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中文论文题目：外国直接投资对中国创新的溢出效应：基于省级面板数据的实证研

英文论文题目：**Spillover effects of FDI on innovation in China: Evidence from the provincial panel data**

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外国直接投资对中国创新的溢出效应：基于省级面板数据的实证研

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Spillover effects of FDI on innovation in China: Evidence from the provincial panel data

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Name: David O’Connell

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摘要

此论文衡量外国直接投资对创新的溢出效应。研究将创新分为创新绩效和创新环境。创新绩效代表创新产出，通过授予专利和研发支出来衡量；创新环境是区域创新能力，通过教育、学术和人力资本来衡量。这些溢出效应可以通过逆向工程、示范效应或供需关系来实现。从以前的研究来看，关于外资企业对创新的影响是积极的还是消极的，存在着相互矛盾的结果。 结果往往取决于各种政治、经济和技术因素。

中国对外开放以来的成果惊人。改革开放的实施通过设立经济特区，使中国各地吸引外国投资产生了很大的多样性。考虑到这些地区的多样性和中国最近的五年计划的创新重点，本研究对外国直接投资如何影响创新绩效和创新环境进行了区域比较。目前还没有研究考虑到外国直接投资影响创新环境所需要的时间，因此作者对滞后时间进行了分析。纳入滞后时间将确定可能加速或减缓外国直接投资对创新环境的时间效应的因素。

该研究使用了中国 30 个省级地区过去 8 年的面板数据。运用 EViews 软件包，采用池效应模型、固定效应模型和随机效应模型来测度自变量（外国直接投资）对因变量（创新绩效和创新环境）的溢出效应，从而确定了代表外国直接投资溢出效应的相关系数。这个相关系数图表示外国直接投资对创新绩效和创新环境的影响。利用矢量误差修正模型可以确定最优滞后时间。该模型对每次滞后返回赤池信息准则，返回值最低的就是最准确的选择。

本研究发现，总体来说，中国的外国直接投资流入与创新绩效之间存在正向溢出效应，外国直接投资每增加 1%，一个地区的创新绩效就会增加 1.45%。同样，外国直接投资与创新环境的关系之间也存在正向溢出效应，系数为 1.5%。然而，该研究也发现，在某些情况下，外国直接投资会对一个地区的创新绩效产生负面影响。此研究还发现，教育资金投入较少的地区存在负溢出效应，外国直接投资总量每增加 1%，创新绩效下降 0.27%。中低创新环境状况的地区也会受到负面影响。与西部地区相比，东部地区的溢出效应几乎翻了一番。外国直接投资与创新环境总体上存在 6 年的滞后时间。之前外国直接投资水平较低

的地区要比外国直接投资水平较高的地区滞后时间短，显示出趋平效应。高技术地区的滞后时间要比中、低技术地区短。

国内企业可以利用此研究结果来确定从溢出效应中最受益的地区，还可以确定创新环境将会改善的区域。跨国公司可以利用该研究结果来确定在哪设立，以避免溢出效应，还可以为密集的人力资本活动确定高度创新的区域。政府可以利用此研究结果来决定相关的政策，使当地从外国直接投资中获得的利益最大化。此外，本研究还提供了关于受政府和预算政策影响的影响教育环境改善的因素的信息。

关键词： 外商直接投资；区域创新能力；创新绩效；创新环境；溢出效应；滞后时间；

Abstract

This study will measure the spillover effects of FDI on innovation. The research divides innovation into innovation performance and the innovative environment. The innovative performance represents the innovative outputs and is measured by granted patents and R&D spending, the innovative environment is the regions ability in the creation of new ideas and is measured by means of Education, Academia and Human Capital. These spillover effects can occur by means of reverse engineering, demonstration effects or supplier-buyer relationships. From previous research, there is conflicting results regarding whether the presence of foreign firms in a market is positive or negative for innovation. The outcomes often depend on various political, economic and technological factors.

The journey China has taken since opening up to the outside world has been astronomical. The manner in which this implementation has taken place, by means of special economic zones has created great diversity in the implementation of attracting foreign investment to regions throughout China. Considering the diversity of these regions and the innovative focus of the most recent Chinese 5-year plan, a regional comparison on how FDI influences the innovation performance and the innovative environment has been undertaken in this study. There is no research considering the time it takes for FDI to affect the innovative environment, for this reason the researcher has included an analysis of the lag time. Inclusion of the lag time will identify the factors which may accelerate or deaccelerate the time effect of FDI on the innovative environment.

The study uses panel data for 30 provincial level regions in China for the past 8 years. Using software package EViews, the Pooled, fixed and random effects models were used to measure spillover effects the independent variable FDI has on the dependent variable’s innovative performance and innovative environment. The correlation coefficient which represents the FDI spillover effects is then identified. This correlation coefficient figure represents the influence FDI has on Innovative Performance and the Innovative Environment. The optimal lag time will be identified using the Vector Error Correction model. This model will return the Akaike information criterion (AIC) for each lag, the lowest returned value is the most accurate selection.

This study found overall in China positive spillover effects between inward FDI and the innovative performance, for every 1% increase in FDI, the innovative performance of a region increases by 1.45%. The same can be said for the relationship between FDI and the innovation environment at 1.5%. However, the study also found that in some cases FDI can negatively affect a regions innovative performance. This study founded that regions which have received low amounts of educational funding experience negative spillover effects, for every 1% increase in total FDI in these regions the innovative performance decreases by 0.27%. Regions with medium and low innovative environment status also experience negative effects. Eastern regions experience nearly double the spillover effects as opposed to western regions. Regarding lag time between FDI and innovative environment this study found that overall there is a lag period of 6 years. Regions which have previously received low levels of FDI, experience shorter lag times than medium and high receivers showing a levelling off effect. High tech regions experience shorter lag times to medium and low-tech regions.

This study can be used by domestic firms to best identify regions to set up in to benefit from spillover effects. Furthermore, they can identify regions where the innovative environment will improve. These results can be used by MNC’s to identify where to set up to avoid spillovers. They can also identify highly innovative regions for intensive human capital activities. This study can be used by the government to identify relevant policies to put in place to maximise the local benefits from FDI. Furthermore, the study provides information on factors which can influence improvement of the educational environment which governmental and budgetary policy can influence.

Keywords: Foreign Direct Investment; Regional innovation; Innovative Performance; Innovation Environment; Spillover effects; Lag time;

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1. Introduction

1.1 Background of Study

FDI (foreign direct investment) has become an effective means to enhance the standard of living and technological advancement of developing countries. Developing countries can avail of the advancement in other countries by allowing MNCs (multi-national corporations) conduct business in their market. With this inward FDI, markets can take advantage of the spillover effects brought by activities of MNCs. These spillover effects allow domestic firms to access expertise from the operations of MNCs. Innovations in the domestic market can then be accelerated as technology and know-how is implemented into the activities of local firms.

These spillover effects can occur in a series of forms.

Demonstration effects can advance the technological know-how and even have an impact on human capital in a domestic firm “The demonstration effect through inward FDI can stimulate local firms’ innovative activities through learning-by-doing or by analysing and observing the outputs of MNCs’ R&D projects. As a result, local firms may become more effective in conducting their own innovative activity.” (Liu & Zou, 2008) These demonstration effects can occur by means of skilled labour turnovers which occur when employees from MNCs move to a local firm, thus carrying with them vital knowledge and knowhow to the domestic firm in the form of a knowledge spillover, “Knowledge spillovers arise once workers employed by foreign firms switch to local establishments” (Huang, & Youxing, 2017)

Another form of spillover is by means of reverse engineering. Local firms can observe foreign innovations and use this technology as inspiration for use of technology in the domestic market. These spillovers occur from the presence of MNCs in a region and alike demonstration effects, can occur through skilled labour turnovers. This spillover can also occur by reverse engineering of imports.

Supplier-customer relationships are another form of spillover effect. This is when the buyer of a product or piece of technology can provide innovative inspiration to the buyer, “Linkages with buyers and suppliers are likely to be an important source of learning for importers” (Liu & Buck, 2007)

Entry of FDI into markets can come in a series of modes. Certain modes may result in stronger spillover effects of each form.

One of which is Greenfield FDI, this involves entry to the host nation from scratch by a foreign firm. Previous literature specifies that greenfield FDI can spur innovation in a variety of forms. One is by means of human capital, skilled labour turnovers occur where a worker may learn skills from the MNCs greenfield venture and then this knowledge may further spillover to domestic firms. Demonstration effects can also occur by means of this method.

Another form is by means of Merger and Acquisitions (M&A) where a foreign corporation enters the market by either acquiring a company currently in the market or merges with one in the market. It is the quickest means of entry to a market by an MNC. It can also be the most effective to the domestic market as local presence can spur spillover flow as opposed to a wholly foreign owned greenfield venture, “M&As offer the additional benefit that they involve (in cases where foreign ownership is partial) local shareholders directly in the process. The spillover, demonstration and learning effects are likely to be greater.” (Lall, 2002).

Trade and Imports can also create a flow of spillover from foreign firms to domestic firms. When domestic companies have access to foreign innovations this gives them the opportunity to reverse engineer the products or act purely as a motivator of innovation to the domestic market. Demonstration effects can also act as a source of innovative inspiration. “Demonstration effects, which operate when firms observe and imitate the products or practices of foreign firms, seem likely to be affected by trade” (MacGarvie, 2006)

These spillover effects can occur both horizontally and vertically, horizontal spillovers are from foreign firms to domestic firms, the phenomenon occurs within the one industry “via channels such as reverse engineering, labour turnovers, formal or informal contacts between employees of FDI and local firms, and the demonstration effect.” (Lin & Cheung, 2003). Vertical spillover effects occur through supplier-buyer relationships, “the effect of FDI on domestic firms in supplier or customer sectors” (Irsova & Havranek, 2013)

1.2 Reasoning for research

Since the opening up of china to the outside world in 1978 (Huang, Liu, & Xu, 2012) and the attractive environment sold by Deng Xiaoping in 1993, (Lin & Cheung, 2003) interest from foreign firms has increased in consequence, “China has been the largest recipient of FDI among the developing countries in the 1990s.” (Lin & Cheung, 2003) China’s climb to becoming a world leader is largely due to Deng Xiaoping’s change in foreign policy and allowing inward FDI. “As a result of “reform and opening” and greater engagement with the international community, China has enjoyed a remarkable period of economic and social development unprecedented in human history.” (Denmark, 2018) From this shift in policy and the consequential spillover effects, we can see Chinese firms innovating on their own accord. “FDI projects and the operations of foreign-invested firms have also helped to improve China’s access to advanced technologies, to management practices and to a wide range of skills.” (OECD, 2008) Now that China has evolved from being a market by which MNCs took advantage of low cost to a domestic market of innovations, Xi Jinping has time and time again stressed China’s importance for innovation as Xi “called for efforts to develop China into a world leader in science and technology.” (BBC Monitoring Asia Pacific, 2018) In this study I will look into how FDI has influenced the innovative performance in China. I will revise past data so we can see the importance of FDI in creating an environment eligible for implementation of Xi Jinping’s innovation policy.

1.3 Research Approach

To measure innovation performance in regions there are two main variables I will use. One of which is patents, this is because patents provide reliable available statistics into the inventive activities in a region, “patent statistics remain a unique resource for the analysis of the process of technical change.” (Khan, 2005) Patents consists of three types, invention, design and utility model. It is important to consider that some of these types of patents may carry more weight towards innovative environment of a region, “because technically invention patents in general are the most sophisticated and design patents are the least sophisticated so that spillover effects are more likely on the design and utility model patents than on the invention patents.” (Lin & Cheung, 2003)

Amount spent in R&D is another means of which to measure the innovative performance of a region. This figure represents the amount firms are willing to invest to stimulate their inventive processes. It is important to consider the effect FDI has on the mentality of local firms and demonstration effects which may spillover, "inward FDI has a demonstration effect on local R&D activity. By their mere presence in the domestic markets, foreign products/technologies can inspire and stimulate local innovators to develop new products and processes." (Lin & Cheung, 2003).

I will measure the direct influence which inward FDI has on the innovative performance of a region. I will then measure how this direct influence of FDI on innovation performance creates an innovative environment, which will keep my thesis relevant over the long term. Factors incorporated into innovative environment will include Education, Academia and Human Capital. Considering these factors are not as directly influenced by FDI as innovation performance, I will measure the time needed after certain levels of FDI to see changes to the innovative environment. This will be an effective means to see which areas of China has benefited from FDI from an innovative perspective and compare which areas can expect to improve.

Education is important to nurture an innovative environment for a region. For a region to meet the demands for science and technology-based activities, a regular supply of highly skilled individuals is needed in the region. This study will speculate how FDI has influenced the educational perspectives of people in the region, by years spent in education. If opportunities for high skilled jobs appear in a region it is reasonable to speculate the people in the area are most likely to pursue an avenue of higher education to meet a perceived career pathway, "the number of returned students drastically rose from less than 10,000 in 2000 to 25,000 in 2004." (Yasuyuki , Weiying , & Li-An Zhou, 2009).

After observing the increase in innovation performance with regards to R&D through FDI, I will consider how this may affect the academic presence of universities in the regions. With the presence of MNCs in a region, this gives more opportunity to the local universities to contribute to "New roles and forms of interactions with industry (U-I links, R&D collaborations, spin-offs)" (Tödtling, 2006). This experience is beneficial for universities as access to these MNC activities by geographic location can increase the quality of education and academic contributions, "the research institutions are quite active in this respect and make a significant contribution to innovation activities in the private sector" (Fritsch & Schwirten, 1999). I will measure academia by mans of third level academic citations in a region's universities.

To meet the demand of these projects and ensure high quality infrastructure for S&T research, the Chinese government has further funded these universities so their S&T activities can keep up in research qualities, "China's expenditure sustained steady growth in 2007, with the nation's R&D expenditure in the year reaching RMB 371 billion, or RMB 70.7 billion more than the preceding year. The 23.5 per cent growth has raised S&T expenditure to 1.49 per cent as a proportion of GDP, a new historical high." (Gupta, Gupta, & Gupta, 2009) thus, adding to the advancing innovative environment.

(Huang, Liu, & Xu, 2012) proved that "the relatively high innovation levels of eastern coastal areas such as Beijing, Tianjin, Shanghai, Guangdong, Zhejiang, and Jiangsu were associated with their high levels of economic development, human capital and infrastructure." From previous research and the numerous definitions of innovation, a reoccurring labelling of innovation is that it is an idea-based topic, "A new idea, method, or device. The act of creating a new product or process, which includes invention and the work required to bring an idea or concept to final form." (Kahn, 2012) when measuring the innovative environment, human capital must be considered. In addition, I will be considering human capital based on number of S&T personnel in industrial enterprises to ensure incorporation of the human capital activities of an innovative environment.

1.4 Scope of the study

To get a better comparison of the environmental factors needed for spillover effects to occur I will conduct a Chinese Regional study so I can compare provinces within China. This is because the opening up process by Deng Xiaoping was gradual and only relevant to certain regions at first, "Specifically, the central and local governments of China granted preferential policies on taxes, land usage, and other matters, often in the form of policies for special economic zones" (Lua, Taoc, & Zhu, 2017) The means of which FDI has been applied to China has been a gradual process from region to region, "there is great regional diversity in China in terms of the levels of international trade, inward FDI, and economic, social and technological development" (Huang, Liu, & Xu, 2012). Initially FDI occurred mainly in the coastal regions however now we are seeing a gradual improvement in the amount invested in central and western regions. "in 1996 nearly 90% of FDI (in realized value) was concentrated in coastal provinces and more precisely in five of them: Guangdong, Jiangsu, Fujian, Shanghai municipality, and Shandong received more than 65% of total FDI. The Central region received only 9% and the West region only 2.45% of the total FDI inflow in that year." Observing the absorption levels of each province regarding innovation performance takeaways will also give insight into threshold levels needed for provinces to take advantage of FDI, "An enterprise needs to attain the scale or human capital threshold in order to benefit from FDI." (Haskel, Pereira, & Slaughter, 2007)

The manner of implementation of policy differs from region to region, it is important to consider how these policies effect spillovers from FDI. Each province now has some autonomy to attract FDI, "within the Chinese fiscal decentralization context, local governments are assigned a high degree of autonomy in some economic activities." (Wang, Wei, Deng, & Yu, 2017) by creating an ever-attractive environment, policy changes per region will also give insight to highly influenced or lowly influenced regions. Considering these policies will also give me oversight to be aware of the share of influence between national and provincial governments on the innovative environment in a region or FDI.

1.5 Purpose of the Study

The purpose of this study is to identify how the independent variables relating to FDI spillovers interact with the corresponding dependent innovation performance variables. Upon this inspection I will identify the length of time needed (lag) for the FDI spillovers to affect the innovative environment of a region. Please read purpose statement below.

The purpose of this thesis is to identify the relationship between FDI, innovative performance and the time needed to influence the innovative environment and gain insights into factors influencing this relationship.

In doing so, I will identify factors which may accelerate or hinder this relationship. Depending on how reactive regions appear to be, I will speculate the political, economic, social and technological factors which influence the absorption capacity of a region's innovative environment with regards to FDI.

The study will be useful from the following point of views,

(i) Domestic Firms – This study will provide insightful information on the ways in which domestic firms can increase innovation from FDI in the region.

Highlight the important external factors needed in an environment to best take advantage of spillover effects from MNCs FDI.

(ii) MNC's – When multinationals set up in different markets, they want their trade secrets to be kept confidential. This study will provide information for MNC's on how domestic firms exploit their presence and they can implement strategies to counteract information leakages based on this study.

(iii) Regulatory – from a regulatory point of view my study will provide information identifying regions which have benefited strongly from FDI and I shall speculate which policies may have accelerated or hindered innovation. Furthermore, this study will better help identify the time needed to recoup the innovative advantages from FDI.

1.6 Research Questions

Based on this purpose, the following Research questions are derived.

Research Question 1: The relationship between FDI and innovative performance in a region.

Research Question 2: The time needed for FDI to influence the overall innovative environment within a region.

A regional study on how spillover effects from FDI has affected the innovation performance of a market and the time influence this has on the innovative environment.

2. Literature Review

2.1 Overview of previous research

There is a wide range of research regarding the relationship between FDI and innovative performance. As mentioned in an empirical study by (Blomstroom & Kokko, 1998) “host country spillovers vary systematically between countries and industries and that the positive effects of FDI are likely to increase with the level of local capability and competition” (Blomstroom & Kokko, 1998), often causing conflicting results depending on the country, industry or methods of measurement. For example, domestic firms in export based economies may find greater opportunities in benefiting from spillovers as opposed to service based economies, “R&D spillovers from multinationals to domestic firms and the presence of multinational firms in the sector positively affect the decision to export and the export ratio” (Görg & Greenaway, 2004).

Attracting FDI, can be a highly effective tool for developing countries in achieving fast growth for the market’s innovations, “Policy makers in many developing and transition economies place attracting foreign direct investment (FDI) high on their agenda, expecting FDI inflows to bring much-needed capital, new technologies, marketing techniques, and management skill” (Javorcik, 2004) However, as stated by (Huang, Liu, & Xu, 2012) it is important to note that there must be suitable capabilities in place for the home market to take advantage of this investment. Similarly, (Balasubramanyam, Salisu, & Sapsford, 1996) founded that appropriate policies must be in place, “the growth enhancing effects of FDI are stronger in countries which pursue an EP policy than in those following an IS one” (Balasubramanyam, Salisu, & Sapsford, 1996). Without consideration of an apt environment, FDI may be interpreted as being exploitative by critics, “by exploiting workers with substandard wages and working conditions” (Deardorff, 2003).

