	6.1778002	67.000146	450
	2004	5.6943002	67.497195	490
	2005	6.23527	67.971854	530
	2006	7.1219301	68.425634	560
	2007	7.67804	68.859976	590
	2008	8.6079302	69.277854	640
	2009	10.52058	69.68378	710
	2010		70.080293	780
	2011	13.28069	70.471951	870
	2012	13.38656	70.860268	940
China	2003	15.6358	73.033122	1280
	2004	17.91103	73.419951	1510
	2005	19.335859	73.766951	1760
	2006	20.49769	74.071707	2060
	2007	20.84453	74.340439	2510
	2008	20.93998	74.583268	3100
	2009	22.515961	74.803268	3690
	2010	23.94792	75.007415	4340
	2011	24.87281	75.202171	5060
	2012	27.184429	75.392927	5940
India	2003	10.67384	63.774537	510
	2004	10.98428	64.147805	600
	2005	10.73016	64.523878	700
	2006	11.54056	64.908098	790
	2007	13.18877	65.300439	920
	2008	15.1171	65.699439	1000
	2009	16.102989	66.102634	1110
	2010	17.911489	66.506146	1220

	2011	22.86137	66.904171	1380
	2012	24.36533	67.289878	1480
Indonesia	2003	16.02808	66.788805	900
	2004	16.61841	66.974878	1080
	2005	17.256809	67.168561	1220
	2006	17.312929	67.367488	1370
	2007	17.816771	67.567732	1600
	2008	20.700279	67.76478	1940
	2009	23.057329	67.957634	2140
	2010	24.199671	68.147195	2520
	2011	26.50421	68.33439	3000
	2012	30.65633	68.519561	3570
Malaysia	2003	30.527109	73.349293	4160
	2004	29.964359	73.48122	4740
	2005	27.91556	73.60061	5280
	2006	28.593731	73.711439	5850
	2007	30.27387	73.818268	6780
	2008	33.753521	73.926073	7550
	2009	35.756721	74.038415	7550
	2010	37.13459	74.15778	8240
	2011	35.397518	74.286756	9040
	2012	35.87376	74.423317	10150
Pakistan	2003	2.730149984	63.458341	560
	2004	3.41546011	63.667463	640
	2005	4.941559792	63.877634	730
	2006	4.993289948	64.09939	820
	2007	5.630730152	64.338732	910
	2008	5.606389999	64.598146	1010
	2009	6.929669857	64.876098	1060
	2010	7.797829866	65.162561	1080
	2011	8.665989876	65.447	1150
	2012	9.930230141	65.716878	1260
Philippines	2003	29.0592	67.038927	1260
	2004	28.34799	67.154195	1400
	2005	27.511271	67.266488	1520
	2006	27.84532	67.374756	1650
	2007		67.479024	1890
	2008	29.352341	67.58078	2230
	2009	28.70719	67.681049	2470
	2010	29.754009	67.783317	2730
	2011	30.920839	67.890659	2620
	2012	31.29874	68.007073	2980
Sri Lanka	2003		73.222317	950
	2004		73.680293	1070
	2005		73.973561	1220
	2006		74.124537	1370

	2007		74.194122	1570
	2008		74.238732	1810
	2009		74.280293	2020
	2010	16.34794	74.339244	2430
	2011	15.24237	74.424561	2860
	2012	17.162439	74.531244	3360
Thailand	2003	40.810692	71.433927	2180
	2004	41.857571	71.786463	2530
	2005	44.216648	72.157268	2790
	2006	44.244598	72.525732	3100
	2007	48.233292	72.874439	3530
	2008	47.881458	73.188439	3980
	2009	48.819408	73.461732	4140
	2010	50.202621	73.694366	4580
	2011	52.747051	73.89239	4950
	2012	51.56916	74.071902	5520
Vietnam	2003	10.1185	73.772537	510
	2004		73.959024	590
	2005	16.05287	74.138122	680
	2006	16.67087	74.312366	760
	2007	18.36364	74.483854	850
	2008	18.945749	74.653098	1000
	2009	20.109921	74.82261	1120
	2010	22.687679	74.990366	1270
	2011	24.80246	75.156805	1390
	2012	25.02092	75.31939	1550

Annex 4: Infrastructure in Asian countries

Country	Year	Access to electricity	Internet users	Air freight
Bangladesh	2003	38.40781	0.001638777	175.496
	2004	40.6	0.001990363	180.432
	2005	44.23	0.002416373	183.493
	2006	45.354099	0.01	190.831
	2007	46.5	0.018	89.026
	2008	50.032177	0.025	84.219
	2009	52.385216	0.031	0.013
	2010	55.26	0.037	164.42464
	2011	59.6	0.045	159.69278
	2012	59.479324	0.05	152.31904
China	2003	96.191467	0.062	5650.63
	2004	96.652313	0.073	7024.25
	2005	97.117607	0.08523257	7579.401
	2006	97.591255	0.10523153	7692.205
	2007	98.083878	0.16	11189.538