And even negative spillover effects may be experienced, as discovered by (Aitken & Harrison, 1999) FDI can cause competition and productivity difficulties for domestic firms in the same industry, “increases in foreign ownership negatively affect the productivity of wholly domestically owned firms in the same industry.” (Aitken & Harrison, 1999). Similarly, in a study by (Konings, 2000), focusing on the effects of FDI on domestic firms in Bulgaria, Romania and Poland found a negative correlation to the spillovers, “I find no evidence of positive spillovers, but rather negative or no spillovers of foreign investment to domestic firms. This is rationalised through a competition effect that dominates a technological spillover effect”

Contrastingly there’s a series of studies in various countries (developed and developing) proving positive spillover effects. For example, (Blomstrom & SjoKholm, 1999) founded in Argentina “that labor productivity is higher in establishments with foreign equity than in purely domestically owned firms and that the latter benefit from spillovers from FDI.”. (Buckley, Clegg, & Wang, 2002) also founded positive spillover effects in China relished through vertical spillovers to domestic firms, “The spillover benefits that are enjoyed by COEs arise through interactions in final, intermediate and factor markets”. In Mexico, (Blomstrom & Wolff, 1989) found that the presence of mainly American MNCs in Mexico brought about growth in productivity, “local firms in Mexico have gained productivity "spillovers" from the presence of multinational firms in the Mexican economy.”. As you can see from previous literature, the results are not always black or white. Many factors need to be taken into consideration of data analysis methods, further research is then often pursued in many studies upon analysis of results. (Huang, Liu, & Xu, 2012) conducted a regional study within China from 1985-2008 and found insignificant FDI spillover effects in the regions. However, when they considered threshold levels of regional innovation, “the authors found clear evidence of double-threshold effects of regional innovation on productivity spillovers from FDI in China.” meaning that once a region achieved a certain level of innovation it was then that they could reap the benefits from MNC spillovers.

2.2 Thresholds & Absorption Capacity

Upon research of Threshold levels concerning the relationship between FDI and Innovation, various amounts of factors have been considered in accounting for achieving absorption capacity to fully avail of FDI spillovers, “Whether a firm benefits depends on its relative backwardness and its capacity for assimilating knowledge” (Görg & Greenaway, 2004). Much of the research investigates certain factors of the current position of domestic firms to avail of FDI spillovers. As previously mentioned, regarding (Huang, Liu, & Xu, 2012)’s study of threshold levels of regional innovation, once a regions innovation reached a level, they are then in a position of absorption capacity where the region is equipped enough to take advantage of the spillovers.

One of the most frequently investigated factors for achieving absorption capacity is the level of technology achieved by domestic firms. In particularly when the host nation is a developing country, “Local firms in developing countries have relatively large technology gaps with multinational enterprises.” (Huang, Liu, & Xu, 2012) Research into this area begs the question, have the domestic firms reached a level of technological sophistication to take advantage of FDI spillovers, “a technical threshold effect, that is, a host country’s absorption of FDI spillover effects is associated with its level of technology.” (Huang, Liu, & Xu, 2012). Researchers often reference the technology gap when discussing the phenomenon relating the distance of sophistication between MNC technology and domestic firm technology. However, as per (Castellani & Zanfei, 2006) they have distinguished that the technology gap refers to horizontal spillovers, whereas absorptive capacity is a broader term relating to both horizontal and vertical spillovers. Interestingly in a study, (Sawada, 2010) found an increase in spillovers with an increase in technology gap originally, but when this technology gap further increased the spillovers reduced, “As the technology gap between the foreign and home firms increases from a small initial level, technology spillovers increase. However, when the technology gap exceeds a certain critical level, increases in the technology gap lead to smaller spillovers.” (Sawada, 2010). Results from (Girma, Greenaway, & Wakelin, 2001) found similar outcomes considering environmental factors but the results can be interpreted depending on the sector, they found that “firms located in sectors characterised by high levels of skills and a high degree of international competition (even if they have a technology gap) can also gain from FDI.” (Girma, Greenaway, & Wakelin, 2001) But depending on the nature of the business for the domestic firms, FDI can be looked upon as a threat, “Firms with large technology gaps, in sectors with low skill levels and low levels of foreign competition, may be damaged by the presence of foreign firms” (Girma, Greenaway, & Wakelin, 2001).

Technological capabilities are not the only factors which affect the absorption capacity of FDI, (Borensztein, Gregorio, & Lee, 1998) questioned the role human capital played in enjoying spillover effects and founded, “that the effect of FDI on economic growth is dependent on the level of human capital available in the host economy.” (Borensztein, Gregorio, & Lee, 1998). Other studies looked into how the levels of human capital affected a firm’s ability to benefit from a foreign firms technology which subsequently results in positive spillover effects, (Ford, Rork, & Elmslie, 2008) conducted a regional study in the United States and founded that “only states that contain a comparatively well-trained workforce have the capacity to take advantage of the presence of foreign technology.”. Similarly, (Xu, 2000) study founded “that the level of human capital is crucial for a country to benefit from the technology spillovers of MNEs.”. Each of these previous three studies measured Human Capital by means of time spent in education.

2.3 Measure by Industry or region

There are several ways in which researchers have approached data collection and analysis for this topic. The two most common means of data collection and analysis is by industry or by region. Upon analysis, results and conclusions can then be interpreted depending on the industry or depending on the region. (Sawada, 2010) (Buckley, Clegg, & Wang, 2002) and (Liu & Zou, 2008) conducted their studies by means of the industry. This means of analysis can be beneficial in analysing phenomena’s such as inter-industry spillovers. (Girma, Greenaway, & Wakelin, 2001) takes a similar approach in order to conclude results based on sectors. This approach can also provide an industry-centric perspective when analysing the technology gap.

An abundant of research papers can be found from the perspective of the other lens, measuring by region. This method has been taken up in the papers by (Lin & Cheung, 2003), (Huang, Liu, & Xu, 2012), and (Borensztein, Gregorio, & Lee, 1998). This can be a great approach when measuring as a means of comparison. When considering threshold effects, it can be used to contrast areas of high absorption with areas of low absorption as seen in the study by (Huang, Liu, & Xu, 2012). The country in which the study has been conducted can influence this choice, if the study was conducted in a place of high diversity amongst regions, a regional approach may be more effective. As stated by (Wei & Liu, 2001) there is great regional diversity in China in terms of the Political, Economic, Social and Technological environments.

Using this lens allows for comparison of effectiveness of policies amongst regions. The levels of autonomy provincial governments hold strengthens my reasoning for this approach, “provinces in China are administratively and economically independent geographical regions.” (Li, 2009). This approach will allow me to compare policies amongst regions. Since a shift towards ‘Bureaucratic decentralization’ in China in the 80s and 90s the provincial government has gained more sovereignty over how best to manage the region, “more autonomy to local governments in financial, budgetary and administrative issues.” (Gua & lundvall, 2016).

When considering spillovers, it has been observed that spatial proximity can amplify the results, "the spatial distribution of patent and innovation counts, demonstrates a striking similarity, both at the state and county geographical scale" (Acs, Anselin, & Varga, 2002). From previous studies it has been shown that for knowledge spillovers to occur, geographical proximity plays a big role, "spatial proximity is of crucial importance for technology and knowledge spillovers" (Lin & Cheung, 2003). The reasoning for this is that the closer a domestic firm is to MNC the more likely interactions facilitating the flow of knowledge is to occur, "The probability that knowledge is transmitted from one agent to other decreases as geographic distance increases. The closer a local firm is located to an FDI firm, the more likely and more frequently their employees will interact with each other, and more frequent labor moves between these two firms." (Lin & Cheung, 2003). This can come in the form of linkages between suppliers and distributers. It is also reasonable to consider the influence of geographic proximity in facilitating knowledge spillovers from training of employees and labour turnovers. (Haacker, 1999).

Measuring regionally also proves beneficial from the perspective of the MNCs. In order to avoid the exposure of trade secrets and increased competition MNC's will consider setting up in regions where spillovers are kept to a minimum, "Indigenous Chinese firms are innovating themselves as a result of knowledge ''spillovers.'' These forms now represent a serious competitive threat to firms in the west, as leading Chinese firms 'invade' western markets using trade and outward FDI." (Liu & Zou, 2008) From previous studies, areas of low technology tend to be disadvantaged areas, these areas sometimes have high subsidy levels in countries as a means of aid for less developed regions. "if MNEs locate in less-developed regions to take advantage of subsidies, spillovers may be reduced, as local firms in these areas do not have the technological capacity to benefit from the MNEs." (Girma & Wakelin, 2000).

(Girma & Wakelin, 2000) combined both regional and industrial for their studies. They founded evidence of a regional impact on spillovers which can behave differently depending on being inter or intra industrial, "we do find evidence that positive spillovers from foreign firms occur only to domestic firms in the same sector and region as the foreign firms." (Girma & Wakelin, 2000). They also found these can have inverse effects concerning geographic proximity, "We also find some evidence of negative spillovers at the sector level but outside the region." (Girma & Wakelin, 2000). From the same study, (Girma & Wakelin, 2000) also found positive spillovers when the technology gap is low, “regional spillover variable FDI is only significant for the firms in sectors with a low technology gap between foreign and domestic firms.”

2.4 Policy

Drastic changes to policies have played a massive role in the growth and development of China over the past four decades. The developments and revising of policies have been highly influential in firstly attracting FDI and secondly absorbing the benefits of FDI. This paper accepts that considering the different outcomes regarding positive and negative spillover effects that have occurred in various markets that the outcome is largely due to the policies put in places and the relationship between government, MNE’s and local firms.

China first opened up to the outside world economically in 1977. It took some time to build relationships and portray a low risk environment trustworthy for MNCs. These doubts were created by a period of political uncertainty and sanctions amongst the international trading community throughout the 80s and 90s, “political changes in China such as the Tiananmen events in 1989 and the subsequent economic sanctions by major trading partners of China during early 1990s.” (Lin & Cheung, 2003).

It wasn’t until Deng Xiaoping’s South tour in 1993 when we saw international popularity for business in China. This tour portrayed an image to MNCs that China was open for business, “The political uncertainty of investing in China was greatly reduced after Deng Xiaoping’s South Tour in 1993” (Lin & Cheung, 2003). China capitalised on this positive image by implementing a series of new policies beneficial to MNCs, “Following Deng Xiaoping’s support of further economic liberalization in 1993, the Chinese government resumed a policy of far reaching economic reforms and launched a new round of measures to attract FDI.” (Lin & Cheung, 2003) This in consequence saw a period of exponential FDI growth over the next decade, “In 2002 it displaced the US as the top recipient of FDI in the world” (Cheng, 2005).

In parallel with these foreign policy changes, the government also pursued innovation policies. These policies are highly important to co-exist in order to avoid becoming a market reliant solely upon MNCs, “policy measures that simply seek to attract FDI along with its presumed inflow of superior technology would be inefficient.” (Marin & Bell, 2006). These innovation policies were created and revised at a series of

S&T conferences, “China’s post-1978 era can be divided into five periods, marked by five significant national S&T conferences, held in 1978, 1985, 1995, 1999 and 2006” (Liua, Simon, Suna, & Caoc, 2011) In creation of the innovation policy, the government resurrected S&T institutions, many of which were dormant throughout the cultural revolution, “revitalization of China’s S&T system, including research institutions, experiment bases, technology equipment and facilities, all of which emerged from the Cultural Revolution severely damaged.” (Liua, Simon, Suna, & Caoc, 2011).

It wasn’t until the 1995 period in parallel to Deng Xiaoping’s south tour where we saw these innovation policies incorporate FDI policies, “There also were provisions encouraging higher levels of foreign investment as part of the overall development strategy for these two sectors.” (Liua, Simon, Suna, & Caoc, 2011). Foreign policies have been put in place since opening up to ensure MNCs could impart knowledge with domestic firms and research institutes. These policies are important in creating an environment to lower the technology gap and subsequently enhance absorption capabilities for domestic firms, “The Chinese authorities have long put a premium on the transfer of technology to local industry to generate productivity gains.” (Buckley, Clegg, & Wang, 2002). As founded by (Buckley, Clegg, & Wang, 2002), the policies in place created a strategy whereby Chinese companies further developed upon western technologies to profit, “Chinese policy towards FDI since 1979 has been predicated upon appropriating western technology, either directly or indirectly, and our findings demonstrate the existence of the indirect route” (Buckley, Clegg, & Wang, 2002). These policies can create a strategy whereby the technology gap is quickly reduced. As per previously mentioned studies, once the technology gap is reduced, absorption capacities are achieved and then spillovers can be taken advantage of. This can be a highly effective tactic for developing nations, “The policy package that the developing economy can use is to promote FDI up to the threshold level of the technology gap and at the same time to support local firms to improve their absorptive capacities” (Sawada, 2010).

Although, it is easier said than done for Chinese industries to learn from foreign firms, particularly when the technology gap is large. Furthermore, the primary factors for foreign firms setting up in China is rarely to work in accordance with domestic firms or research institutions, “’pull’ factors continue to attract foreign R&D investment to China (for example, a substantially lower-cost, sizeable and increasingly skilled labour force).” (Walsh, 2007) These knowledge sharing environments are yet to be highly effective for knowledge sharing and may come across as being forced, “China must foster greater interaction between foreign and domestic research enterprises and institutions, which recent studies show remains surprisingly low.” (Walsh, 2007). This may be a contributing factor as to why China gained the nickname as ‘the worlds factory’, “China has been the leader since the 2000s, winning the title of ‘world factory” (Wang & Li, 2017).

Policymakers need to be careful to avoid this route of overreliance upon foreign technologies, if the market continues in this direction my previously mentioned exploitive negative perception of FDI may become truth, “This scenario could exacerbate latent fears of a zero-sum outcome where MNE R&D investments are perceived as unfairly exploiting China’s human, tangible and intangible resources.” (Walsh, 2007)

Without domestic innovations the advancement of robotics in the manufacturing industry may also prove worrying for the Chinese market as low wages will no longer be a major factor in competitive advantage and the MNCs carrying technology which China is reliant upon may choose to conduct business elsewhere, “Rising wages and demands for faster production are convincing Chinese manufacturers to invest in more robots to maintain their competitive advantage as global manufacturing exporter.” (Rethink Robotics - Finding A Market, 2013) Chinese policymakers look to be aware of these uncertainties. Regarding robotics, China are investing heavily in this sector, “Last year China installed 87,000 new industrial robots, with about a third produced by domestic companies, overtaking Japan to become the world’s biggest operator of the machines.” (Bland, 2017).

Since the 2006 S&T conference it looks as though Chinese policymakers have been aware of the lack of indigenous innovation, “high-level government and party leaders as they travel across the country to strengthen indigenous innovation efforts and outcomes suggests that the level and pace of progress are lacking in terms of both their expectations and the actual results.” (Liua, Simon, Suna, & Caoc, 2011). Chinese policymakers have then implemented regulations calling for stricter means of technology transfer from MNCs, “This may help explain some of the reasons why in late 2009 and early 2010, PRC government officials chose to adopt a series of strong technology transfer requirements vis-a-vis foreign firms regarding domestic government procurement to help better support the country's indigenous innovation goals and objectives." (Liua, Simon, Suna, & Caoc, 2011). To avoid overreliance of foreign technology, Chinese policymakers have recently included programs and policies influencing knowledge sharing between MNCs and domestic firms, "National Guideline on China's Long- and Medium-Term Plan for Science and Technology Development (2006–20) call for continued openness to foreign technology investments as a means to improve China's own scientific and technological capabilities. As part of this effort, China plans to 'encourage transnational companies to establish R&D bodies in China'" (Walsh, 2007).

Considering the indigenous side of these barriers to knowledge spillovers, governmental officials must focus on how research institutions can work with firms to spur innovations. This focus will also be beneficial to the research community's communication and absorption skills with MNCs, "China must also enhance the horizontal connections between its own research communities, bridge the gap that still exists between researchers and domestic industry on the Mainland, and provide enhanced training and financial incentives to state and private-sector researchers." (Walsh, 2007).

These policies were put in place with the focus to diminish this overreliance of foreign technology, the following medium and long term goals were set in 2006, "National Guideline on Medium- and Long-Term Plan for Science and Technology Development calls for a reduction to 30 per cent of China's reliance on foreign technology in 15 years' time, down from the present estimated dependence rate of over 50 per cent" (Walsh, 2007).

In 2016 we were presented by the 13th five-year plan incorporating the current vision for China. Importance of research looked to be prioritised by policymakers for this plan, "according to China's latest 5-year development plan, which could triple funding for basic research by 2020." (Xin, 2016). Policymakers look to be focusing much of their attention on indigenous innovation from this plan, titling part II of the document, 'Innovation-Driven Development'. With innovation being described as, "the primary driving force for development Innovation must be placed at the heart of China's development and advanced in every field, from theory to institutions, science, technology, and culture." (Compilation and Translation Bureau, 2016) it is evident that the government has chosen now to shift focus from FDI attraction to idea creation. In saying this, FDI attraction is still mentioned in the plan but the motivations for this FDI has shifted. Previously FDI would have been wanted for jobs but now it is for utilization of technology, "bring in foreign capital and advanced technology, and increase the overall efficacy of foreign capital utilization." (Compilation and Translation Bureau, 2016).

The previously mentioned problems of transferring knowledge amongst research institutions, MNCs and domestic firms are still highlighted in this plan. This plan includes an 'innovation network' in which the party hopes to overcome these barriers of innovation prosperity amongst enterprises, universities and institutions, "We will make clear the functions and roles of different types of entities involved in innovation and establish an innovation network that integrates the efforts of the government, enterprises, universities, research institutes, and end-users." (Compilation and Translation Bureau, 2016). There is much stress placed on the need to develop the educational institutions to have the ability to play an effective role in the innovation system, especially considering the focus of Science and technology, "We will integrate the development of science and education, encourage institutions of higher learning, vocational colleges, and research institutes to participate fully in the development of a national innovation system" (Compilation and Translation Bureau, 2016).

The plan also mentions reverse engineering from imports, one of the variables I will be using when measuring FDI to a region, "innovation based on import and assimilation" (Compilation and Translation Bureau, 2016)

2.5 Patents

I previously mentioned that before 1993 there was little eagerness for MNCs to enter Chinese market. Entering the Chinese market was unknown risky territory for global firms. Before the 90s the laws were not consistent with the international norm. This included the Intellectual Property (IP) environment of the country, "China's first patent law was enacted in 1984 and came into effect in 1985." (Lin & Cheung, 2003) This meant that before 1985 there was not protection for the innovations of MNCs in China.

The presence of a strong IP legal system can act as a barrier to spillovers between MNC and domestic firms. Reverse engineering can be ruled illegal in certain cases. Furthermore, benefiting from demonstration effects will have to be approached carefully. Knowledge spillovers are also limited to non-patented inventions, “though it may have negative effects on spillovers. If intellectual property rights protection is enforced, the imitation activities may be limited to other technologies than the patented ones;” (Sawada, 2010). On the other side, if there is evidence of a weak IP environment, FDI will be deterred and there will be a lack of trust in the market by MNCs. So if there is no IP legislation there may be limited FDI to take advantage of and even with an IP presence there are still many opportunities for domestic firms to learn from MNCs, “the home firms can still gain a lot from other technologies which are not patented, such as management techniques” (Sawada, 2010).

China has continued to improve the IP environment since the first law, “the law has been amended twice. The first revision, undertaken in 1992, extended the patent length from 15 to 20 years for invention patents and from 5 to 10 years for patents on utility model and external design.” (Lin & Cheung, 2003). However, even with IP laws on par with the international community questions can still be made considering the enforcement of these laws. Thankfully there is a trend proving to MNCs that the Chinese legal system is taking IP laws seriously, “Chinese courts adjudicated a total of 23,636 IP cases, a 40% increase over the period between 1993 and 1997” (Jia, 2004). One example of successful implementation of these laws was the legal victory for US pharmaceutical company Pfizer over Guangzhou based Viaman Pharmaceutical, “Pfizer (New York) successfully stopped its Chinese rival, Guangzhou Viaman Pharmaceutical, from registering the trademark of an erectile dysfunction drug whose name 'weige' is pronounced in Chinese like Viagra, Pfizer's best-selling product.” (Jia, 2004) Giving increasingly more confidence to MNCs based in China.

Considering the legal autonomy each region in China has, it can also be speculated that highly developed regions in China are more advanced regarding implementation of IP laws in China. This may raise some worry concerning IP protection for MNCs in less developed central and western regions. To combat this, “In 2001, China ratified the Trade-Related Intellectual Property Rights Agreement, which compels signatories to enforce IP protection in their territories, as part of fulfilling its World Trade Organization membership commitments.” (Jia, 2004) Strengthening this IP environment can increase FDI from abroad, “The enforcement of intellectual property rights protection can also promote FDI” (Sawada, 2010). It can also increase the value R&D activities conducted in China by convincing MNCs to conduct highly innovative research activities, for example this strengthening of laws was a big factor for Roche (Basel) selecting Shanghai for a development centre, “The recent strengthening of IP protection was a major factor in convincing Roche to establish the center in China, according to Andreas Tschirky, head of Roche R&D in Shanghai.” (Jia, 2004)

2.6 Grants

From the perspective of an MNC deciding which country to invest in can have massive implications if gone wrong, they must consider the political, economic, legal, technological and human factors of the host country. From the perspective of the host nation there is eager competition from many other markets willing to host the MNC. One way in which countries express their eagerness to an MNC is to offer incentives, “Subsidies or tax incentives for FDI are effective to promote FDI” (Sawada, 2010). This is a method which has been effectively used by Chinese policymakers to attract FDI for quite some time now, “an orientation which is encouraged by China's cheap labor and incentive policies and by OC MNEs' advantages in labor-intensive production” (Buckley, Clegg, & Wang, 2002). These incentives and policies should be made in parallel with the long-term vision of the nation. If these policies are in place aggressively to satisfy economic, FDI and foreign reserve targets, as found in (Aitken & Harrison, 1999) in Venezuela, exploitation of workers and negative spillovers may occur due to increased competition, “These policies may result in a flow of FDI that does not respond to higher efficiency but only to profit opportunities created by distorted incentives.” (Borensztein, Gregorio, & Lee, 1998).

The ideal type of MNC a host country will want to attract is an exports company as this negative spillovers from competition will be kept to a minimum, also companies whereby the technology gap with the domestic firms are low so knowledge spillovers can occur, “especially when the foreign firm chooses exports instead of its entry with smaller technology gaps, yet the home country gains welfare from FDI” (Sawada, 2010).

Attracting FDI to less developed regions can be a great way to promote jobs and technology. Policymakers often increase incentives to domestic firms for investing in poorer areas. However, depending on the desired outcome, a careful approach must be considered.

As seen in a study by (Girma & Wakelin, 2000) in the UK, the government invested heavily in providing incentives for underdeveloped regions, “The assumption behind such packages is that the long-term economic impact on the region will exceed the cost of the subsidies.” (Girma & Wakelin, 2000). It was founded that the less developed areas did not benefit as much as the areas without underdeveloped status, “Sectors with high levels of competition and in regions without Assisted-Area status gained more from the presence of foreign firms. It seems that attracting FDI through regional incentives may actually reduce the level of spillovers resulting from their location in the UK.” (Girma, Greenaway, & Wakelin, 2001) This is because the underdeveloped regions did not have the technological capabilities to benefit from foreign presence. This is another consideration for Chinese policymakers, particularly when trying to develop the western region. Furthermore, it begs the question is it better to roll out these incentive programs nationally or regionally, “This may partly be because other firms in those regions do not have the necessary knowledge and skills to benefit from the presence of foreign firms. Ironically, regional policies to attract FDI may limit exactly what they wish to attract.” (Girma, Greenaway, & Wakelin, 2001).

Attraction of FDI is now a very popular strategy by developing countries to reach economic and technological levels of the developing world. However, this causes increased competition between developing countries thus, giving more opportunities of exploitation by MNCs. One of the most effective policies to aid sustainability and future benefits from FDI is to develop human capital and education in accordance with inward FDI. This will help reduce the human capital and technological gap in the future.

In a paper by (Hoekman, Maskus, & Saggi, 2005) which analyses effectiveness of policies for international technology transfer (ITT), education and encouraging supplier relationships between locals firms and MNCs is of priority, “A main priority in all types of developing countries is effective general technology policies, including improving basic education, building appropriate infrastructure, and reducing entry barriers for local firms that could be suppliers for MNEs.” (Hoekman, Maskus, & Saggi, 2005). This study identifies that education and human capital must be developed in order to benefit from the presence of FDI and MNCs technologies, “This is a complex task that involves building human capital, expanding national innovation systems, and appropriately protecting IPR.” (Hoekman, Maskus, & Saggi, 2005). Similarly, (Borensztein, Gregorio, & Lee, 1998) concluded their paper by stating “The most robust finding of this paper is that the effect of FDI on economic growth is dependent on the level of human capital available in the host economy", further highlighting the importance of the inclusion of Human capital and education variables in this study.

2.7 Decentralisation

As previously mentioned, China is a nation with great regional diversity. Decentralisation has contributed to this level of diversity through provincial policy autonomy. Provincial governments have a lot autonomy in attracting FDI regarding fiscal policy, "Since the open-door reform, provincial governments have gained autonomy for formulating economic and social development policies". (Li, 2009) FDI policy has been a pivotal factor in economic growth since opening up, "Since the reform and opening-up policy of the 1970s, Foreign Direct Investment (FDI) has played an increasingly prominent role in stimulating the economy" (Wang, Wei, Deng, & Yu, 2017) this, in turn has made FDI attraction a priority for policymakers from the top down, and has even caused competition amongst local governments "governments at all levels compete with each other to attract FDI by introducing preferential tax rates and land policies." (Wang, Wei, Deng, & Yu, 2017). This means of attraction also plays a pivotal role in the hierarchical structure within governmental work culture, "local officials pay great attention to economic development for the opportunity of political promotions." (Wang, Wei, Deng, & Yu, 2017). This system has its benefits, but an aggressive means of attraction is a means of concern when maximising the benefits of FDI, "local governments tended to attract FDI inflows by sacrificing environmental quality." (Wang, Wei, Deng, & Yu, 2017). This also creates a system whereby regional interests prioritise national interests, "every city in China is an independent economic unit and hence seeks to further its own interests." (Wang, Wei, Deng, & Yu, 2017)

After 1994 the new fiscal policy outlining what provincial governments could and could not do, from an incentive point of view they could not give tax breaks to MNCs, "local governments were no longer allowed to grant tax breaks." (He & Sun, 2014) As per national law each province is governed by the same legal and political system however local governments do have control over certain policies and certain means of attraction of FDI, "Although all are subject to the same legal and political institutions that are under the control of the central government, each has its own governance rules. Technology policies and innovation plans have strong regional features." (Li, 2009).

2.8 OLI Model

One of the most popular frameworks regarding FDI is the OLI model, also known as the eclectic paradigm. This framework outlines purposes as to why MNCs engage in FDI and strategic insight to gain competitive advantage, "the eclectic (or OLI) paradigm has remained the dominant analytical framework for accommodating a variety of operationally testable economic theories of the determinants of foreign direct investment (fdi) and the foreign activities of multinational enterprises (MNEs)." (Dunning, The eclectic paradigm as an envelope for economic and business theories of MNE activity, 2000). The model consists of three variables, Ownership, Location and Internalisation. The ownership variable consists of "the competitive advantages of the enterprises seeking to engage in fdi (or increase their existing fdi), which are specific to the ownership of the investing enterprises" (Dunning, The eclectic paradigm as an envelope for economic and business theories of MNE activity, 2000). The second is the location variable, "The second is the locational attractions (L) of alternative countries or regions, for undertaking the value adding activities of MNEs" (Dunning, The eclectic paradigm as an envelope for economic and business theories of MNE activity, 2000). And finally internalisation, which accepts that, "the greater the net benefits of internalizing cross-border intermediate product markets, the more likely a firm will prefer to engage in foreign production itself, rather than license the right to do so" (Dunning, The eclectic paradigm as an envelope for economic and business theories of MNE activity, 2000).

For the purpose of this study we will focus on the location variable, considering this variable implements the way in which host countries can improve location specific advantages to attract MNC's and also consider the development of the domestic economy, "The improvement in the L advantages of countries may also help indigenous firms to upgrade their own competitive advantages." (Dunning, The Eclectic (OLI) Paradigm of International Production: Past, Present and Future, 2001). In saying this, these variables are interlinked with each other, so the other two variables will be considered, for example an improvement in location specific advantages such as skilled labour will fuel the potential of ownership advantages, "its L advantages have become more attractive as an indigenous technological infrastructure and pool of skilled labour is built up. This, in turn, makes it possible for domestic firms to develop their own O advantages and begin exporting capital." (Dunning, The Eclectic (OLI) Paradigm of International Production: Past, Present and Future, 2001).

Governmental policy is considered an important factor for the attraction of MNCs, these policies can benefit or defect the L advantages, “the role of government is often of critical importance in influencing the quality of L-specific advantages”. Furthermore, these policies can determine how the domestic market benefits from FDI spillovers, “setting the competitive environment for their own firms to effectively exploit the opportunities offered by the global economy” (Dunning, The Eclectic (OLI) Paradigm of International Production: Past, Present and Future, 2001).

This model will provide a lens for the researcher throughout the study in which the L specific advantages are the basis for how domestic firms may benefit from the presence of MNC’s. These L specific advantages are used in the analysis of this research, examples of these L advantages include, skilled labour, human capital, technological infrastructure, favourable policies and education. These L advantages will be a basis for scoring the innovative environment of regions in China.

2.10 Research Gap

There has been a broad range of approach’s taken when measuring the phenomenon of how FDI spillovers can affect the innovation performance of an environment.

Previous research tends to measure specific variables related to innovation, measure the relationship and conclude. (Lin & Cheung, 2003) study measured R&D spending and granted patents as the independent variables, (Huang, Liu, & Xu, 2012) recognise R&D spending and patents while also considering human capital as an output. To the best of the researcher’s knowledge, there has been no analysis which divides how the effect on innovative performance and the innovative environment separately. Innovation performance represents instantaneous results, in this study we will go further and measure the innovative environment which portrays sustainability and regional innovative capabilities. Measurement of the innovative environment will be a combination of educational, academic and human capital variables.

Until now most of the studies regarding this topic consider threshold levels of technology or human capital such as in (Huang, Liu, & Xu, 2012)’s study, however, to the best of the researcher’s knowledge level of academia of the regions universities and education systems in China have yet to be considered. The activities of Universities are central to the innovative mindset of a regions educated workforce. As stated in the most recent Chinese five year plan these activities are key factors in execution of the Chinese governments' innovative strategy, "We will make clear the functions and roles of different types of entities involved in innovation and establish an innovation network that integrates the efforts of government, enterprises, universities, research institutes, and end-users." (Compilation and Translation Bureau, 2016).

To the best of the researcher's knowledge there has been no research in speculating how long it takes for FDI to affect the innovative environment. There have been studies which have lagged the FDI variable, for example in (Lin & Cheung, 2003)'s study the FDI variable was lagged by one year. I will test relevant lagged time variables and then speculate groups of regions in the speed of absorption of the innovative environment relevant to FDI. (Dunning, The Eclectic (OLI) Paradigm of International Production: Past, Present and Future, 2001)'s OLI theory recognises the location specific advantages needed present in order for a region to benefit positively from spillovers. These location specific advantages will be measured in this study by means of human capital and technology. This theory and previous studies such as (Huang, Liu, & Xu, 2012) and (Lin & Cheung, 2003) back up many of the hypotheses' in this study however OLI theory nor other research papers recognise the time effect.

2.11 Research Model

Please see my research model below. This is the graphical representation of my research question. The independent and dependent variables are shown in oval boxes. The factors which make up these variables are shown in square boxes. At the top of the model we have moderating factors 'IT capability' and 'Education funding' which may play part in the effects between the dependent and independent variables. A straight line represents 'influence on' and a curved line represents 'time to influence'. Imports is used as an element of FDI because this causes import spillovers by means of reverse engineering, "Import spillovers occur when importing firms observe and imitate foreign producers' technology, i.e. by reverse engineering." (Liu & Zou, 2008)

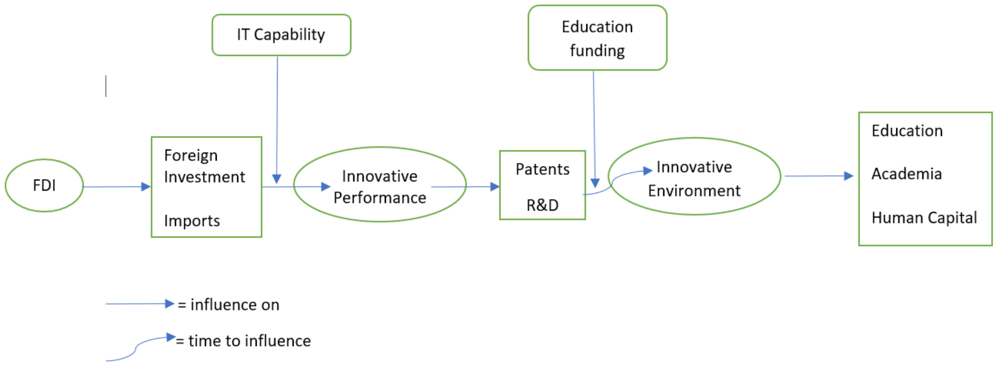

Figure 2.1 Research Model

2.12 Hypotheses

Based on the results from previous research and the phenomenon's regarding how spillovers transfer from MNCs to domestic firms, I am expecting a positive relationship between FDI in a region and Innovative performance. However, I expect the regions levels of previous FDI and technology to play influence on the strength of this relationship. Like in (Huang, Liu, & Xu, 2012)'s study which found there to be "clear evidence of a double-threshold effect of the level of regional innovation on productivity spillovers from FDI in China." (Huang, Liu, & Xu, 2012)

Although previous research has conflicting results regarding hypotheses 1 and 2 depending on the region, I believe that as per my analysis the Chinese government have put regulations and structures in place to satisfy the location specific advantages as per (Dunning, The Eclectic (OLI) Paradigm of International Production: Past, Present and Future, 2001)'s OLI theory to benefit positively from FDI. Previous studies analysing the relationship between FDI and spillovers such as (Huang, Liu, & Xu, 2012) and (Lin & Cheung, 2003) conclude that overall positive spillovers occur in China. These positive correlations occur because of demonstrations effects, Local Linkages and labour turnover. (Spencer, 2008)

Hypothesis 1: There is strong positive correlation between FDI and the Innovative performance of a region.

Hypothesis 2: There is strong positive correlation between FDI and the Innovative environment of a region.

Hypothesis 3 is based on the technology gap phenomenon as mentioned in papers by (Huang, Liu, & Xu, 2012), (Castellani & Zanfei, 2006) and (Sawada, 2010).

As regions attain a high level of technology based on previous research they appear to be better equipped to benefit positively from spillovers. This is because they have stronger location specific advantages (Dunning, The eclectic paradigm as an envelope for economic and business theories of MNE activity, 2000) to benefit positively from spillovers. From these studies I have concluded the hypothesis that regions with high levels of technology will show high returns.

Hypothesis 3: Regions with high (low) levels of Technology show a strong (weak) relationship between FDI and Innovation Performance.

Hypothesis 4 will speculate whether the level of FDI received to a region previously can increase the absorption rate. This will identify if there is advantage in previously receiving high levels of FDI in the absorption rates. Maybe local governments can adapt better to benefit from previous experience more. With years of previous positive spillovers from FDI, these regions may have strong location specific advantages to better absorb positive spillovers as per (Dunning, The Eclectic (OLI) Paradigm of International Production: Past, Present and Future, 2001) OLI theory. Furthermore, from previous research it is evident that non-developed regions which have comparatively before received low amounts of FDI such as Venezuela from (Aitken & Harrison, 1999) study, Czech Republic from (Djankov, Simeon, & Hoekman, 2000) study and Bulgaria from (Konings, 2000) study tend to experience negative spillovers.

Hypothesis 4: Regions which have previously received high (low) levels of FDI show a strong (weak) relationship between FDI and Innovation Performance.

Hypothesis 5 is a similar principle to the technology gap. Only it is to identify the effects of education gap on absorption rates. Results from (Xu, 2000)'s study "suggest that a minimum level of human capital may be required before a country can benefit from technology spillovers from MNEs." If a region has a low level of education they may not have the intellectual know how to observe the multinational corporations and adopt their processes in the domestic economy. This hypothesis is in accordance with (Dunning, The Eclectic (OLI) Paradigm of International Production: Past, Present and Future, 2001)'s OLI theory that a region with better human capital capabilities can benefit from positive spillovers.

Hypothesis 5: Regions which have previously received high (low) levels of Educational Funding show a strong (weak) relationship between FDI and Innovation Performance.

When considering the speed of time for the innovative environment to take effect from FDI and changing levels of Innovative Performance I expect the following hypothesis. The previous hypotheses measure the strength and weakness effect. The researcher recognises the relevance to measure the length of time it will take for spillover effects to take place. When regions have received low amounts of FDI, educational funding and have an underdeveloped innovative environment, reaction rates to spillovers may be smaller as they have not reached a certain level of absorption capabilities. There is little or no research into this phenomenon which strengthens the research gap of the paper. (Dunning, The Eclectic (OLI) Paradigm of International Production: Past, Present and Future, 2001)'s OLI theory recognises the ability in which a current locations advantage can positively avail of these spillovers however the theory does not necessarily identify the speed. Hypothesis 6, 7 and 8 recognise that because the extent of positive spillovers occurs in a region this will subsequently accelerate the speed of absorption. We expect these results based on similar principles to hypotheses 1, 2 and 5. Hypotheses 1, 2 and 5 will speculate the intensity of spillovers whereas hypothesis 6, 7 and 8 will acknowledge the speed to take effect.

The researcher recognises that because regions have previously received high amount of FDI the region is better equipped to benefit from positive spillovers. Similarly, as per hypothesis 6 we believe that this previous strengthening of the region by FDI will accelerate the speed in which the regions innovative environment benefits from FDI.

Hypothesis 6: The innovative environment of areas with high (low) levels of FDI are quickly (slowly) positively affected.

Hypothesis 7 shares some logic with hypothesis 2. Regions of high innovative environment are in a stronger position regarding location specific advantages as per (Dunning, The Eclectic (OLI) Paradigm of International Production: Past, Present and Future, 2001)'s OLI model. Based on this hypothesis the researcher will speculate as to whether this increase in absorption capabilities is in parallel with absorption speed.

Hypothesis 7: The innovative environment of areas with high (low) levels of Innovation performance are quickly (slowly) positively affected.

This hypothesis is important in order to identify when to expect positive effects from increasing educational funding. As per previous research from (Xu, 2000), (Ford, Rork, & Elmslie, 2008) and (Borensztein, Gregorio, & Lee, 1998) education and human capital environment is beneficial for spillovers. The researcher recognises this and speculates that this increase funding into education will place a regions innovative environment in a position to benefit at a speedier rate.

Hypothesis 8: The innovative environment of areas with high (low) levels of Educational Funding are quickly (slowly) positively affected.

I subsequently expect the inverse effect of the above hypothesis.

3. Methodology

As a means of introduction to the Methodology section of my research we shall review the research question and hypothesis. As stated in the Purpose of this study section of the paper the research question is stated as below

A regional study on how spillover effects from FDI has affected the innovation performance of a market and the time influence this has on the innovative environment.

To test for these research questions time series data is needed to inspect the effects and FDI and variables which give insight to Innovation.

Each hypothesis I stated in the previous section will also be carefully analysed upon confirmation.

3.1 Technical

There is very few economic theories or formulas for this topic. Because of this we see conflicting methods pursued as a means of analysis from previous literature.

One of the biggest decisions to consider is weather to use cross-sectional or panel data as an approach.