	2008	98.576591	0.226	11386.055
	2009	99.061661	0.289	11976.438
	2010	99.7	0.343	17193.877
	2011	99.794266	0.383	16764.869
	2012	99.946846	0.42300117	15568.753
India	2003	63.686302	0.0168649	579.85
	2004	64.4	0.019761365	708.475
	2005	66.431946	0.02388075	774.04
	2006	67.9	0.028054999	842.55
	2007	69.210045	0.0395	967.684
	2008	70.61525	0.0438	1233.937
	2009	75	0.0512	1235.158
	2010	76.3	0.075	1630.9641
	2011	67.6	0.1007	1702.7027
	2012	79.9	0.12580061	1579.2299
Indonesia	2003	87.94	0.023870198	424.362
	2004	89.01	0.026002859	434.101
	2005	87.127419	0.036020248	439.773
	2006	90.62	0.047648131	469.222
	2007	91.1	0.057862747	484.52
	2008	92.73	0.079174794	394.583
	2009	93.55	0.0692	276.918
	2010	94.15	0.1092	665.66363
	2011	94.83	0.1228	754.29794
	2012	96	0.1452	880.34026
Malaysia	2003	97.432899	0.34971152	2178.51
	2004	97.677597	0.42252266	2599.165
	2005	97.926743	0.4862917	2577.581
	2006	98.192108	0.51637989	2597.404
	2007	98.460724	0.557	2661.528
	2008	98.738907	0.558	2444.462
	2009	99.3	0.559	2853.263
	2010	99.315887	0.563	2564.6582
	2011	99.589005	0.61	2193.26
	2012	99.8	0.658	1943.9589
Pakistan	2003	79.90326691	0.050411581	346.607
	2004	81.4691925	0.06164321	402.035
	2005	83.85	0.063323291	407.926
	2006	84.61829376	0.065	426.991
	2007	89.2	0.068	313.872
	2008	87.80886078	0.07	319.796
	2009	90.73	0.075	303.905
	2010	91.03442383	0.08	332.9572972
	2011	91.37	0.09	297.6835198
	2012	94.28098297	0.0996	286.0756858
Philippines	2003	76.6	0.048576723	278.368

	2004	77.915657	0.052436285	300.637
	2005	79.000481	0.053976363	322.706
	2006	80.093651	0.057405863	318.85
	2007	81.198135	0.0597	285.577
	2008	83.3	0.0622	277.362
	2009	83.436836	0.09	227.454
	2010	84.567566	0.25	460.19405
	2011	85.703545	0.29	470.00341
	2012	86.843025	0.362351	533.28361
Sri Lanka	2003	74.192848	0.014585802	238.009
	2004	75.792122	0.0144616	312.627
	2005	77.395844	0.017920468	310.362
	2006	79.007919	0.025375661	325.413
	2007	80	0.0388	343.641
	2008	82.265182	0.058	331.457
	2009	83.907806	0.0878	278.998
	2010	85.3	0.12	339.04892
	2011	87.76	0.15	364.50263
	2012	88.870697	0.182854	405.42043
Thailand	2003	87.426018	0.092990272	1764.122
	2004	89.077072	0.10677303	1868.578
	2005	90.732574	0.15026004	2002.424
	2006	92.396431	0.17160715	2106.87
	2007	94.071594	0.2003	2454.554
	2008	95.757256	0.182	2288.961
	2009	97.45166	0.201	2132.553
	2010	99.7	0.224	2938.6704
	2011	99.496307	0.23669926	2870.7889
	2012	99.880783	0.2646	2758.4388
Vietnam	2003	89.538475	0.037802808	164.459
	2004	90.682709	0.076424085	216.527
	2005	96.1	0.12739929	230.186
	2006	96	0.17254562	216.012
	2007	94.156769	0.20755445	258.488
	2008	95.335617	0.2392	295.759
	2009	96.1	0.2655	311.502
	2010	97.717796	0.3065	426.91573
	2011	99	0.3507	475.38566
	2012	100	0.3949	503.55032