3.1.1 Cross sectional Data approach

Cross sectional is described as, “Widely dispersed data (such as per capita income) relating to one period, or without respect to variance due to time.” (Business Dictionary, 2019). Studies such as (Blomstrom & SjoKholm, 1999) (Blomstrom & Wolff, 1989) pursued this method. Some of the critiques for using this method for measuring spillovers from FDI is that cross sectional data does not consider other factors which may influence the result, these factors may be influenced by time or regional differences, “cross-sectional studies may overstate the spillover effects of MNCs on domestic productivity because they do not allow for other time-invariant firm or sector specific effects, which may impact on the relationship between MNCs and productivity, but for which the researcher does not have any information.” (Görg & Strobl, 2001)

3.1.2 Panel Data approach

On the other hand, Panel data can be described as “a dataset in which the behaviour of entities are observed across time.” (Torres-Reyna, 2007). This method has been used in studies by (Aitken & Harrison, 1999), (Lin & Cheung, 2003) and (Girma & Wakelin, 2000). Panel data has been the preferred method of choice more recently; however, it is important to consider publication bias, “the possibility of publication bias in the literature suggests that studies of productivity spillovers are more likely to be published if they find statistically significant results for the presence of either positive or negative spillovers.” (Görg & Strobl, 2001). For my study I will use a panel data approach because it will allow me to analyse the influence of FDI on a region’s innovation over the time period of 8 years, “they permit investigation of the development of domestic firms' productivity over a longer time period, rather than at one point in time.” (Görg & Greenaway, 2004). I will also include some insight to cross sectional data within my empirical evidence to strengthen and challenge my conclusions.

3.1.3 Moderating effects

We must also consider how external factors my influence the results of my findings. There are a variety of reasons for these factors which can include political, economic, social or technological factors. These factors may be due to changing trends over time or differences amongst regions. Also, the urban rural divide in China has further influenced the diversity amongst regional technological capability. Calculating by means of panel data allows me to measure for spillover effects but also control for these moderators which may be caused by difference in time or regional differences, "they allow investigation of spillovers after controlling for other factors." (Görg & Greenaway, 2004) This will then give a more accurate calculation between dependent and independent variables.

3.1.4 Panel data models

When using panel data, heterogeneity is applied across units (regions in our case). This means that each region is treated differently, "Heterogeneity in statistics means that your populations, samples or results are different." (Statistics How To, 2019). This is an important factor in our study. In a study by (Lin & Cheung, 2003), both panel data and pooled timeseries and cross-section data approaches were undertaken, when comparing results of both types of analysis they found that the FDI coefficients for panel data was smaller than pooled timeseries and cross-section data. This was because pooled timeseries and cross-section data overestimated the effects of FDI, "without accounting for provincial heterogeneity, the pooled data estimations appear to overestimate the effects of FDI." (Lin & Cheung, 2003)

Choosing panel data allows for consideration of other (invisible) effects which may impact the data. These influencing factors may be fixed effects, which means, "analyzing the impact of variables that vary over time." (Torres-Reyna, 2007). The other model contrasting to this approach is the random effects approach. This model considers parameters which can affect the results completely randomly, "the variation across entities is assumed to be random and uncorrelated with the predictor or independent variables included in the model" (Torres-Reyna, 2007). Many previous studies of this kind include both models as a means of result comparison. I will also include a pooled analysis correlation matrix to look for significance between all variables, this approach will also allow for me to pool regions by means of geography and provide an effective means of comparison.

3.1.5 Hausman Test

A Hausman Test is usually conducted to select suitability between a fixed effect or a random effect model, "specification tests are devised for a number of model specifications in econometrics. Local power is calculated for small departures from the null hypothesis.” (Hausman, 1978). This well-known test has been empirically reviewed and used as a basis of suitability of choice regarding a fixed effect model or a random effects model. The reasoning behind the test is that “if there is no correlation between regressors and effects, then FE and RE are both consistent, but FE is inefficient” (University of Sterling, 2015), thus proving the parameters are random and a random effect model should be pursued if the Hausman tests returns probability of less than 5% the null hypothesis must be accepted and a fixed effects model is more suitable, contrastingly if the probability is greater than 5% a random effects model is more suitable, “The corresponding P values under the Hausman test (.06 and .11, respectively) suggest that the null hypothesis that the random effect model is the correct specification cannot be rejected at the 5% level”

The following is an example of a panel data formula with fixed effects.

$Yit = \beta 1Xit + αi + ui$ (2.1)

Where Yit is the dependent variable for region i and time t.

Xit is the independent variable for region i and time t.

αi is the unknown intercept for each entity

$\beta 1$ is the coefficient for Xit

$u$it is the fixed effects error term

The random effect model formula is very similar to the fixed effect model however the random effects model contains an extra factor, like below.

$Yit = \beta Xit + α + uit + \varepsilon it$ (2.2)

This new factor εit is an additional error term for control for within entity error terms.

Source: (Torres-Reyna, 2007)

When considering moderating effects, the results can be strengthened for by including additional independent control variables as moderators which may influence the variable. This additional data can be especially effective in increasing the accuracy of spillover effects. As seen in study by (Lin & Cheung, 2003) they formulated the following formula when measuring the effects of FDI on patent applications.

$Patent_{it} = \beta_0 + \beta_1 FDI_{it-1} + \beta_2 S\&Tper_{it} + \beta_3 S\&Texp_{it} + \beta_4 Fexport_{it} + \beta_5 PGDP_{it} + \varepsilon_{it}$ (2.3)

"subscripts i and t denote province and time period, respectively. We use the number of patent application (Patentit) as a measure of R&D output. FDI_{it-1} refers to the realized value of FDI in province i in year t-1." (Lin & Cheung, 2003) These are the main dependent and independent variables (Lin & Cheung, 2003) are researching in their study, however, to consider other variables to strengthen the resulting spillover effects from FDI (β_1) (Lin & Cheung, 2003) included the following, "As measures of input to R&D activity, we include the number of personnel for science and technical development (S&Tperit) and expenditures on science and technical development (S&Texpit)". Similarly, reasoning for $Fexport_{it}$, "include the share of foreign funded enterprises' export to its gross output (Fexportit)" (Lin & Cheung, 2003). PGDP was included to "to account for the fact that different provinces are at different stage of economic development so that their innovation capabilities should also differ, we include the level of per capita GDP (PGDPit) in our estimation." (Lin & Cheung, 2003).

3.2 Type of data needed

Firstly, we must consider the input values needed to measure the spillover effects from FDI. As previously mentioned in the literature review these spillover effects can come in a variety of forms. We must collect the relevant data which fuel the following phenomimes between MNC's and domestic firms.

(i) Reverse Engineering, (ii) Demonstration effects and (iii) Supplier-customer relationships

When measuring for Foreign direct investment, it is important to consider how far to go regarding the measurement of data. Furthermore, each variable must have a direct effect on the above spillover effects, as these are the vehicles which carry our speculation between the dependent and independent variables.

Firstly, I will include the Investment of foreign firms as a factor for FDI figure. This figure will be the Actual Utilization of FDI per region in China. This will be a measure of all inward investment from abroad. This will include inward investment of greenfield venture by foreign firms in regions in China and inward funding for Mergers & Acquisitions involving domestic firms. Foreign presence in the market will increase accessibility of foreign knowledge and innovations in the region and will thus cause an increase of reverse engineering of foreign innovations in the region.

This figure for Actual Utilization of FDI is the figure which funds the wages and salaries of each worker in each foreign firm in the region. As previously defined, the demonstration effects occur from employee turnover from MNC's to the domestic firms. The knowledge attained from demonstration effects is funded by salaries and the extent to which is a direct influence of the Actual Utilization of FDI. Therefore, this will be a reliable source for fuelling demonstration effects as a spillover.

Supplier-customer relationships can spur spillover effects because it gives local firms the opportunity to position themselves in the MNC's supply chain. This can provide valuable expertise and even in some cases helps MNC's in training and technology transfer to the domestic firms to ensure high quality throughout their supply chain. "The demands of MNEs for local inputs may increase the backward and forward activities of local industries, and local firms can learn about the designs of new products and technology through interaction with foreign firms." (Liu & Zou, 2008)

The presence of MNC's comes in the form of greenfield investment and merger and acquisition and can therefore be measured as Actual Utilization of FDI, the basis figure for these activities.

Another effective factor in measuring the amount of FDI into a region is imports. Imports can supply a market with high-tech and innovative products which can be used as a source of motivation for creating new technologies. This figure can satisfy FDI spillover by the means of reverse engineering. Access to these products give domestic firms opportunities in observing innovations from abroad and then applying reverse engineering techniques to adapt the current products or act as a means of motivation to create a new product.

Innovation can be a broad and highly disputed topic. We even see contrasts and debates in 'simply' defining the phenomenon. For this study I have broken innovation into two different phenomimes (i) innovation performance and (ii) innovation environment.

3.2.1 Innovation Performance

Innovation performance consists of the innovation output in a region from a business context. For this variable we are measuring the levels of innovative activities as an output variable. Innovative activities consist of activities which "involves deliberate application of information, imagination and initiative in deriving greater or different values from resources, and includes all processes by which new ideas are generated and converted into useful products." (Business Dictionary, n.d.). One means of measurement for generation of new ideas in a region is the number of patents granted.

In measuring innovation performance, I think it is important however to not just focus on the number of patents granted. In this case there are some aspects of innovation performance we may be neglecting. For example, many firms choose against filing for patents for certain products and choose the strategy of trade secret instead. This gives the firm the advantage of keeping the information secret, out of the public domain and reduces the potential of reverse engineering by competitor firms. Furthermore, one highly innovation patent may contain a higher level of innovation and creativity than other variables and yet they will still hold the same value in this respect. Highly innovative R&D projects may require higher innovation power as opposed to a patent filed for the sake of obstructing competitors.

For these previously stated reasons in accordance with number of domestic patents granted I must also include a figure which can express R&D activities in regions in China. It must give an accurate representation of the R&D projects funded in China with the intention of discovery and idea generation.

3.2.2 Innovative Environment

The innovation environment, on the other hand consists of the environmental factors needed in a region to nurture effective creation of new ideas. Considering innovative ideas within firms come mainly from Science and Technology activities, highly educated employees are needed for idea generation. For this reason, I must include a variable which accurately measures the educational environment in a region. This figure should portray the importance of higher education by the population.

There has been greater concern placed on the importance of research institutions in being involved in satisfying the innovation focus of the most recent 5-year plan. Third level institutions are key players in the academic side of innovation performance. They are the funders of many research projects and often work in accordance with firms for these projects. To measure this variable, we need to measure the activity of academic institutions within regions in China. This kind of data should ensure the academic output level is of adequate standards.

We also need data which can represent internal capabilities of companies to generate new ideas. Education focus' mainly externally to the firms but can still highlight the availability of people, thus strengthening the innovation environment from activities external to companies. Academic institutions act both with and without corporations and still engage in research and other innovative projects. To ensure each angle (company internal and company external) is considered in measurement, regarding corporation involvement we need a variable which can represent the internal capabilities of a corporation to create new ideas. This variable can be in the form of Human capital but must have a focus on the business's idea generating abilities.

I will also need to include some variables to act as control variables. By this I mean other variables which may have input on the result. These will act as independent variables. Inclusion of these will strengthen the resulting covariance outcome for spillovers from FDI.

3.3 Data Collection

All my data will be collected from a variety of sources. The Chinese national bureau of statistics will be used for the following variables.

Education, Human Capital, Imports, Innovative environment, Innovation performance, Investment, Per capita GDP, R&D Spending, Invention patents, Utility Patents, Design Patents, Granted Patents

There is no one source readily available which contains inward FDI to regions in China. For this reason, I must search through individual regions statistic yearbooks and extract the data. Not every region has the official figure for 2017 released, for this reason the most recent data must be 2016.

For academic citations I used Elsevier as a source. Elsevier peer review and constantly examine the standards of journals they publish to ensure utmost academic trust and quality. The data is used in identifying the amount of papers published from each region. The data for each year only provides the 160 most publicised institutions for mainland China, Taiwan and Hong Kong.

3.4 Measuring statistical relationship

Once all the relevant data is collected, I must then decide on the methods of measurement which needs to be undertaken to satisfy the research question. When looking at research question one which investigates the effects of FDI on innovative performance we can take several different approaches to cover all angles. As previously mentioned the FDI figure will consist of the sum of FDI actually utilized and total imports. The formula will be represented as below.

$$TotalFDI_{it} = \ln FDI_{it} + \ln Imports_{it} \quad (3.1)$$

Because my data is categorical (by region) and time series this means my dataset is a panel data set. I will use software package EViews as it is ideal for analysing panel data. Before inputting my data to EViews I will convert each figure into natural logarithms. This is because of the various units of measurement my data will contain. Converting to the natural log will only consider the percentage, this method will better analyse (for example) the degree of change one patent has on one dollar.

The most effective way to get an overall analysis of how each variable interacts with each other will be to produce a correlation matrix of all input variables. This method quickly identifies variables of high correlation and low correlation. It can highlight certain factors of formulas which have stronger relationships with the independent variable. It will also be beneficial to run these types of correlation matrix's by pooling different categories of regions together and comparing the differences e.g. geographical location. To ensure statistical accuracy, the researcher will only be considering results with a probability statistic of less than 5%. If there are not enough statistically significant results returned the researcher will make variations of the model until strong statistically significant conclusions can be made.

To measure the effect of FDI on innovative performance the researcher will input a formula consisting of the relevant independent and dependent variables. The researcher will include extra independent variables which is necessary to act as moderators. However, upon return of results the researcher will only focus on the relationship between FDI and Innovation Performance, like the correlation matrix analysis, probability statistics will need to be below 5% to be of statistical relevance. The correlation coefficient will be the resulting spillover effects of FDI on innovation performance. Similar analysis between FDI and the innovation environment will be conducted to get an insight of the relationship.

There are three different methods I can execute for the regression analysis. The first one is the pooled OLS (ordinary least squared) method, this will assume that unobservable characteristics are uncorrelated with the independent variables. This method also does not recognise regionally specific effects. I will include this analysis as a means of comparison to the other methods. In satisfying this comparison, my next two models will be factors of individual-specific effects model, these models "assume that there is unobserved heterogeneity across individuals" (Kalita, 2013). From theory this is a more suitable approach as there is a variety of examples of how individual effects can affect the results, e.g. Policy or economic factors. I will conduct a fixed effects model which presumes that these individual effects vary over time and have a relationship with the independent variable (FDI). The final model I will conduct is the Random effects model, which presumes these effects act completely randomly and have no correlation with the independent variable.

For research question one we will have the below formulas

$$GrantedPatents_{it} = \ln GrantedInvention_{it-1} + \ln GrantedDesign_{it} + \ln GrantedUtility_{it} \quad (3.2)$$

$$InnPer_{it} = GrantedPatents_{it} + \ln R\&DSpending_{it} \quad (3.3)$$

$$InnPer_{it} = \beta_0 + \beta_1 TotalFDI_t + \beta_2 PGDP_{it} + \varepsilon_{it} \quad (3.4)$$

$InnPer_{it}$ is the variable for innovation performance from region i time t. Innovation performance consists of the sum of all the granted patents plus R&D spending. Please note that invention patents are taken from the previous year as the validation process takes around one year. Equation 3.4 is the panel data approach for measuring the spillover effects on innovation performance from FDI. The spillover effects will be the resulting correlation coefficient which is represented by β_1. Calculation of this will either prove or disprove hypothesis 1. $PGDP_{it}$ is included in our formula to consider the varying stages of development for each region. β_0 is the intercept.

For each of the three models, equation 3.4 can be used. However, there are different interpretations for the error term factor, ε_{it}. For the pooled regression model, as previously mentioned this error term assumes, “that there is unobserved heterogeneity across individuals” (Kalita, 2013). Regarding the fixed effects model this error term is treated as if, “the individual-specific effects are the leftover variation in the dependant variable that cannot be explained by the regressors” (Kalita, 2013). The random effects model includes β_0 in the error term. For this model, it is assumed “that the entity’s error term is not correlated with the predictors which allows for time-invariant variables to play a role as explanatory variables.” (Torres-Reyna, 2007).

3.4.1 Hausman Test

It is difficult to decide which is the most appropriate model to use based on the type of data as considering whether the regressors and effects share correlation is difficult based on a large amount of data. Furthermore, the effects may change depending on the grouped region. For this reason, the researcher will run a Hausman Test for each model to highlight the most statistically relevant results to consider, fixed effects model or random effects model.

3.4.2 Relationship between Innovative Environment and FDI

For analysing research Question two I will use the following formula in measuring the innovative environment for region i time t.

$$InnEnvi_{it} = \ln Edu_{it} + \ln Aca_{it} + \ln Hum_{it} \quad (3.5)$$

$\ln Edu_{it}$ is used to measure education. The variable to measure academia, $\ln Aca1_{it}$, and $\ln Hum_{it}$ for human capital. Similar to the previous panel data formula, the below panel data formula will be used to measure the relationship between Total FDI and the Innovation environment.

$$InnEnvi_{it} = \beta_0 + \beta_1 TotalFDI_t + \beta_2 PGDP_{it} + \beta_3 EduFund_{it} + \varepsilon_{it} \qquad (3.6)$$

This formula contains two control variables. $PGDP_{it}$ is included for the same reason as the previous panel data equation. Furthermore $EduFund_{it}$ is included as an independent variable because it highlights the fact that different regions have different levels of educational funding which will affect the innovative environment. In this case $\beta_1$is the spillover effects on the innovative environment caused by total FDI.

To inspect the relationship between the innovative performance of a region and the effect this has on the innovative environment of a region we will pursue the following formula.

$$InnEnvi_{it} = \beta_0 + \beta_1 InnPer_{it} + \beta_2 PGDP_{it} + \beta_3 EduFund_{it} + \varepsilon_{it} \quad (3.7)$$

Pooled regression models, fixed effect models and random effect models will be conducted for each panel effect model. In this case β_1 will be the correlation coefficient which will represent the effect the innovative performance poses on the innovative environment.

Calculation of this β_1 correlation coefficient in equation 3.7 will either prove or disprove hypothesis 2. The methodology for analysing hypothesis 3 (Regions with high (low) levels of Technology show a strong (weak) relationship between FDI and Innovation Performance.) will be the same panel data approach as previous, however the regions will be divided into three separate groups depending on the value of the regions technical market (low tech/medium tech/high tech) and the analysis will be ran three separate times and the results shall be compared. A similar grouping approach will be taken with hypothesis 4 (Regions which have previously received high (low) levels of FDI show a strong (weak) relationship between FDI and Innovation Performance.) with the groups being (low FDI/medium FDI/high FDI).

3.5 Lag Time Effect

To measure the time for inward FDI to take effect on the innovative environment of a region we will measure what is the suitable lag time between innovative performance and total FDI variables. The lag time is the most suitable approach for this measurement, "to capture dynamics and temporal dependence is to include the lagged Y term" (Finkel, 2015), For the data we have, there are two models for measuring this effect, the Vector Autoregression (VAR) model and the Vector Error Correction model. When the data is not cointegrated the Vector Autoregression Model is suitable, when cointegrated the Vector Error Correction model is more suitable. "If each element of a vector of time series x, first achieves stationarity after differencing, but a linear combination a'x, is already stationary, the time series x, are said to be co-integrated with co-integrating vector a" (Engle & Granger, 1987). We speculate cointegration between variables however, to ensure the most relevant model selection the researcher will run a Johansen test of cointegration. The test will return the probability of the null hypothesis for there being no cointegration. If the probability of this is greater than 5% null must be accepted, meaning there is no cointegration and the VAR model is most appropriate. If there is a return of less than 5% the null is rejected meaning there is cointegration and a Vector Autoregression model is more acceptable.

We will run the appropriate model at every interval accepted and take note of the Akaike information criterion (AIC), “Akaike information criterion (AIC) is a fined technique based on in-sample fit to estimate the likelihood of a model to predict/estimate the future values.” (Mohammed, Naugler, & Far, 2015). This criterion returns a result which will be noted. At the end of running the model for each lag criteria the AIC results will be compared. The lowest value will be the most suitable selection for the lag effect. This approach will prove or disprove hypothesis 6,7 and 8. I will use a similar grouping approach as I did with the correlation analysis and then compare the results.

4. Data Analysis & Results

This chapter will analyse and describe the data which I have used in my research.

4.1 Datasets

The below is a description of the datasets I will use.

4.1.1 Chinese Regional

I will use Chinese regional data throughout my study. This includes 30 of the 31 provincial level regions in China consisting of 23 provinces, 4 municipalities (Beijing, Tianjin, Shanghai, Chongqing), 4 autonomous regions (Guangxi, Inner Mongolia, Tibet, Ningxia, Xinjiang). Tibet will be omitted due to lack of reliable information. These provincial level regions can be found in table 4.1. Throughout my studies I will group regions categorically depending on their geography (table 4.1), level of FDI received (table 4.2) and technical market (table 4.3).

4.1.2 Time series

The time used in research is data ranging over 8 years from 2009 to 2016. Ideally a full decade was the objective, however there is a lack of available data for certain regions FDI which posed me the make the decision to narrow the time span rather than narrowing the data quality. At the time of research, certain regions were yet to publish their 2018 statistical yearbook which caused me to omit the 2017 figures from the analysis.

4.2 Key Variables

The below is a description of the key variables used in the study.

4.2.1 Independent Variables

The independent variable will be FDI. To get an overall representation for FDI, equation 3.1 was formulated

Imports will be used as the Total Value of Imports of operating units (1,000 US dollars) sourced from the Chinese nation bureau of statistics. As mentioned previously Imports can be a great measure of foreign products which can influence the innovation of a region by means of reverse engineering.

The figure used for foreign direct investment will be Foreign Capital Actually Utilized. This figure is an effective means of measurement as it portrays the amount of inward funding from MNCs to specific regions in China. This represents wages, infrastructure, projects etc. It can be a driver of FDI spillover effects by means of reverse engineering or demonstration effects. These figures were sourced from the statistical yearbooks of each region.

4.2.2 Dependent variables

There is no one variable which can portray the innovative performance of a region. For this reason, the researcher has chosen to add the natural log of the variables in equation 3.3.

Granted Patents can be an effective indicator of the innovative activities undergone in a region. It represents new ideas and innovations. It will be measured by means of Number of Domestic Patents Applications Granted (item). This figure will be made up of domestic, invention and utility patents. It takes around 6 months for domestic and utility patents to be granted. Because it takes around 1 year for utility patents to be granted, we will lag the value for invention patents by 1 year, so it corresponds with the year in which the innovative activity was undergone. The researcher will analyse these figures separately as previous literature has speculated on the innovation superiority invention patents may hold over domestic or utility patents. These figures have been sourced from the Chinese National Bureau of Statistics.

R&D activities can provide an accurate portrayal to the innovative activities undergone in a region. It can represent the time and money investment by firms on the creation of new ideas. The input to R&D will be represented by, Expenditure on R&D

of Industrial Enterprises above _Designated Size (10000 yuan). These figures have been sourced from the Chinese National Bureau of Statistics

Using panel data, it is important to consider other variables which may affect the outcome of the spillover effects. To highlight the fact that certain regions are at different levels of development I have included per capita GDP and Per Capita Gross Regional Product (yuan/person) as control variables. These figures have been sourced from the Chinese National Bureau of Statistics.

Similarly, with the innovation performance, the innovation environment of a region can be a broad topic and should be represented by several variables in order to increase accuracy. Equation 3.5 contains the variables to express this phenomenon.

Education is a key representation of the access to educated individuals for idea generation-based activities. The figure will be represented by, Number of Students Per 100 000 Population in Higher _Education (person). I included higher education because a large proportion of employees who engage in R&D and S&T projects have higher level education. These figures have been sourced from the Chinese National Bureau of Statistics.

There has been ever more importance on educational institutions and universities involvement in the innovative potential of each region. To portray the quality of the academic environment per region in China I use the number of publications affiliated with Chinese institutions which have been published on the Scopus database, "Scopus is the largest abstract and citation database of peer-reviewed literature: scientific journals, books and conference proceedings." (Elsiever, 2019). This is a world-renowned reliable source of academic publications. To ensure utmost reliable and academic credibility it is, "Updated daily, Scopus delivers the most comprehensive overview of the world's research output in the fields of science, technology, medicine, social sciences and arts and humanities." (Elsiever, 2019). Unfortunately, when researching the Chinese affiliated intuitions information, only 160 institutions with the highest amount of publications can be attained per year. Any institution after this point will be omitted from that year's data.

To drive the idea making abilities of an innovative environment, consideration of the readily available human capital resources in a region will be made. This variable will be measured as, Full-time Equivalent of R&D Personnel of Industrial _ (man-years). These figures have been sourced from the Chinese National Bureau of Statistics. For the year 2010, the only figure available was Full-time Equivalent of R&D Personnel of Industrial _Enterprises for large and medium enterprises (man-years). The personnel part of the figure was the same, only the size of companies used in the calculation of the figure was different. Using the 2008 and 2009 figures for both 1/Enterprises above Designated Size and 2/large and medium enterprises I estimated the 2010 human capital figure as per table V in appendix.

To consider the amount invested in education as an additional factor which may influence calculating the result of spillovers of FDI on the innovative environment, educational funds will be included as a moderator. “Educational Funds refer to the total investment in education funding, including the state education budget, social groups and individual citizens school funding, donations funding, tuition and fees, other educational expenses.” (National Bureau of Statistics of China, 2019). Considering the innovative environment includes educational, academic and (skilled) human capital variables the funding of education to a region may affect these outcomes. The educational funds figure for 2012 is omitted from the National Bureau of statistics website, when running panel data this removes consideration of all contributed 2012 data. To avoid this, I will run the data twice, with education funds and without educational funds to get as clear a picture as possible. These figures have been sourced from the Chinese National Bureau of Statistics.

4.3 Summary Statistics

4.3.1 FDI Analysis

Regarding Total FDI (FDI utilized + imports) we have seen a downward trend in the total Imports and Total FDI figure Since 2014, for researched regions can be seen below,

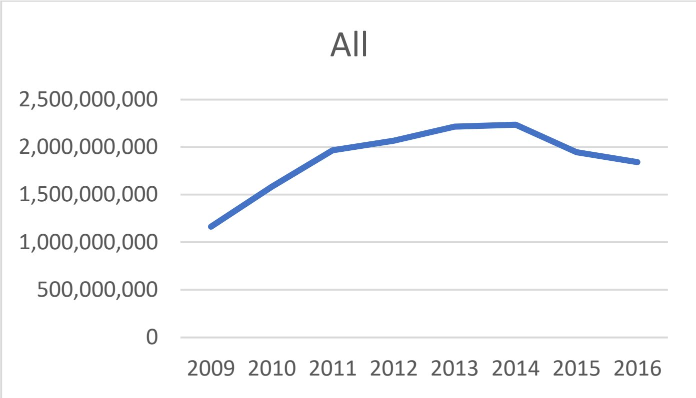

Figure 4. 1 Total FDI

The accumulated Total FDI (FDI utilized + imports) for the 8 eight-year period from order of most received region to least received can be seen below.

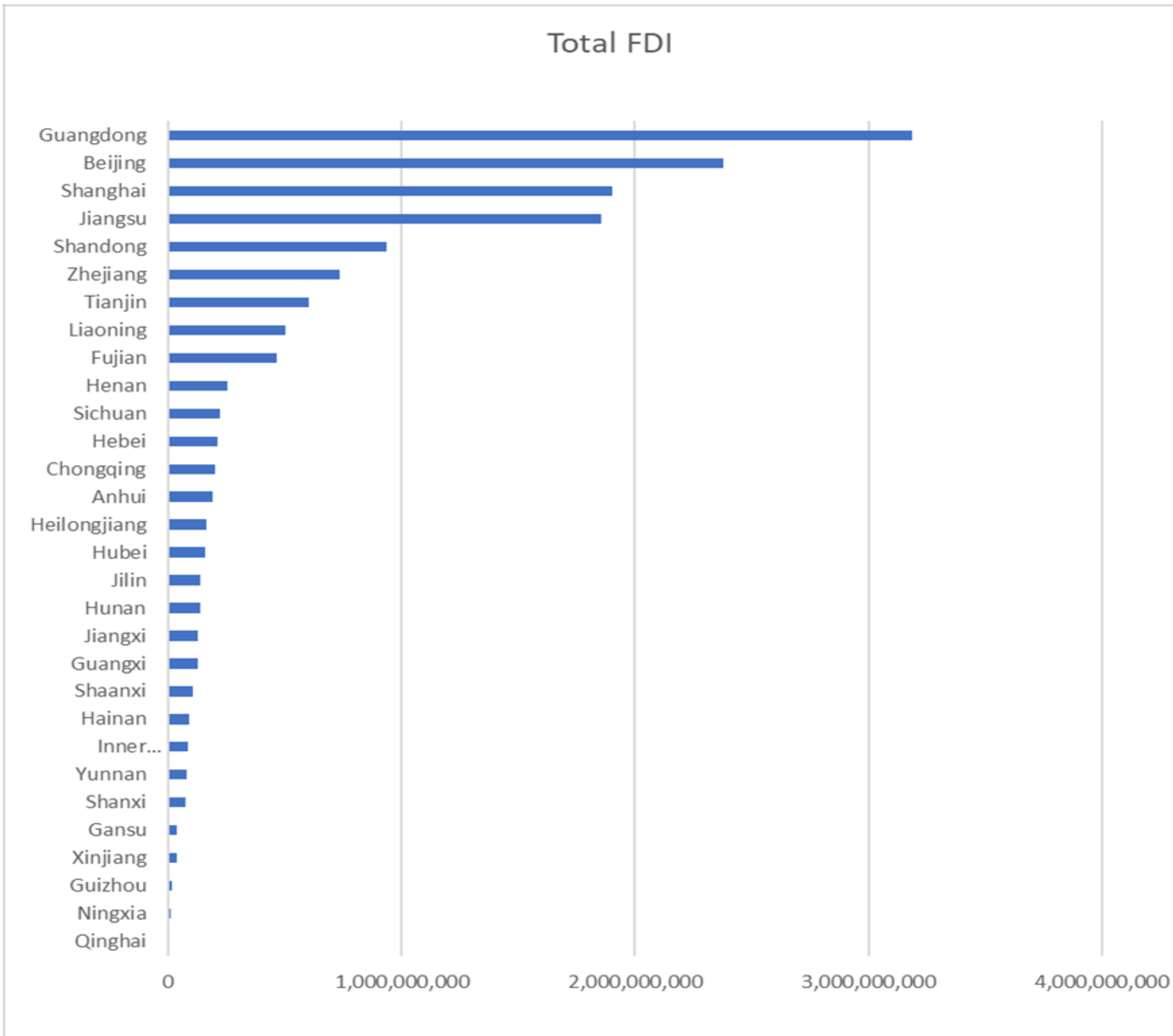

Figure 4. 2 Total FDI by region

As you can see a large proportion of this is concentrated in certain regions, in particularly Guangdong, Beijing, Shanghai and Jiangsu, making up over 62% of the total.

Each of these regions are situated in the highly attractive eastern region. Although this figure has decreased recently, it still equates to a largely disproportionate distribution through China, as per figure 4.3 the percentage of eastern regions contribution to total FDI has decreased from 89% to 83%.

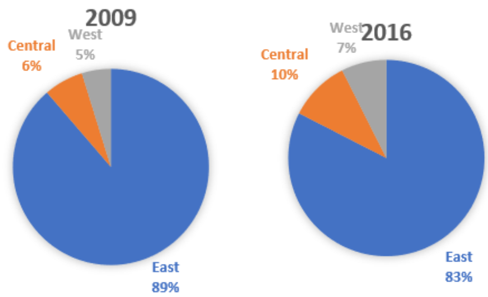

Figure 4.3 Total FDI by geographic location 2009 vs 2016

In the 8 years since the research, this minor loss in percentage from the eastern regions has been absorbed predominantly by the central region.

The region which has experienced the largest amount of FDI actually utilized has been Jiangsu. The amount for Total amount of FDI actually utilized fluctuates somewhat depending on the year. This number is rarely consistent please see below line graph showing the amount of foreign investment actually utilized per region over the 8-year period.

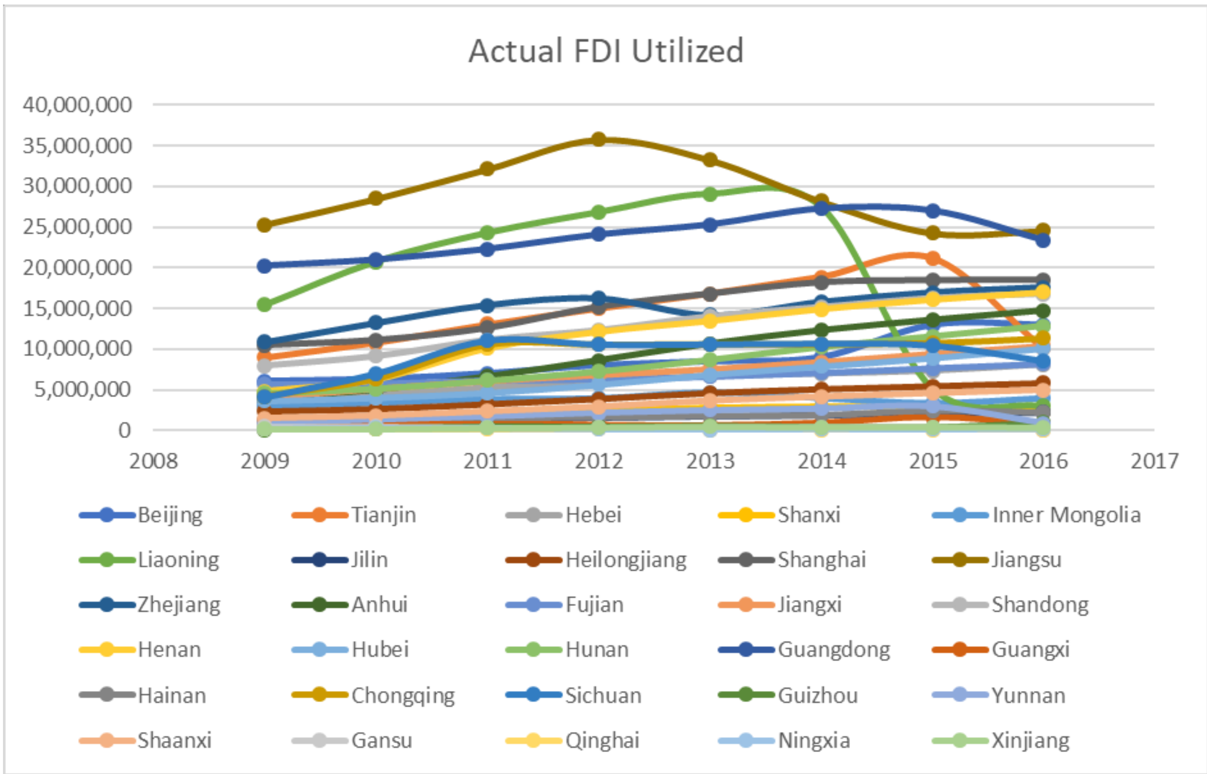

Figure 4.4 Actual FDI utilized by region

The above graphs represent the sudden change in foreign investment from year to year. It captures the downward trend in foreign investment actually utilized for certain regions, despite an average inflation rate of 2.32% over this period. (The World Bank, 2019)

Nonetheless, foreign capital actually utilized has experienced substantial gains in the 8 central regions. Nearly doubling in percentage from 2009 to 2016 as per figure 4.5.

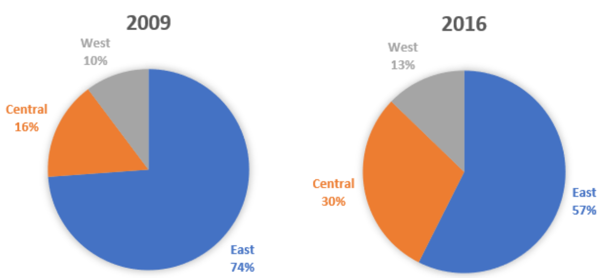

Figure 4. 5 FDI actually utilized by geographic location 2009 vs 2016

Imports has followed a slightly similar trend as to foreign investment actually utilized in showing a decrease since 2014.

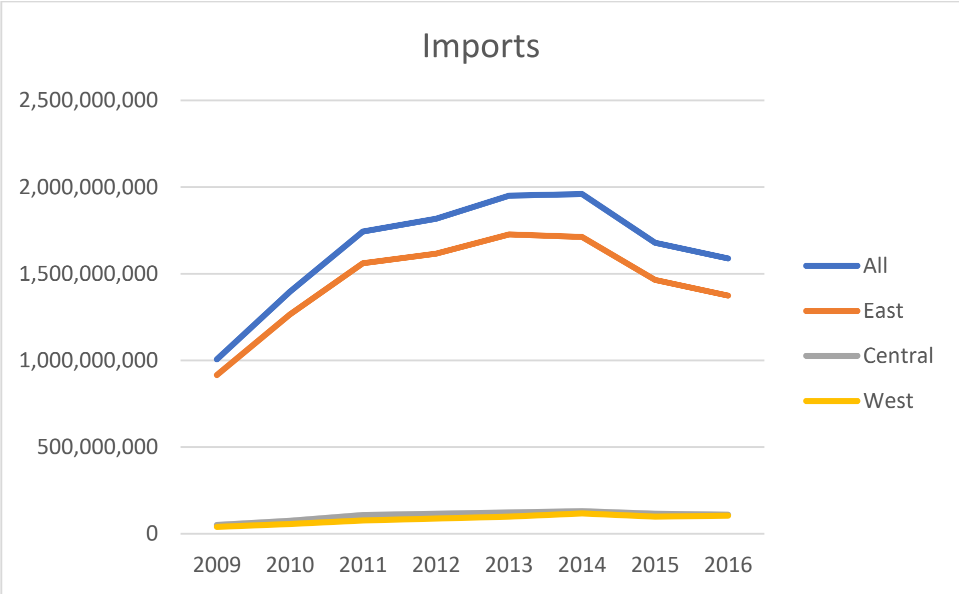

Figure 4.6 Imports by geographic location

The shares have not fluctuated rapidly depending on region. The total figure is fuelled largely by the eastern regions as we can see from the chart.

4.3.2 Innovation Performance Analysis

Moving onto analysis of innovation-based statistics. Granted patents has increased at a fast and steady rate as you can see below.