Annex 4: Institutional quality in Asian countries

Country	Year	Regulatory quality	Investment profile
Bangladesh	2003	-0.92	5.75
	2004	-1.1	6.5
	2005	-1.03	6.958333333
	2006	-0.96	7.125
	2007	-0.91	6.75
	2008	-0.89	7
	2009	-0.85	7
	2010	-0.83	7
	2011	-0.8	6.708333333
	2012	-0.96	6
China	2003	-0.34	7.5
	2004	-0.28	7.416666667
	2005	-0.13	7.208333333
	2006	-0.18	7.291666667
	2007	-0.15	7.083333333
	2008	-0.13	7
	2009	-0.2	7
	2010	-0.22	6.5
	2011	-0.21	6.583333333
	2012	-0.26	7
India	2003	-0.36	8.166666667
	2004	-0.4	9.166666667
	2005	-0.24	9.333333333
	2006	-0.23	8.916666667
	2007	-0.27	8.5
	2008	-0.36	8.5
	2009	-0.3	8.5
	2010	-0.37	8.5
	2011	-0.33	8.5
	2012	-0.47	7.75
Indonesia	2003	-0.78	5.5
	2004	-0.67	6.208333333
	2005	-0.54	6.75
	2006	-0.34	9.125
	2007	-0.32	9
	2008	-0.32	9
	2009	-0.33	9
	2010	-0.39	8.875
	2011	-0.33	7.541666667
	2012	-0.28	7.4
Malaysia	2003	0.6	8.583333333
	2004	0.49	9
	2005	0.61	9

	2006	0.55	9
	2007	0.54	9.333333333
	2008	0.36	9.5
	2009	0.31	9.5
	2010	0.59	9.291666667
	2011	0.59	9.5
	2012	0.55	9.5
Pakistan	2003	-0.73	4.25
	2004	-0.88	4
	2005	-0.61	5
	2006	-0.45	7.583333333
	2007	-0.5	8
	2008	-0.57	7.5
	2009	-0.55	7.5
	2010	-0.58	7.5
	2011	-0.63	7.166666667
	2012	-0.73	6.75
Philippines	2003	-0.03	9.75
	2004	-0.26	9.166666667
	2005	-0.12	9.25
	2006	-0.15	8.958333333
	2007	-0.1	9
	2008	-0.07	9
	2009	-0.09	9
	2010	-0.22	9
	2011	-0.21	9.083333333
	2012	-0.06	9.05
Sri Lanka	2003	0.1	8.333333333
	2004	-0.04	7.833333333
	2005	-0.35	7.416666667
	2006	-0.25	7.5
	2007	-0.26	7.5
	2008	-0.35	7.5
	2009	-0.26	7.916666667
	2010	-0.2	8.5
	2011	-0.11	8.333333333
	2012	-0.12	7.4
Thailand	2003	0.37	8.625
	2004	0.25	9.25
	2005	0.46	8.5
	2006	0.25	8.5
	2007	0.15	7.083333333
	2008	0.24	7.458333333
	2009	0.24	7.5
	2010	0.19	7.5
	2011	0.21	8

	2012	0.23	8.5
Vietnam	2003	-0.56	7.333333333
	2004	-0.54	7.75
	2005	-0.57	8.5
	2006	-0.59	8.916666667
	2007	-0.53	9
	2008	-0.61	8.416666667
	2009	-0.62	8
	2010	-0.61	8
	2011	-0.59	7.166666667
	2012	-0.68	7

Annex 5: Panel regression and panel regression with interaction terms of Total FDI towards Industrial design application

Model	1	2	3	4	5	6	7	8	9
VARIABLES	Industrial design	Industrial design	Industrial design	Industrial design	Industrial design	Industrial design	Industrial design	Industrial design	Industrial design
Total FDI	0.000582	-0.0512	-0.276	-0.477	0.0677	0.125	-0.224	0.0112	-0.252
	(0.05)	(0.08)	(0.80)	(0.36)	(0.07)	(0.10)	(0.20)	(0.05)	(0.30)
Tertiary education enrollment	5.103*	3.607	4.924	6.043**	4.457	5.541*	5.818*	5.360*	5.467*
	(2.90)	(3.55)	(2.97)	(2.97)	(2.90)	(2.90)	(2.96)	(2.97)	(2.94)
Life expectancy	-0.214	-0.232	-0.225	-0.271	-0.132	-0.264	-0.313	-0.217	-0.200
	(0.21)	(0.21)	(0.21)	(0.21)	(0.21)	(0.21)	(0.22)	(0.21)	(0.21)
GNI	0.662*	0.634	0.639	0.0878	0.525	0.484	0.543	0.612	0.580
	(0.39)	(0.39)	(0.39)	(0.58)	(0.39)	(0.40)	(0.40)	(0.40)	(0.40)
Access to electricity	-0.428	-0.357	-0.379	-0.137	-3.916	0.0660	0.335	-0.523	-0.758
	(1.75)	(1.76)	(1.77)	(1.75)	(2.92)	(1.77)	(1.86)	(1.77)	(1.80)
Internet users	0.0666	0.0768	0.0610	0.106	0.105	-0.214	0.0643	0.0814	0.0907
	(0.15)	(0.15)	(0.15)	(0.15)	(0.15)	(0.25)	(0.15)	(0.15)	(0.15)
Air freight	-0.00394	0.00411	-0.00316	0.0146	0.0441	0.0102	-0.0810	0.00416	0.00451
	(0.04)	(0.05)	(0.04)	(0.05)	(0.05)	(0.05)	(0.08)	(0.05)	(0.05)
Regulatory quality	0.577	0.625	0.626	0.594	0.761	0.702	0.634	0.313	0.510
	(0.56)	(0.57)	(0.58)	(0.56)	(0.57)	(0.57)	(0.56)	(0.80)	(0.57)
Investment profile	-0.0109	-0.0106	-0.0113	-0.00660	-0.0152	-0.0154	0.00695	-0.0143	-0.217
	(0.07)	(0.07)	(0.07)	(0.07)	(0.07)	(0.07)	(0.07)	(0.07)	(0.25)
GDP growth	0.00900	0.00835	0.00935	0.00638	0.00333	0.00612	-0.000530	0.00664	0.00626