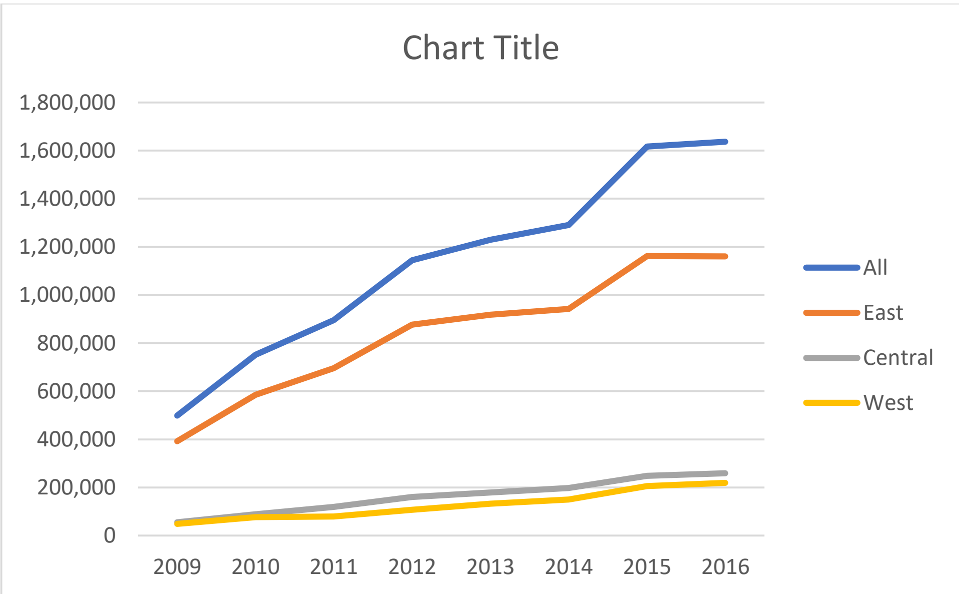

Figure 4. 7 Granted patents by geographic location

Passing 1,000,000 granted patents in 2012 alone and further surpassing the 1,500,000 point in 2015. This shows the rapid adoption of patents in the Chinese market. As you can see the figures are once again fuelled strongly by innovative activities in the eastern region. The below ranking shows nearly 40% of the patents in China over this period are concentrated in Jiangsu, Zhejiang and Guangdong.

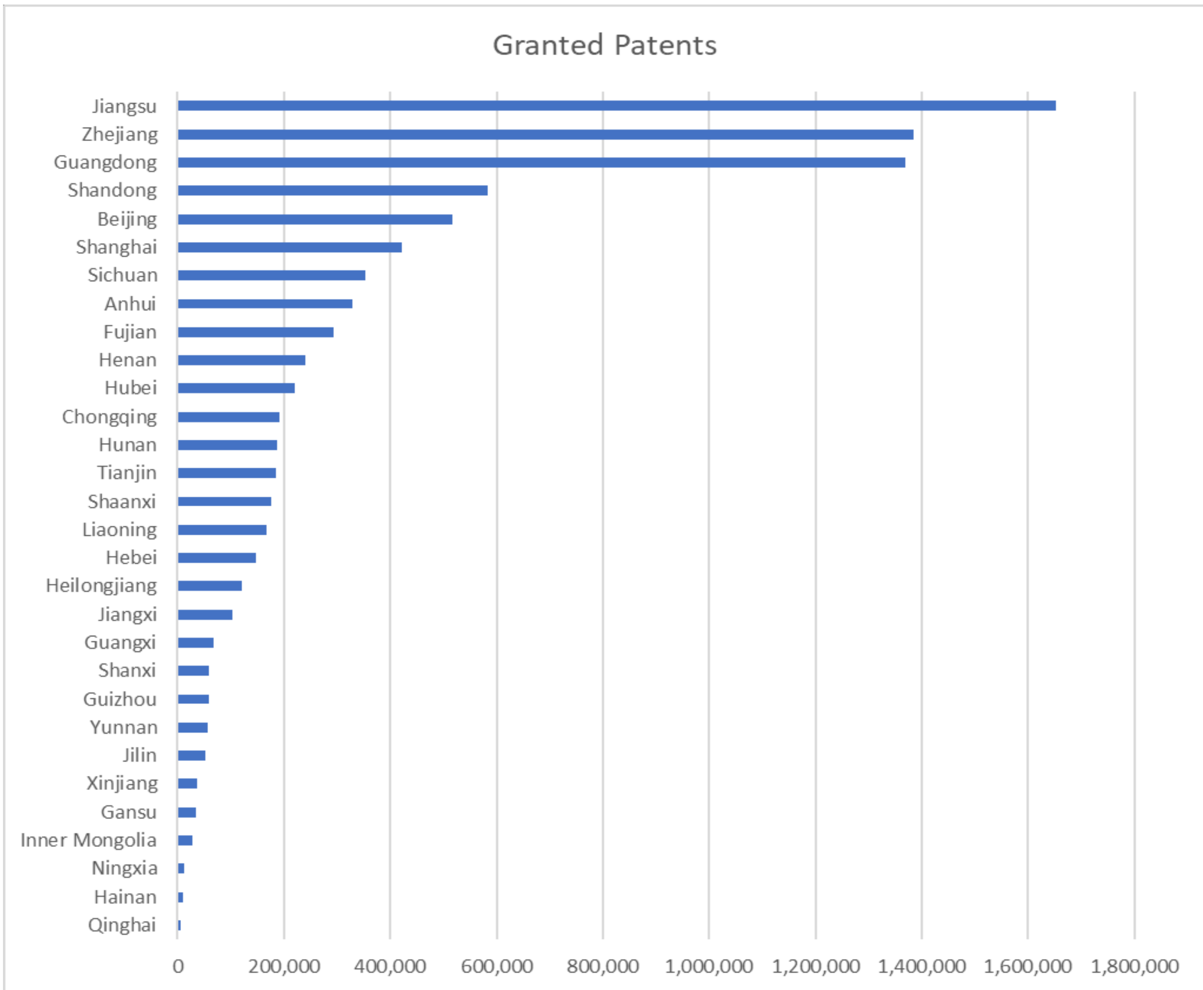

Figure 4. 8 Total Granted patents per region for period 2009 to 2016

The spending on R&D has been on a steady incremental increase. Below shows Average spending on R&D of Industrial Enterprises above _Designated Size per region.

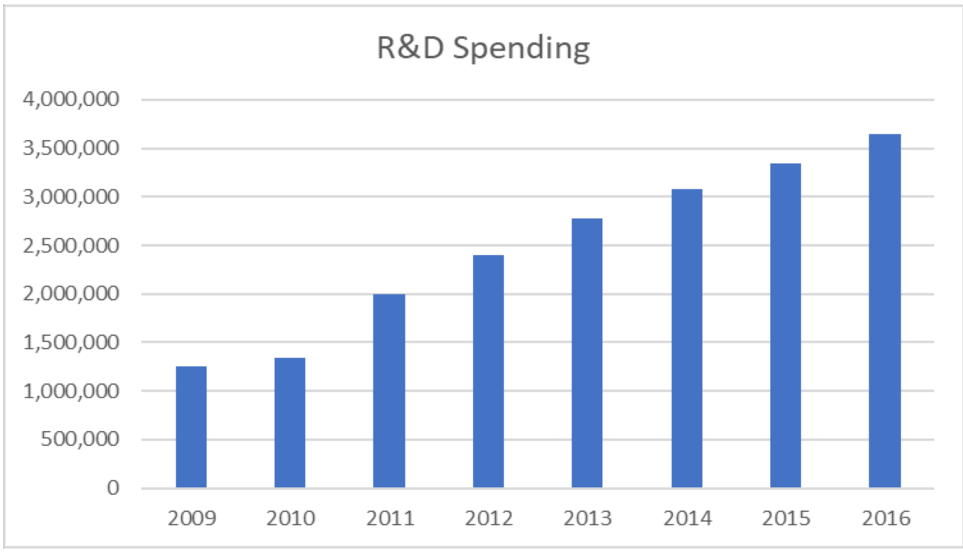

Figure 4. 9Total average spending on R&D of industrial enterprises above designated size

This average R&D spending per region figure has increased by 190% over the 8-year period to 36,480,860,000 RMB, this can portray the importance companies are placing on R&D activities. The relationship between this figure confirms the hypothesis that funding to R&D contributes to patent output. 4 of the top 5 regions in total patents granted are also the largest regions for total R&D spending.

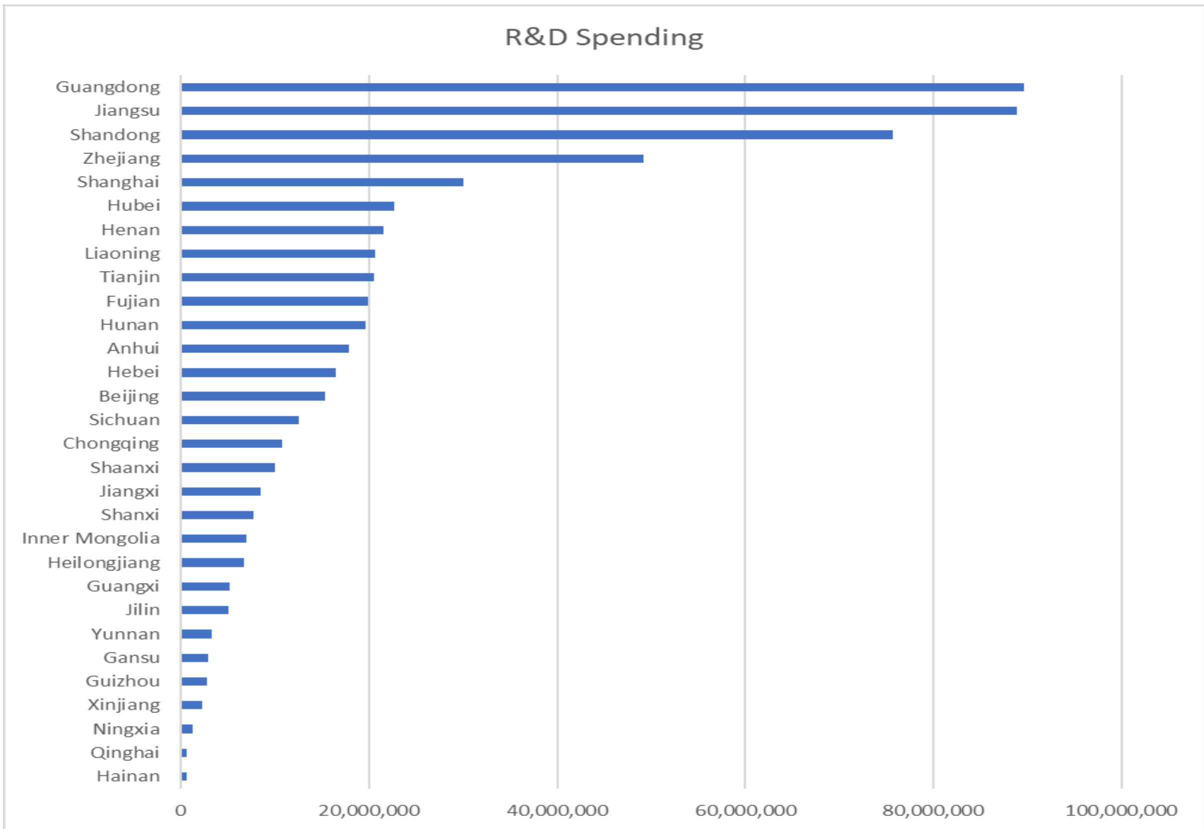

Figure 4.10 R&D spending of enterprises above designated size per region for period 2009 to 2016

4.3.3 Innovation environment Analysis

I will now analyse the situation of the innovation environment of the past 8 years and take insight into how this has changed.

From the data we can see a positive increase in the number of students per 100,000 in higher education. Below shows the average per region, the only decrease from the previous year was in 2016 and was minimal.

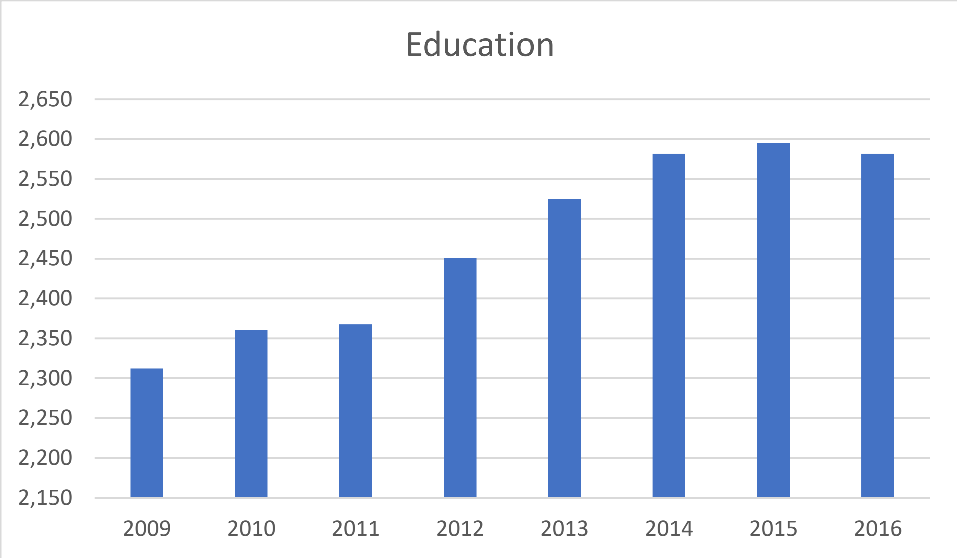

Figure 4. 11 Total number of students per 100,000 in higher education

The only regions which showed a decrease in in this variable over the 8 years were Shanghai, Beijing and Tianjin. This could be due to rapid urbanisation. The below chart shows the percentage increase from 2008 to 2016. As you can see, much of this relative increase is concentrated in Western regions. 4 of the top 5 fastest growers are western regions. Although, it is worth noting that these fast-growing western regions are still situated in the bottom half nationally for percentage of students in higher education.

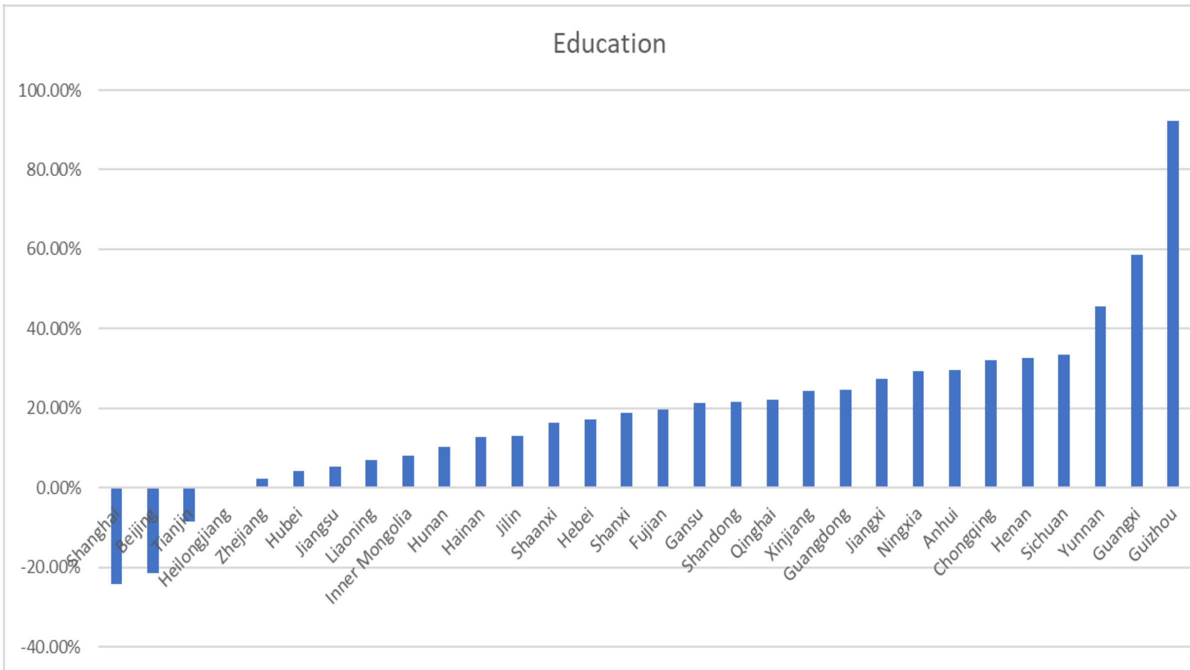

Figure 4. 12 Number of students per 100,000 in higher education per region for period 2009 to 2016

Academia is one of the most unevenly distributed variables. A massive percentage is concentrated in Beijing institutions, at 36% for the total over the eight-year period. In total, academic citations have been on the increase year for year as can be seen below.

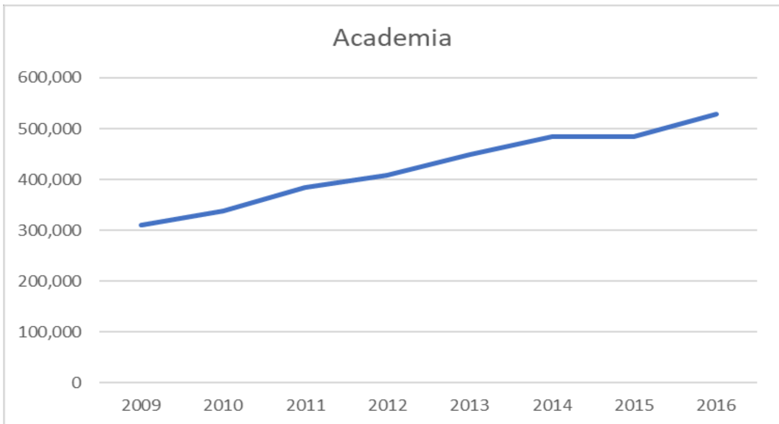

Figure 4. 13Total Academic citations 2009 to 2016

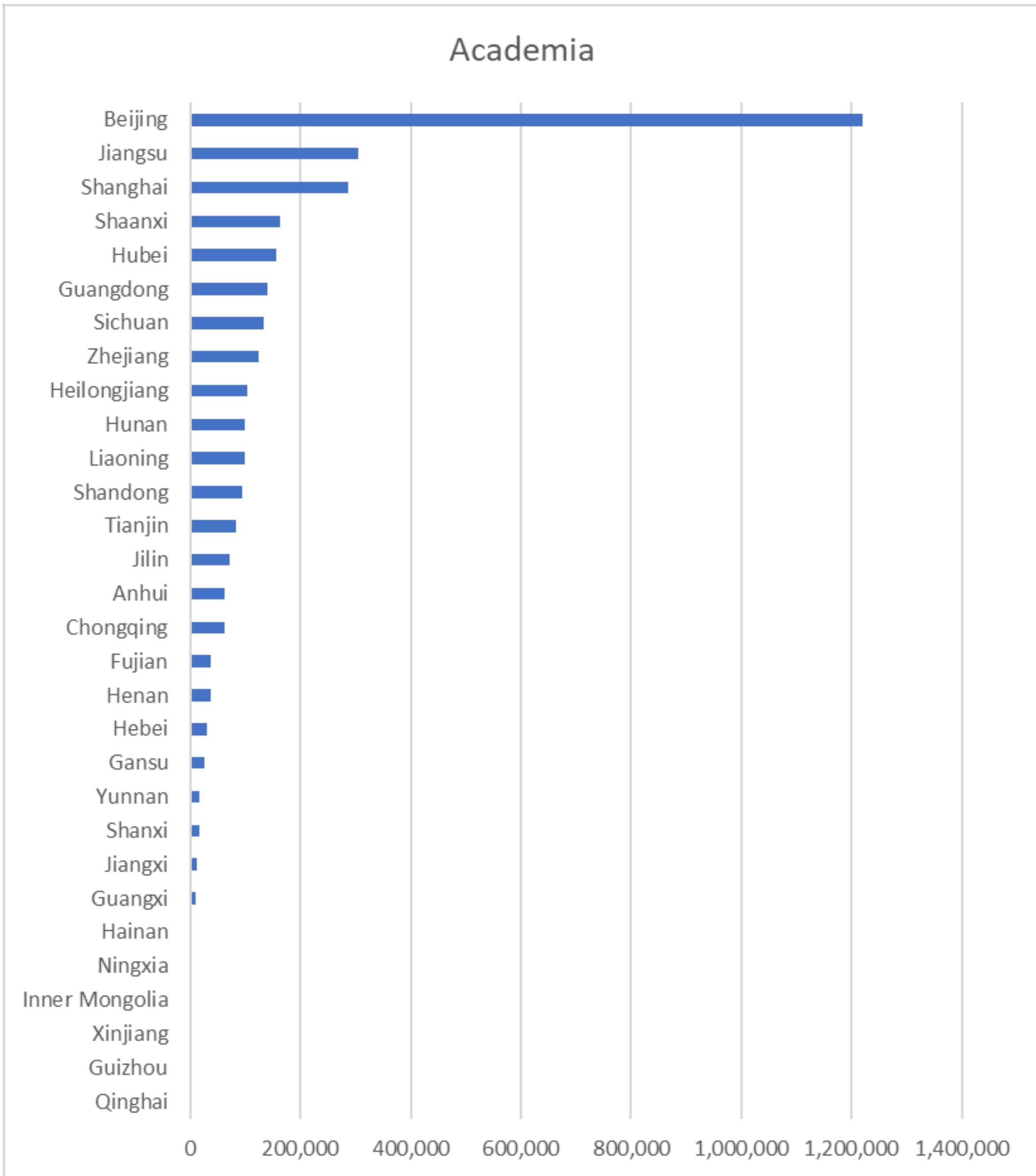

Figure 4. 14Academic citations per region for period 2009 to 2016

The bottom 6 regions recorded an accumulated score of 0 over the 8 eight years. This is in part to the lack of available data for discovering affiliated university contributions. Only the highest 160 contributors in China per year were accessible. Nonetheless, it shows the lack of scientific academic contributions made in these regions compared to the rest of China. It is also important to highlight that 5 of these 6 null contributors are located in Western China.

Similarly, to Academia, education and R&D spending, human capital too has increased steadily over the past few years by 87% in total.

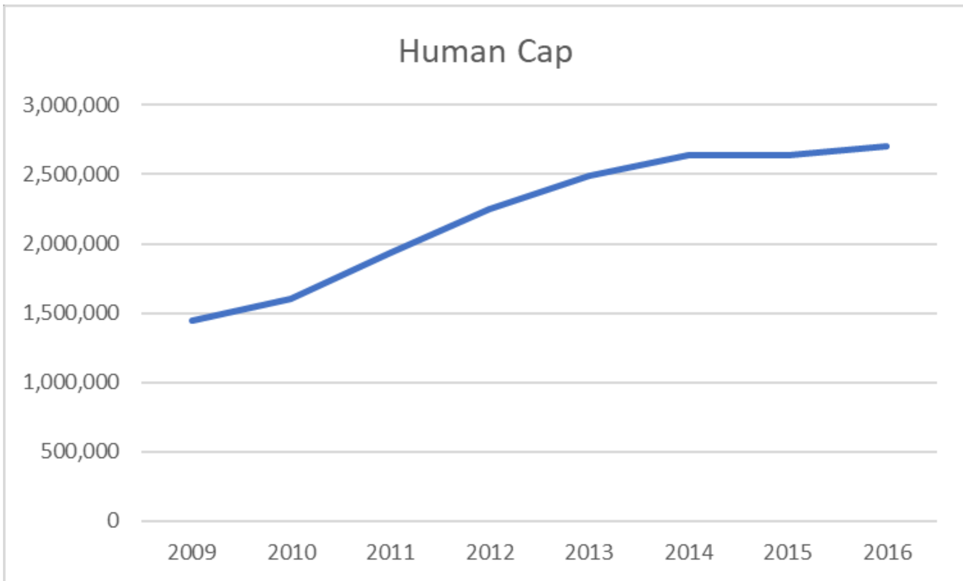

Figure 4. 15 Total Full-time Equivalent of R&D Personnel of Industrial Enterprises above Designated Size

Only one region saw a decrease in this figure from 2009 to 2016, this region is Chongqing. The regions which have the most workers in R&D activities include, Guangdong, Jiangsu, Zhejiang and Shandong. This variable shows geographical disparity throughout China. 8 of the bottom 10 regions for Full-time Equivalent of R&D Personnel of Industrial _Enterprises above Designated Size are western regions.

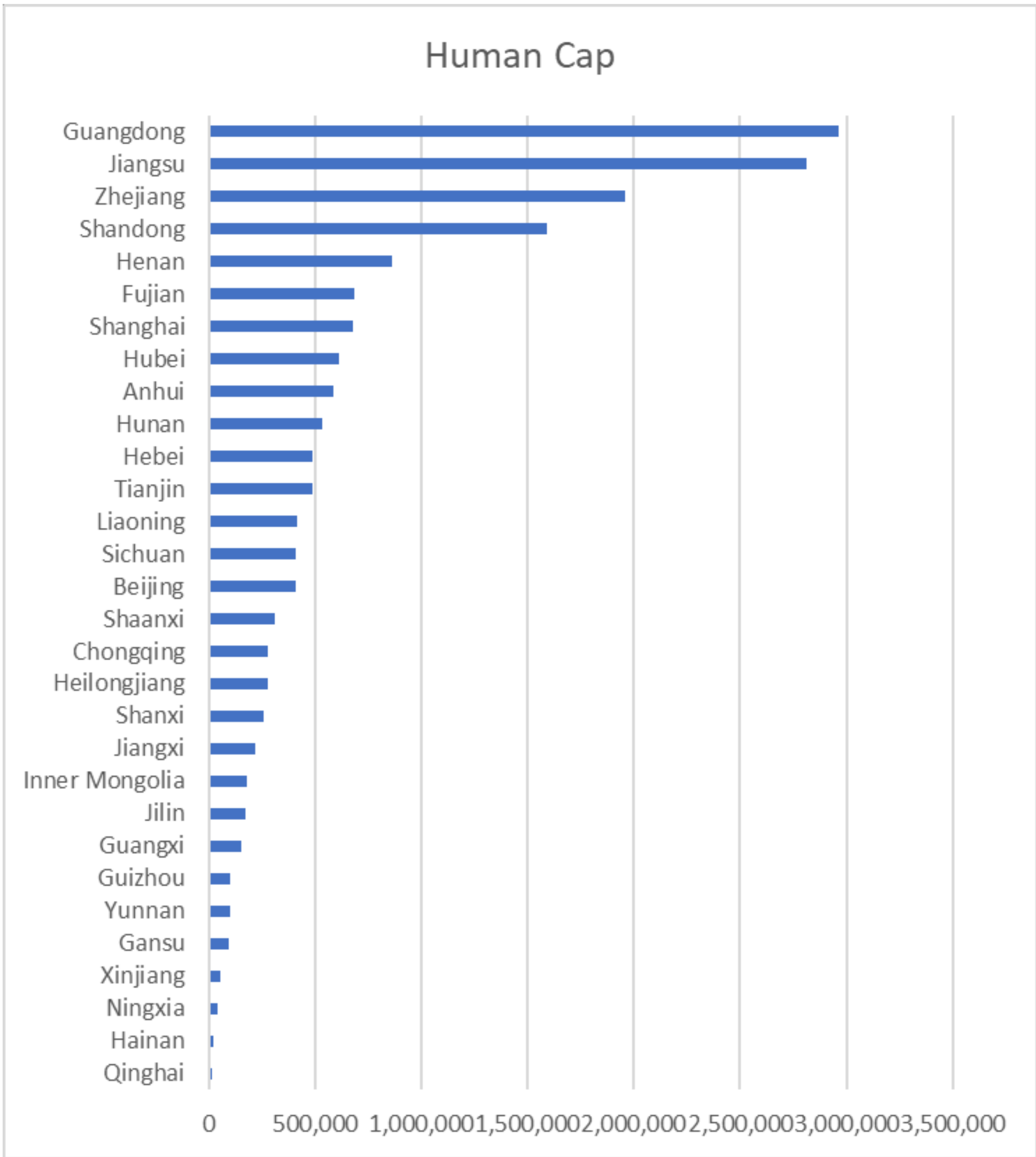

Figure 4. 16 Full-time Equivalent of R&D Personnel of Industrial Enterprises above Designated Size per region for period 2009 to 2016

4.3.4 Rankings

To gain greater insight into how external environmental factors may or may not play role on the absorption rate of FDI spillovers, I will group regions together for a variety of reasons. As you can see from the previously introduced charts, geographical location plays quiet a big role in the levels of advancement amongst the regions. There is huge amount of disparity between the Eastern, Central and Western Regions. Even for 2016 the below chart 4.17 shows the strength over the western regions for GDP per person. Besides geographical ranking the criteria for grouping consists of selecting groups of size 7 to maximum 13 to ensure they can each be accurately compared with each other from a data analysis standpoint. The cut-off point will be based upon calculating the difference between each consecutive ranking, measuring this as a percentage of the regions total figure (to consider the extent) and selecting the cut-off point between region 7 and 13.

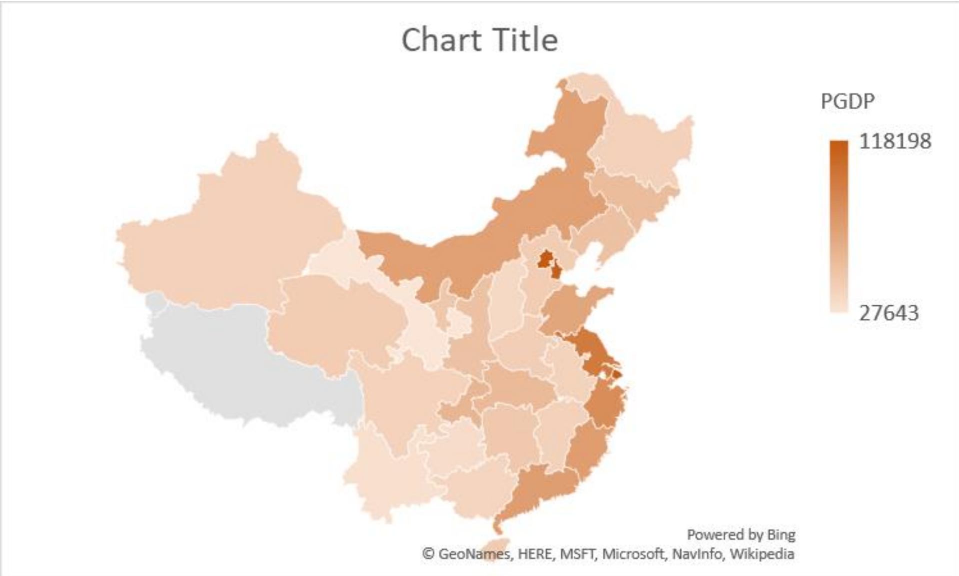

Figure 4. 17 Total GDP per capita

4.3.4.1 Geography

The regions will be divided into Western, Central and Eastern regions and following the same grouping as applied by the Chinese national bureau of statistics as per the below table 4.1.

Table 4. 1 Region by geographic location

East	Central	West
Beijing	Shanxi	Inner Mongolia
Tianjin	Jilin	Guangxi
Hebei	Heilongjiang	Chongqing
Liaoning	Anhui	Sichuan
Shanghai	Jiangxi	Guizhou
Jiangsu	Henan	Yunnan
Zhejiang	Hubei	Shaanxi
Fujian	Hunan	Gansu
Shandong		Qinghai
Guangdong		Ningxia
Hainan		Xinjiang

The hypothesis will be calculated as China as a whole and then re-analysed in these geographical groupings.

4.3.4.2 FDI

The researcher will rank the regions depending on the total FDI (foreign investment + imports) over the eight-year period. This grouping is for the analysis of hypothesis 4. It is to confirm the hypothesis that regions which have previously received large amounts of FDI are in a better position to absorbing positive FDI spillovers. The below table 4.2 shows the accumulated amount for FDI over the 8 years of research from highest to lowest. I have categorised the regions into three distinctions, regions which have received high amounts of FDI (High), regions which have received medium amounts of FDI (Medium) and regions which have received low amounts of FDI (Low). The criteria for High are regions which have received over 3 trillion USD in FDI (imports +financial capital) over the 8-year period. The criteria for Medium consist of regions which have received between 1 and 3 trillion USD over the 8-year period and low consists of regions which have receive below 1 trillion USD over the same period.

Table 4. 2 Ranking of region by Total FDI

Province	Total FDI	Category
Guangdong	3,187,873,553	High
Beijing	2,377,021,973	High
Shanghai	1,900,377,542	High
Jiangsu	1,854,072,738	High
Shandong	933,072,032	High
Zhejiang	736,837,301	High
Tianjin	601,930,613	High
Liaoning	504,098,884	High
Fujian	462,277,806	High
Henan	252,272,042	medium
Sichuan	223,596,490	medium
Hebei	210,785,838	medium
Chongqing	202,738,960	medium
Anhui	187,494,162	medium
Heilongjiang	161,219,963	medium
Hubei	156,933,422	medium
Jilin	138,578,850	medium
Hunan	136,302,776	medium
Jiangxi	128,228,536	medium
Guangxi	125,164,836	medium
Shaanxi	103,334,256	medium
Hainan	87,568,409	Low
Inner Mongolia	84,881,815	Low
Yunnan	78,922,943	Low
Shanxi	75,771,837	Low
Gansu	37,786,086	Low
Xinjiang	35,654,370	Low

Guizhou	15,628,706	Low
Ningxia	7,764,358	Low
Qinghai	3,968,274	Low

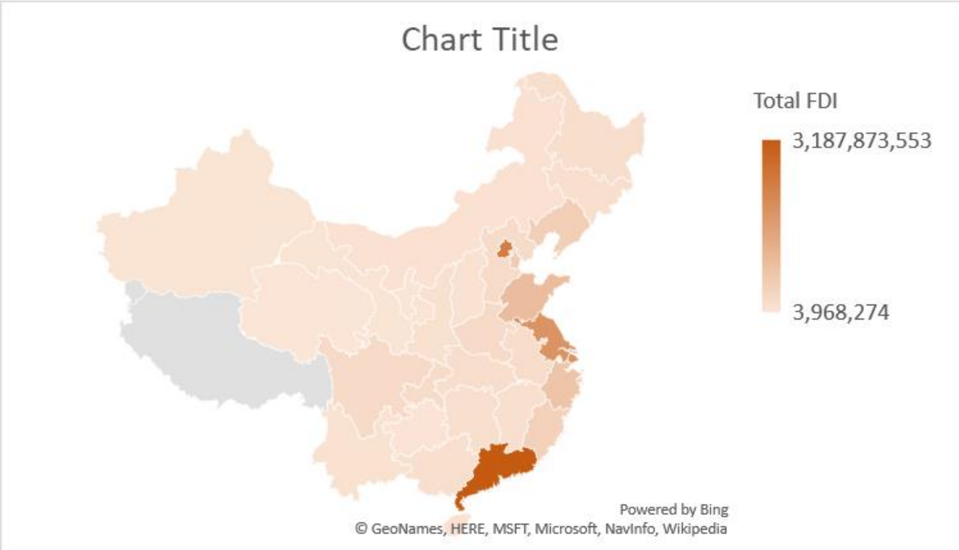

Figure 4. 18 Total FDI

4.3.4.3 Technological

As mentioned in the literature review, the technological advancement of certain regions can play a large part to play in the absorption capabilities of FDI for a region. This ranking will aid in my confirmation of hypothesis 3. The variable used as a means of measurement for this ranking will be value of the technical market. Table 4.3 shows the values of the technical market per region over the past 5 years. The regions will be ranked as high value, medium value or low value. The criteria for high value regions consists of attaining a value of greater than 50 billion RMB in the past 3 years. The criteria for attaining medium status consists of achieving a market value of 10 Billion RMB over the past 3 years and less than 50 billion RMB. The criteria for low value status consist of having a value of less than 10 billion RMB over the previous three years.

Table 4. 3 Ranking of Region by Value of technical market

Province	2009	2010	2011	2012	2013	2014	2015	2016
Beijing	1,236.25	1,579.54	1,890.28	2,458.50	2,851.72	3,137.19	3,453.89	3,940.98
Hubei	77.03	90.72	125.69	196.39	397.62	580.68	789.34	903.84
Shaanxi	69.81	102.41	215.37	334.82	533.28	640.02	721.82	802.79
Shanghai	435.41	431.44	480.75	518.75	531.68	592.45	663.78	780.99
Guangdong	170.98	235.89	275.06	364.94	529.39	413.25	662.58	758.17
Jiangsu	108.22	249.34	333.43	400.91	527.5	543.16	572.92	635.64
Tianjin	105.46	119.34	169.38	232.33	276.16	388.56	503.44	552.64
Shandong	71.94	100.68	126.38	140.02	179.4	249.29	307.55	395.95
Liaoning	119.71	130.68	159.66	230.66	173.38	217.46	267.49	323.22
Sichuan	54.6	54.74	67.83	111.24	148.58	199.05	282.32	299.3
Anhui	35.62	46.15	65.03	86.16	130.83	169.83	190.47	217.37
Zhejiang	56.46	60.35	71.9	81.31	81.5	87.25	98.1	198.37
Gansu	35.63	43.08	52.64	73.06	99.99	114.52	129.7	150.66
Chongqing	38.32	79.44	68.15	54.02	90.28	156.2	57.24	147.19
Heilongjiang	48.86	52.91	62.07	100.45	101.77	120.28	127.26	125.81
Jilin	19.76	18.81	26.26	25.12	34.72	28.58	26.47	116.42
Hunan	44.04	40.09	35.39	42.24	77.21	97.93	105.06	105.63
Jiangxi	9.79	23.05	34.19	39.78	43.06	50.76	64.85	79.01
Hebei	17.21	19.29	26.25	37.82	31.56	29.22	39.54	59
Henan	26.3	27.2	38.76	39.94	40.24	40.79	45.04	58.71
Yunnan	10.25	10.88	11.71	45.48	42	47.92	51.84	58.26
Qinghai	8.5	11.41	16.84	19.3	26.89	29.1	46.88	56.92
Fujian	23.26	35.66	34.57	50.09	44.69	39.19	52.14	43.22
Shanxi	16.21	18.49	22.48	30.61	52.77	48.46	51.2	42.56
Guangxi	1.77	4.14	5.64	2.52	7.34	11.58	7.31	33.99
Guizhou	1.78	7.72	13.65	9.67	18.4	20.04	25.96	20.44
Inner Mongolia	14.77	27.15	22.67	106.1	38.74	13.94	15.39	12.05
Xinjiang	1.21	4.52	4.38	5.39	3	2.82	3.03	4.28
Ningxia	0.9	1	3.94	2.91	1.43	3.18	3.52	4.05
Hainan	0.56	3.27	3.46	0.57	3.87	0.65	2.19	3.44

4.3.4.4 Educational Funding

To speculate the importance of funding education in a region I will categorize and compare areas which have received high, medium and low levels of educational funding. This figure consists of "the total investment in education funding, including the state education budget, social groups and individual citizens school funding, donations funding, tuition and fees, other educational expenses." (National Bureau of Statistics of China, 2019). I will calculate educational funds per capita to avoid uneven ranking of highly populated regions. Please see below table outlining the level of educational funding per capita for 7 of the available previous 8 years. This will portray how the absorption rates can be stronger due to level of educational funding. The criteria for high levels of funding consists of an accumulated value of over 16 million RMB per capita over the previous 8 years. Regions of medium status are those which have received between 12 million RMB and 16 million RMB per capita over the previous 8 years. Regarding regions of low educational funding the criteria consists of those which have received below 12 million RMB per capita.

Table 4. 4 Ranking of Region by Educational Funding

Region	EduFunds	Category
Beijing	30070.369	High
Shanghai	24350.188	High
Tianjin	22341.239	High
Qinghai	19310.7	High
Zhejiang	17958.193	High
Xinjiang	16822.859	High
Hainan	16560.691	High
Jiangsu	16031.283	High
Ningxia	15917.014	Medium
Inner Mongolia	15848.937	Medium
Guangdong	15279.158	Medium
Shaanxi	14417.187	Medium
Chongqing	14388.619	Medium
Fujian	14215.725	Medium
Guizhou	12901.898	Medium
Liaoning	12648.161	Medium
Gansu	12493.48	Medium
Jilin	12377.833	Medium
Shanxi	12198.034	Medium
Yunnan	12114.844	Medium
Shandong	11498.87	Low
Jiangxi	11474.58	Low
Sichuan	10991.724	Low
Guangxi	10970.02	Low
Hubei	10531.046	Low
Anhui	10494.936	Low
Henan	10243.621	Low
Heilongjiang	10211.595	Low
Hunan	10192.821	Low
Hebei	9549.1363	Low

4.3.4.5 Innovation Performance

To test hypothesis 7, I will rank regions by terms of innovation performance. Analysing the total level of innovation performance of a region can also be an effective means of measuring and comparing the innovative output of regions. To avoid an unbalanced ranking which would place the highest populated regions at the top of our ranking the researcher took the per capita amount of our innovation performance variables. This included Granted Patents (per capita) and Expenditure on R&D (per capita). Considering patents is a numeric and expenditure is in currency form we will get the natural log and add together to score regions by means of innovative performance.