	(0.03)	(0.03)	(0.03)	(0.03)	(0.03)	(0.03)	(0.03)	(0.03)	(0.03)
Inflation	-0.00938	-0.00812	-0.00995	-0.00641	-0.0127	-0.00944	-0.0104	-0.00864	-0.00878
	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)
Total FDI * Tertiary education enrollment		0.246							
		(0.33)							
Total FDI * Life expectancy			0.00397						
			(0.01)						
Total FDI * GNI				0.0647					
				(0.05)					
Total FDI * Access to electricity					0.390				
					(0.26)				
Total FDI * Internet users						0.0515			
						(0.04)			
Total FDI * Air freight							0.0364		
							(0.03)		
Total FDI * Regulatory quality								0.0443	
								(0.09)	
Total FDI * Investment profile									0.0315
									(0.04)
Constant	17.04	18.84	18.07	25.07*	11.75	21.21	25.16	17.55	18.24
	(13.70)	(13.97)	(14.12)	(14.88)	(14.02)	(13.93)	(15.31)	(13.84)	(13.81)
Observations	80	80	80	80	80	80	80	80	80
R-squared	0.449	0.454	0.450	0.466	0.469	0.467	0.462	0.451	0.456
Number of countryid	10	10	10	10	10	10	10	10	10
Standard errors in parentheses									
***** p<0.01, ** p<0.05, * p<0.1**									

Annex 6: Panel regression and panel regression with interaction terms of FDI Service towards industrial design application

Model	1	2	3	4	5	6	7	8	9
VARIABLES	Industrial design	Industrial design	Industrial design	Industrial design	Industrial design	Industrial design	Industrial design	Industrial design	Industrial design
FDI Service	0.0390	0.0101	0.314	-0.252	0.0524	0.0629	-0.144	0.0670	-0.0420
	(0.03)	(0.04)	(0.46)	(0.21)	(0.04)	(0.07)	(0.15)	(0.04)	(0.11)
Tertiary education enrollment	4.790*	3.284	5.093*	5.248*	4.530	4.727	5.544*	4.933*	4.717
	(2.85)	(3.27)	(2.91)	(2.85)	(2.93)	(2.88)	(2.91)	(2.87)	(2.86)
Life expectancy	-0.167	-0.180	-0.166	-0.203	-0.148	-0.169	-0.243	-0.163	-0.156
	(0.20)	(0.20)	(0.20)	(0.20)	(0.21)	(0.20)	(0.21)	(0.20)	(0.20)
GNI	0.537	0.521	0.559	0.126	0.508	0.490	0.408	0.479	0.515
	(0.36)	(0.36)	(0.36)	(0.46)	(0.36)	(0.38)	(0.37)	(0.36)	(0.36)
Access to electricity	0.112	0.487	-0.115	0.708	-0.101	0.356	0.753	0.135	0.203
	(1.62)	(1.67)	(1.67)	(1.66)	(1.69)	(1.75)	(1.69)	(1.62)	(1.63)
Internet users	0.0435	0.0417	0.0665	0.0728	0.0453	0.00769	0.0501	0.0521	0.0388
	(0.14)	(0.14)	(0.15)	(0.14)	(0.14)	(0.17)	(0.14)	(0.14)	(0.14)
Air freight	0.00418	0.00714	0.00326	0.0110	0.00516	0.00502	-0.0938	0.00542	0.00277
	(0.04)	(0.04)	(0.04)	(0.04)	(0.04)	(0.04)	(0.09)	(0.04)	(0.04)
Regulatory quality	0.765	0.754	0.742	0.707	0.747	0.741	0.734	0.421	0.707
	(0.57)	(0.57)	(0.57)	(0.57)	(0.58)	(0.58)	(0.57)	(0.70)	(0.58)
Investment profile	-0.0336	-0.0239	-0.0417	-0.0205	-0.0305	-0.0292	-0.0135	-0.0303	-0.101
	(0.07)	(0.07)	(0.07)	(0.07)	(0.07)	(0.07)	(0.07)	(0.07)	(0.11)
GDP growth	0.0101	0.0114	0.00793	0.00995	0.0110	0.0110	0.00437	0.00876	0.0105
	(0.02)	(0.03)	(0.03)	(0.02)	(0.03)	(0.03)	(0.03)	(0.03)	(0.03)
Inflation	-0.0155	-0.0159	-0.0150	-0.0163	-0.0174	-0.0167	-0.0184	-0.0167	-0.0164
	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)
FDI Service * Tertiary education enrollment		0.212							
		(0.22)							
FDI Service * Life expectancy			-0.00397						
			(0.01)						
FDI Service * GNI				0.0430					
				(0.03)					
FDI Service * Access to electricity					0.0402				
					(0.09)				

FDI Service * Internet users						0.00756			
						(0.02)			
FDI Service * Air freight							0.0324		
							(0.03)		
FDI Service * Regulatory quality								0.0493	
								(0.06)	
FDI Service * Investment profile									0.0116
									(0.01)
Constant	14.77	15.96	14.59	20.02	13.62	15.18	21.27	14.71	14.65
	(13.36)	(13.43)	(13.43)	(13.80)	(13.67)	(13.50)	(14.31)	(13.39)	(13.40)
Observations	82	82	82	82	82	82	82	82	82
R-squared	0.471	0.479	0.474	0.487	0.473	0.472	0.484	0.477	0.477
Number of countryid	10	10	10	10	10	10	10	10	10
Standard errors in parentheses									
***** p<0.01, ** p<0.05, * p<0.1**									

Annex 7: Panel regression and panel regression with interaction terms of FDI natural resources towards patent application

Model	**(1)**	**(2)**	**(3)**	**(4)**	**(5)**	**(6)**	**(7)**	**(8)**	**(9)**
VARIABLES	Patent	Patent	Patent	Patent	Patent	Patent	Patent	Patent	Patent
FDI Natural resources	-0.00856	-0.00816	-0.0119	-0.0114	-0.00961	-0.0127	-0.00989	-0.0118	-0.0122
	(0.02)	(0.02)	(0.02)	(0.02)	(0.02)	(0.02)	(0.02)	(0.02)	(0.02)
Tertiary education enrollment	0.777	0.898	0.911	0.930	0.849	0.878	1.030	0.507	1.012
	(2.22)	(2.34)	(2.23)	(2.24)	(2.24)	(2.22)	(2.29)	(2.22)	(2.24)
Life expectancy	-0.0516	-0.0530	-0.0360	-0.0384	-0.0498	-0.0213	-0.0562	-0.0252	-0.0361
	(0.15)	(0.15)	(0.15)	(0.15)	(0.15)	(0.15)	(0.15)	(0.15)	(0.15)
GNI	0.430	0.451	0.343	0.333	0.407	0.347	0.385	0.416	0.326
	(0.26)	(0.29)	(0.28)	(0.29)	(0.27)	(0.27)	(0.28)	(0.26)	(0.29)
Access to electricity	-1.513	-1.572	-1.332	-1.355	-1.076	-1.404	-1.355	-1.368	-1.296
	(1.29)	(1.34)	(1.31)	(1.31)	(1.58)	(1.29)	(1.34)	(1.29)	(1.32)
Internet users	0.121	0.122	0.117	0.119	0.121	0.183*	0.117	0.114	0.115
	(0.10)	(0.10)	(0.10)	(0.10)	(0.10)	(0.11)	(0.10)	(0.10)	(0.10)
Air freight	0.0112	0.0109	0.0119	0.0118	0.0111	0.0123*	0.00722	0.0105	0.0125*
	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)
Regulatory quality	0.465	0.458	0.501	0.492	0.469	0.492	0.477	0.757*	0.489
	(0.39)	(0.40)	(0.39)	(0.39)	(0.39)	(0.39)	(0.39)	(0.45)	(0.39)
Investment profile	-0.0177	-0.0183	-0.0202	-0.0197	-0.0211	-0.0224	-0.0194	-0.0252	-0.0367

	(0.05)	(0.05)	(0.05)	(0.05)	(0.05)	(0.05)	(0.05)	(0.05)	(0.05)
GDP growth	-0.0118	-0.0118	-0.0112	-0.0114	-0.0112	-0.0111	-0.0116	-0.00912	-0.0115
	(0.02)	(0.02)	(0.02)	(0.02)	(0.02)	(0.02)	(0.02)	(0.02)	(0.02)
Inflation	0.0113	0.0117	0.00857	0.00915	0.0105	0.00771	0.0103	0.00869	0.00853
	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)
FDI Nat * Tertiary education enrollment		-0.0218							
		(0.12)							
FDI Nat * Life expectancy			0.000282						
			(0.00)						
FDI Nat * GNI				0.00240					
				(0.00)					
FDI Nat * Access to electricity					-0.0390				
					(0.08)				
FDI Nat * Internet users						-0.00985			
						(0.01)			
FDI Nat * Air freight							0.000448		
							(0.00)		
FDI Nat * Regulatory quality								-0.0384	
								(0.03)	
FDI Nat * Investment profile									0.00283
									(0.00)
Constant	8.622	8.573	8.067	8.305	8.722	7.137	9.281	7.062	8.262
	(10.30)	(10.39)	(10.34)	(10.35)	(10.37)	(10.34)	(10.45)	(10.33)	(10.33)
Observations	84	84	84	84	84	84	84	84	84
R-squared	0.493	0.493	0.499	0.497	0.495	0.505	0.495	0.506	0.500
Number of countryid	10	10	10	10	10	10	10	10	10
Standard errors in parentheses									
***** p<0.01, ** p<0.05, * p<0.1**									

Annex 8: Panel regression and panel regression with interaction terms of FDI natural resources towards industrial design application

Model	**(1)**	**(2)**	**(3)**	**(4)**	**(5)**	**(6)**	**(7)**	**(8)**	**(9)**
VARIABLES	Industrial design	Industrial design	Industrial design	Industrial design	Industrial design	Industrial design	Industrial design	Industrial design	Industrial design
FDI Natural resources	-0.0220	-0.0222	0.474	-0.0371	-0.0231	-0.0235	0.00667	-0.0278	0.0702

	(0.02)	(0.04)	(0.37)	(0.16)	(0.03)	(0.04)	(0.11)	(0.02)	(0.10)
Tertiary education enrollment	5.579*	5.575*	6.098**	5.577*	5.587*	5.584*	5.495*	5.598*	5.500*
	(2.89)	(2.97)	(2.89)	(2.91)	(2.91)	(2.91)	(2.93)	(2.90)	(2.89)
Life expectancy	-0.188	-0.188	-0.136	-0.191	-0.189	-0.188	-0.169	-0.178	-0.181
	(0.24)	(0.24)	(0.24)	(0.24)	(0.24)	(0.24)	(0.25)	(0.24)	(0.24)
GNI	0.708*	0.708*	0.758*	0.697*	0.710*	0.711*	0.725*	0.724*	0.713*
	(0.39)	(0.39)	(0.39)	(0.41)	(0.39)	(0.39)	(0.39)	(0.39)	(0.39)
Access to electricity	-0.503	-0.503	-1.109	-0.495	-0.452	-0.497	-0.599	-0.426	-0.442
	(2.12)	(2.14)	(2.15)	(2.14)	(2.26)	(2.14)	(2.17)	(2.14)	(2.12)
Internet users	0.0303	0.0305	0.0391	0.0318	0.0301	0.0323	0.0267	0.0177	0.0346
	(0.15)	(0.15)	(0.15)	(0.15)	(0.15)	(0.16)	(0.15)	(0.15)	(0.15)
Air freight	0.00307	0.00309	-0.000819	0.00358	0.00262	0.00295	0.00221	-8.24e-05	0.00111
	(0.04)	(0.04)	(0.04)	(0.04)	(0.04)	(0.04)	(0.04)	(0.04)	(0.04)
Regulatory quality	0.567	0.567	0.466	0.570	0.561	0.564	0.563	0.611	0.553
	(0.55)	(0.56)	(0.55)	(0.55)	(0.56)	(0.56)	(0.55)	(0.56)	(0.55)
Investment profile	-0.00517	-0.00522	-0.00179	-0.00621	-0.00461	-0.00468	-0.00558	0.00210	0.0411
	(0.07)	(0.07)	(0.07)	(0.07)	(0.07)	(0.07)	(0.07)	(0.07)	(0.08)
GDP growth	0.0142	0.0142	0.0162	0.0137	0.0145	0.0143	0.0159	0.0168	0.0163
	(0.03)	(0.03)	(0.02)	(0.03)	(0.03)	(0.03)	(0.03)	(0.03)	(0.03)
Inflation	-0.00974	-0.00973	-0.00989	-0.00949	-0.00985	-0.00985	-0.0101	-0.0103	-0.0103
	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)
FDI Nat * Tertiary education enrollment		0.000863							
		(0.14)							
FDI Nat * Life expectancy			-0.00713						
			(0.01)						
FDI Nat * GNI				0.00205					
				(0.02)					
FDI Nat * Access to electricity					-0.00561				
					(0.08)				
FDI Nat * Internet users						-0.000602			
						(0.01)			
FDI Nat * Air freight							-0.00457		

							(0.02)		
FDI Nat * Regulatory quality								-0.0204	
								(0.04)	
FDI Nat * Investment profile									-0.0118
									(0.01)
Constant	14.66	14.68	10.38	14.95	14.72	14.66	13.21	13.80	13.84
	(15.63)	(15.98)	(15.85)	(16.07)	(15.78)	(15.76)	(16.73)	(15.81)	(15.66)
Observations	82	82	82	82	82	82	82	82	82
R-squared	0.460	0.460	0.475	0.460	0.460	0.460	0.460	0.462	0.468
Number of countryid	10	10	10	10	10	10	10	10	10
Standard errors in parentheses									
***** p<0.01, ** p<0.05, * p<0.1**									

Annex 9: Panel regression and panel regression with interaction terms of FDI manufacturing towards patent application

Model	**(1)**	**(2)**	**(3)**	**(4)**	**(5)**	**(6)**	**(7)**	**(8)**	**(9)**
VARIABLES	Patent	Patent	Patent	Patent	Patent	Patent	Patent	Patent	Patent
FDI Manu	-0.00952	0.00385	0.0214	-0.00913	0.000589	0.0428	-0.140	-0.0276	0.0892
	(0.02)	(0.04)	(0.35)	(0.18)	(0.03)	(0.05)	(0.11)	(0.03)	(0.10)
Tertiary education enrollment	-0.585	-0.225	-0.562	-0.586	-0.699	-0.500	-0.155	-0.998	-0.602
	(2.10)	(2.26)	(2.13)	(2.13)	(2.12)	(2.09)	(2.12)	(2.13)	(2.10)
Life expectancy	0.0234	0.0319	0.0248	0.0235	0.0278	-0.000155	-0.0477	0.0377	0.00952
	(0.15)	(0.15)	(0.15)	(0.15)	(0.15)	(0.15)	(0.16)	(0.15)	(0.15)
GNI per capita	0.593**	0.602**	0.597**	0.594*	0.542*	0.427	0.529**	0.657**	0.614**
	(0.26)	(0.26)	(0.26)	(0.32)	(0.28)	(0.29)	(0.26)	(0.26)	(0.26)
Access to electricity	-2.204*	-2.369*	-2.232*	-2.205*	-2.198*	-1.447	-1.426	-2.437**	-2.247*
	(1.16)	(1.23)	(1.21)	(1.27)	(1.17)	(1.31)	(1.32)	(1.18)	(1.16)
Internet users	0.138	0.139	0.138	0.138	0.145	0.0901	0.116	0.132	0.144
	(0.10)	(0.10)	(0.10)	(0.10)	(0.10)	(0.11)	(0.10)	(0.10)	(0.10)
Air freight	0.0144	0.0138	0.0144	0.0144	0.0163	0.0119	0.0127	0.0117	0.0128
	(0.03)	(0.03)	(0.03)	(0.03)	(0.03)	(0.03)	(0.03)	(0.03)	(0.03)
Regulatory quality	0.453	0.431	0.450	0.453	0.509	0.564	0.583	0.563	0.413

	(0.40)	(0.41)	(0.41)	(0.41)	(0.42)	(0.41)	(0.41)	(0.41)	(0.40)
Investment profile	-0.0387	-0.0415	-0.0401	-0.0387	-0.0398	-0.0310	-0.0339	-0.0405	-0.00239
	(0.05)	(0.05)	(0.05)	(0.05)	(0.05)	(0.05)	(0.05)	(0.05)	(0.06)
GDP growth	-0.00942	-0.00813	-0.00926	-0.00941	-0.0102	-0.0126	-0.0147	-0.00635	-0.00616
	(0.02)	(0.02)	(0.02)	(0.02)	(0.02)	(0.02)	(0.02)	(0.02)	(0.02)
inflation	0.0147	0.0144	0.0149	0.0147	0.0143	0.0142	0.0136	0.0126	0.0124
	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)
FDI Manu * Tertiary education enrollment		-0.0686							
		(0.15)							
FDI Manu * Life expectancy			-0.000450						
			(0.01)						
FDI Manu * GNI per capita				-5.35e-05					
				(0.02)					
FDI Manu * Access to electricity					0.0702				
					(0.14)				
FDI Manu * Internet users						0.0218			
						(0.02)			
FDI Manu * Air freight							0.0215		
							(0.02)		
FDI Manu * Regulatory quality								-0.0542	
								(0.05)	
FDI Manu * Investment profile									-0.0124
									(0.01)
Constant	2.742	2.006	2.626	2.735	2.876	5.610	8.142	1.412	3.301
	(9.73)	(9.93)	(9.89)	(10.32)	(9.79)	(9.96)	(10.67)	(9.79)	(9.74)
Observations	83	83	83	83	83	83	83	83	83
R-squared	0.473	0.475	0.473	0.473	0.475	0.486	0.486	0.483	0.482
Number of countryid	10	10	10	10	10	10	10	10	10
Standard errors in parentheses									

*** p<0.01, ** p<0.05, * p<0.1									

Annex 10: Panel regression and panel regression with interaction terms of FDI manufacturing towards industrial design application

Model	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
VARIABLES	Industrial design	Industrial design	Industrial design	Industrial design	Industrial design	Industrial design	Industrial design	Industrial design	Industrial design
FDI Manu	-0.0185	-0.0143	-0.0891	-0.321	-0.0107	0.0511	-0.150	-0.00942	-0.191
	(0.03)	(0.05)	(0.49)	(0.25)	(0.04)	(0.06)	(0.15)	(0.04)	(0.14)
Tertiary education enrollment	4.924**	5.024	4.886**	5.505**	4.869**	5.113**	5.354**	5.130**	5.148**
	(2.82)	(3.03)	(2.86)	(2.85)	(2.85)	(2.82)	(2.87)	(2.90)	(2.82)
Life expectancy	-0.227	-0.224	-0.231	-0.279	-0.225	-0.262	-0.297	-0.234	-0.213
	(0.20)	(0.20)	(0.20)	(0.20)	(0.20)	(0.20)	(0.22)	(0.20)	(0.20)
GNI per capita	0.747**	0.750**	0.739**	0.448	0.707**	0.533	0.672**	0.714**	0.707**
	(0.36)	(0.37)	(0.37)	(0.44)	(0.39)	(0.40)	(0.37)	(0.37)	(0.36)
Access to electricity	0.113	0.0623	0.174	0.951	0.127	1.125	0.899	0.228	0.232
	(1.63)	(1.73)	(1.70)	(1.77)	(1.65)	(1.84)	(1.87)	(1.67)	(1.63)
Internet users	0.0346	0.0347	0.0332	0.0370	0.0405	-0.0299	0.0135	0.0380	0.0252
	(0.14)	(0.14)	(0.14)	(0.14)	(0.14)	(0.15)	(0.14)	(0.14)	(0.14)
Air freight	0.000977	0.000741	0.00104	0.00515	0.00245	-0.00228	-0.000806	0.00238	0.00420
	(0.04)	(0.04)	(0.04)	(0.04)	(0.04)	(0.04)	(0.04)	(0.04)	(0.04)
Regulatory quality	0.560	0.552	0.571	0.652	0.608	0.740	0.680	0.505	0.645
	(0.55)	(0.56)	(0.56)	(0.55)	(0.58)	(0.57)	(0.56)	(0.57)	(0.55)
Investment profile	-0.000556	-0.00127	0.00242	0.00973	-0.00166	0.00723	0.00504	0.000385	-0.0647
	(0.07)	(0.07)	(0.07)	(0.07)	(0.07)	(0.07)	(0.07)	(0.07)	(0.08)
GDP growth	0.00949	0.00984	0.00926	0.00524	0.00894	0.00590	0.00465	0.00791	0.00375
	(0.02)	(0.03)	(0.03)	(0.03)	(0.03)	(0.03)	(0.03)	(0.03)	(0.03)
inflation	-0.00660	-0.00661	-0.00724	-0.00401	-0.00697	-0.00790	-0.00753	-0.00560	-0.00315
	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)
FDI Manu * Tertiary education enrollment		-0.0211							
		(0.22)							
FDI Manu * Life expectancy			0.00103						

			(0.01)						
FDI Manu * GNI per capita				0.0412					
				(0.03)					
FDI Manu * Access to electricity					0.0551				
					(0.20)				
FDI Manu * Internet users						0.0294			
						(0.02)			
FDI Manu * Air freight							0.0218		
							(0.03)		
FDI Manu * Regulatory quality								0.0271	
								(0.07)	
FDI Manu * Investment profile									0.0217
									(0.02)
Constant	17.39	17.13	17.68	23.14	17.60	21.40	22.77	18.06	17.13
	(13.34)	(13.72)	(13.60)	(14.12)	(13.46)	(13.72)	(14.74)	(13.55)	(13.28)
Observations	83	83	83	83	83	83	83	83	83
R-squared	0.458	0.459	0.459	0.471	0.459	0.471	0.465	0.460	0.473
Number of countryid	10	10	10	10	10	10	10	10	10
Standard errors in parentheses									
***** p<0.01, ** p<0.05, * p<0.1**									

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