The following table 4.5 shows the innovation performance scores over the 8-year period. The criteria for regions of High innovation performance is a region which has scored over 9, medium consists of regions scoring over 9 and less than 7 and finally regions of a low innovation performances scoring less than 7.

Table 4. 5 Innovative performance scoring

Region	2009	2010	2011	2012	2013	2014	2015	2016
Beijing	9.012817	9.261739	9.812385	10.06652	10.34372	10.6858	10.84813	10.95509
Tianjin	8.718338	9.16681	9.739059	10.1312	10.45188	10.56745	10.9305	10.96711
Hebei	4.897288	5.395828	5.859109	6.352541	6.683568	6.94388	7.367129	7.494463
Shanxi	5.152928	5.602835	5.880199	6.385439	6.716385	6.764134	6.62204	6.58272
Inner Mongolia	4.625177	5.139331	5.638287	6.050316	6.401592	6.623168	6.959252	7.067798
Liaoning	7.005614	7.489644	7.957803	8.060713	8.234416	8.221362	8.06856	8.099809
Jilin	4.98828	5.412487	5.837217	6.146156	6.342075	6.661826	6.937871	7.164223
Heilongjiang	5.453122	5.880618	6.584932	7.121532	7.165956	7.007428	7.062297	7.041766
Shanghai	9.760085	10.0275	10.35186	10.41332	10.44753	10.67141	10.84576	10.90131
Jiangsu	9.029247	9.446425	10.29446	10.74905	10.77264	10.75807	11.00941	11.00205
Zhejiang	9.176711	9.284838	9.967714	10.51584	10.74327	10.82504	11.10155	11.11197
Anhui	5.371201	6.206981	7.340591	7.860715	8.129263	8.339054	8.592155	8.633469
Fujian	6.902436	7.377311	8.075708	8.549554	8.915711	9.076112	9.605534	9.785297
Jiangxi	4.468293	4.917598	5.394819	5.902366	6.30155	6.801295	7.455174	7.904895
Shandong	7.507046	8.023427	8.483898	8.913261	9.075143	9.18104	9.503412	9.54564
Henan	5.16439	5.683648	6.183086	6.624932	6.901108	7.196953	7.610291	7.725663
Hubei	6.08378	6.691641	7.144078	7.565189	7.916095	8.116076	8.455611	8.646391
Hunan	5.42244	5.949939	6.554474	7.106576	7.317389	7.600054	7.873078	7.991119
Guangdong	8.439654	8.871288	9.28591	9.585523	9.844528	10.03711	10.36792	10.51535
Guangxi	3.651236	4.176001	4.844245	5.306241	5.745173	6.089543	6.198641	6.221999
Hainan	3.104497	2.961425	4.201135	4.733999	4.993239	5.404717	5.61006	5.210059
Chongqing	6.291032	6.941432	7.485567	7.915957	8.269039	8.482561	9.079409	9.324086
Sichuan	5.533909	6.031542	6.169098	6.827598	7.102614	7.310001	7.696767	7.779783
Guizhou	3.498081	4.065928	4.360929	5.081011	5.432148	5.863555	6.287191	6.114234
Yunnan	3.109868	3.573378	4.138574	4.642992	4.962817	5.318617	5.776067	5.982676
Shaanxi	5.628023	6.35358	6.763187	7.148505	7.666457	7.933994	8.314714	8.749505
Gansu	3.704167	4.188685	4.599691	5.248269	5.657279	5.945601	6.21868	6.394512
Qinghai	3.908276	4.019207	4.973685	4.887186	4.939043	5.272572	5.484531	5.683228
Ningxia	5.20699	5.321307	5.243025	5.719734	6.20926	6.537783	6.792125	7.285447
Xinjiang	4.069095	4.540231	4.851859	5.263648	5.737904	5.935656	6.351536	6.18725

In 2009 there were only 4 regions which achieved high innovation performance status, 2016 had 9. The below table 4.6 shows the number of regions per status per year.

Table 4. 6 Number of regions per innovative performance status by geographic location

Area	2009	2010	2011	2012	2013	2014	2015	2016
High	4	5	6	6	7	8	9	9
Medium	4	4	4	9	9	9	10	13
Low	22	21	18	15	14	13	11	8

For the bases of pooling regions together for data analysis I will select the highest status the region has attained over the 8-year period for designation. The below chart shows the geographical disparity for innovation performance for the year 2016.

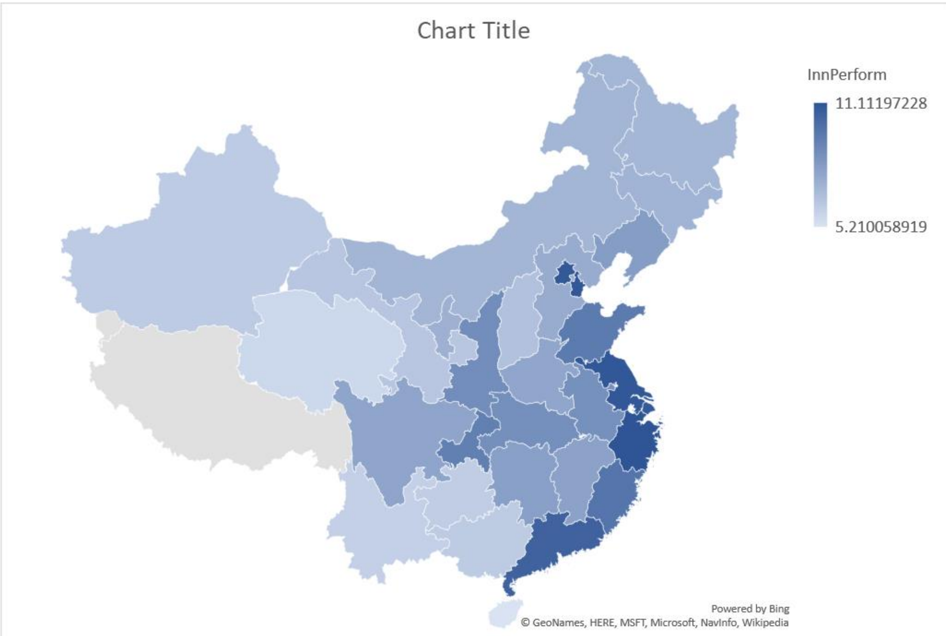

Figure 4.19 Innovative performance scoring

4.3.4.6 Innovation Environment

When scoring the innovative environment, similarly to the innovation performance, calculating the natural log of each of each variable will be calculated and added together. These variables include education, academia and human capital, the scores can be seen in the table 4.7 below. The criteria for highly innovative environments are those which achieved a score of over 29, medium status for scores of between 27 and 29. Lowly developed innovative environment regions are those with scores of less than 27. Compared to innovation performance the innovation environment appears to show less drastic disparity between the east and west. Please see below table.

Table 4.7 Innovative environment scoring

Province	2009	2010	2011	2012	2013	2014	2015	2016
Beijing	30.98151191	31.08636	31.23583	31.39179	31.58396	31.65072	31.49614	31.54752228
Tianjin	27.60077129	27.88552	28.28977	28.60589	28.78494	29.0429	29.03971	29.00547842
Hebei	26.46955315	26.38314	26.74324	27.10047	27.14867	27.35827	26.33903	26.95929953
Shanxi	25.23605715	25.41906	25.72068	25.71454	26.00461	25.6265	25.88556	26.00951235
Inner Mongolia	16.91012653	17.12868	17.33829	17.59791	17.87038	17.88212	17.89983	17.88203953
Liaoning	28.02902318	28.06806	28.09488	28.29267	28.37515	28.446	28.21813	28.07636172
Jilin	26.26539182	26.67004	26.81245	27.17076	27.2902	27.50742	27.32939	27.19752172
Heilongjiang	27.32892623	27.5479	27.87519	27.78247	27.94295	27.93808	27.69712	27.66095099
Shanghai	29.75336457	29.69157	29.81488	29.89027	30.11173	30.15819	30.21439	30.32161025
Jiangsu	30.41460688	30.6488	30.93785	31.15647	31.42283	31.6177	31.68017	31.83961357
Zhejiang	29.05867292	29.45189	29.62635	29.75308	29.88127	30.07883	30.09314	30.23374902
Anhui	26.47146498	26.68334	27.18588	27.68452	28.13477	28.39674	28.47194	28.57706483
Fujian	26.32909252	26.72466	27.18163	27.51861	27.72535	27.97209	28.03958	28.27250979
Jiangxi	24.56726359	24.65701	25.04035	25.10398	25.35357	25.53432	25.76151	26.00371972
Shandong	28.45876801	28.62592	29.15577	29.2573	29.55005	29.6573	29.68766	29.83709389
Henan	26.47916805	26.80374	27.52477	27.66766	27.9669	28.14059	27.95824	28.27448921
Hubei	28.56006173	28.62854	29.0272	29.12463	29.29733	29.40649	29.33375	29.51356614
Hunan	27.40264556	27.53323	28.03779	28.27349	28.26863	28.36541	28.55683	28.71656987
Guangdong	29.31250711	29.62515	29.99325	30.31664	30.45262	30.6104	30.69801	30.84333316
Guangxi	23.2898378	23.67958	24.3263	24.54335	24.73548	24.93872	24.65961	24.90171447
Hainan	14.55413098	14.79047	15.00924	15.62988	15.68626	15.90396	15.84553	15.61878745
Chongqing	26.28841861	26.46703	26.93736	27.26065	27.4923	27.8146	27.87725	28.0421899
Sichuan	27.47950098	27.49017	27.68775	28.07722	28.40766	28.65443	28.59391	28.74445426
Guizhou	15.83640387	16.08644	16.29986	16.64235	17.01969	17.09128	17.11623	17.26951763
Yunnan	23.18847269	23.69414	24.1885	24.33698	24.87094	25.08097	24.653	24.8587273
Shaanxi	27.81251819	28.05689	28.29367	28.53328	28.85438	29.04208	28.97207	29.07030457
Gansu	24.29447072	24.54055	24.84274	25.09551	25.31129	25.5619	25.11184	25.11654447
Qinghai	14.33137148	14.53164	14.50028	14.64348	14.67811	14.74094	14.30922	14.65200022
Ningxia	15.63042129	15.43072	15.84167	15.99491	16.17384	16.38635	16.32305	16.35327449
Xinjiang	15.78721237	15.98085	16.14041	16.10788	16.23222	16.27487	16.35267	16.3813672

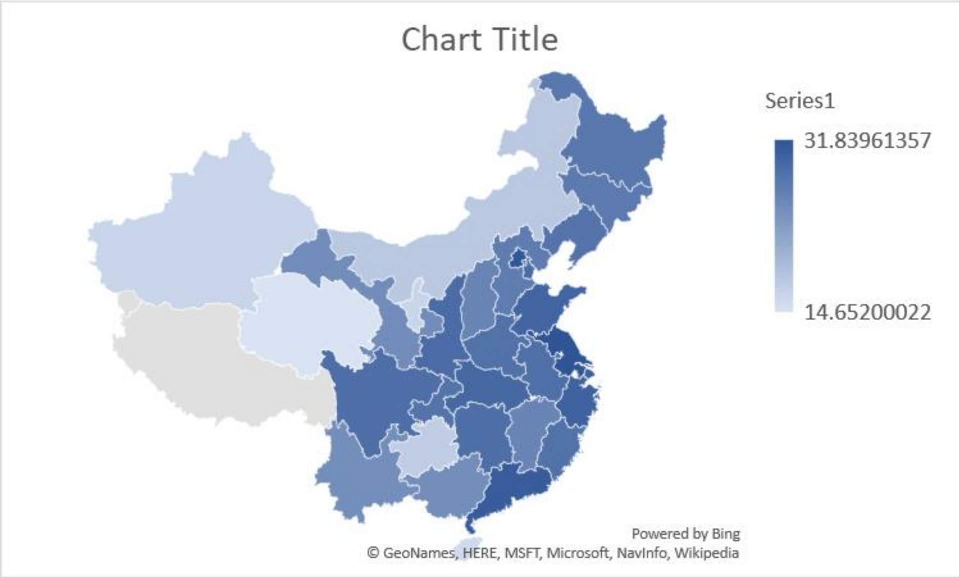

Figure 4.20 Innovative Environment

4.4 Correlation analysis

As per table 4.8 you can see the correlation analysis amongst all 13 variables. This table has educational funds omitted because of one year's missing data, this will not consider the other variables data for this year. As you can see there is strong correlation between many of the variables. Any variables with correlation above 0.8 is highlighted yellow. As some of the variables are the sum of other variables in the table e.g. innovation performance obviously correlates with granted patents as innovation performance incorporates granted patents, we have not highlighted these relationships. Table 4.8 highlights the highly correlated variables which are not interconnected.

Table 4.8 Correlation matrix

	ACADEMIA	DESIGN	EDUCATION	GRANTED	HUMAN CAP	IMPORTS	INNENVIRON	INNPERFORM	INVENTION	INVESTMENT	PGDP	R_D_SPEND	TOTAL_FDI	UTILITY
ACADEMIA	1	0.6798	0.6264	0.7623	0.7673	0.726	0.985	0.7662	0.7988	0.726	0.335	0.7461	0.7471	0.7605
DESIGN	0.6798	1	0.3638	0.9528	0.8918	0.7656	0.7623	0.9261	0.8634	0.7893	0.4674	0.8674	0.7889	0.9086
EDUCATION	0.6264	0.3638	1	0.5141	0.459	0.6468	0.6499	0.5132	0.6182	0.5667	0.6891	0.496	0.6517	0.5243
GRANTED_	0.7623	0.9528	0.5141	1	0.9385	0.8359	0.8454	0.9861	0.9613	0.8318	0.5859	0.9394	0.8562	0.9888
HUMAN_CAP	0.7673	0.8918	0.459	0.9385	1	0.8129	0.8618	0.9732	0.8892	0.8565	0.5242	0.9802	0.84	0.9381
IMPORTS	0.726	0.7656	0.6468	0.8359	0.8129	1	0.7941	0.8385	0.8589	0.8368	0.6772	0.8146	0.9939	0.8203
INNENVIRON	0.985	0.7623	0.6499	0.8454	0.8618	0.7941	1	0.8574	0.8664	0.8003	0.4301	0.8431	0.8171	0.8447
INNPERFORM	0.7662	0.9261	0.5132	0.9861	0.9732	0.8385	0.8574	1	0.9479	0.8563	0.6089	0.9833	0.8628	0.985
INVENTION_	0.7988	0.8634	0.6182	0.9613	0.8892	0.8589	0.8664	0.9479	1	0.8027	0.629	0.903	0.8723	0.9558
INVESTMENT	0.726	0.7893	0.5667	0.8318	0.8565	0.8368	0.8003	0.8563	0.8027	1	0.5573	0.8558	0.888	0.8257
PGDP	0.335	0.4674	0.6891	0.5859	0.5242	0.6772	0.4301	0.6089	0.629	0.5573	1	0.6146	0.6709	0.5961
R_D_SPEND	0.7461	0.8674	0.496	0.9394	0.9802	0.8146	0.8431	0.9833	0.903	0.8558	0.6146	1	0.8424	0.9494
TOTAL_FDI	0.7471	0.7889	0.6517	0.8562	0.84	0.9939	0.8171	0.8628	0.8723	0.888	0.6709	0.8424	1	0.8416
UTILITY	0.7605	0.9086	0.5243	0.9888	0.9381	0.8203	0.8447	0.985	0.9558	0.8257	0.5961	0.9494	0.8416	1

As expected, invention patents have stronger correlation with Total FDI (0.872279) and innovative environment (0.866357) as opposed to design (0.788913 & 0.762271) and utility patents (0.841621 & 0.844667). Considering much of these variables and innovative measures are funded by R&D spending, we repeatedly observe strong correlation, particularly between granted patents, human capital and innovative environment. Proving the link between Total FDI and innovative activities, strong correlation is shared from Total FDI with granted patents, human capital, innovation environment, innovation performance and R&D spending. Innovation performance shares strong correlation with human capital, imports, innovation environment and total FDI. Innovation environment shares strong correlation with Granted patents, innovation performance, R&D spending and total FDI.

4.5 The effects of Total FDI on innovative performance

We now move onto the section of the data where we will formulate our equations. The first equation I will formulate is seen as below.

$$InnPer_{it} = \beta_0 + \beta_1 TotalFDI_t + \beta_2 PGDP_{it} + \varepsilon_{it} \quad (4.1)$$

In this case the researcher is calculating β_1, which represents spillover effects on innovation performance due to Total FDI. This value is represented in the TOTAL_FDI row, coefficient column. To ensure utmost accuracy and relevance upon calculation three different models were ran, pooled, fixed and random. As per the literature review there are some drawbacks with the pooled effects model although it can convey useful calculations despite lack of considerations for environmental factors. The first model ran included PDGP as a contributing dependent variable which may affect the overall outcome. Please see results as per table 4.9 below.

Table 4.9 Eviews results for the effects of Total FDI on innovative performance (including GDP per capita)

Dependent	Variable:	INNPERFORM		
Pooled				
Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	-4.190902	2.100444	-1.99525	0.0472
TOTAL_FDI	1.444794**	0.077206	18.7135	0
PGDP	0.319984	0.258355	1.238544	0.2167
Fixed				
Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	-11.48788	0.888373	-12.9314	0

TOTAL_FDI	-0.014182	0.068114	-0.20821	0.8353
PGDP	3.332125	0.086185	38.66264	0
Random				
Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	-12.77515	0.882802	-14.4711	0
TOTAL_FDI	0.142857**	0.063434	2.252061	0.0252
PGDP	3.20358**	0.084403	37.95597	0
Hausman Test				
Probability	0			

** Statistically significant at the 5% level

As per the pooled effect model (table 4.9) the correlation coefficient means the spillover effects Total FDI has on innovation performance is 1.444794. The Hausman test returns a probability of less than 5% (bottom of table 4.9) so we will reject null hypothesis meaning that the fixed effect model is more appropriate. However, we cannot accept the Total FDI – Innovation Performance spillover effects in the fixed effects model as the probability is not significant at 83.5%. In this case, the statistically significant random effects spillover effects of 0.1428 is more acceptable. Due to this statistical uncertainty, I also ran the model whilst omitting the PGDP variable as per table 4.10.

Table 4. 10 Eviews results for the effects of Total FDI on innovative performance

Dependent	Variable:	INNPERFORM		
Pooled				
Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	-1.88348	0.97117	-1.9394	0.0536
TOTAL_FDI	1.508944**	0.057318	26.3257	0
Fixed				
Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	-5.08561	2.491295	-2.04135	0.0425
TOTAL_FDI	1.69878**	0.14767	11.50391	0
Random				
Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	-3.45233	1.792829	-1.92564	0.0553

Table 4. 10Eviews results for the effects of Total FDI on innovative performance (continued)

TOTAL_FDI	1.601953**	0.105363	15.20412	0
Hausman Test				
Probability	0.3493			

** Statistically significant at the 5% level

This model accepts each spillover value as statistically significant. As per the Hausman test, the random effects model is more efficient meaning we accept correlation coefficient of spillovers due to FDI of 1.6 as per table 4.10 with greater confidence. This model does not consider different regions being at different levels of advancement as PGDP is omitted.

Considering innovation is made up of several variables the below table 4.11 represents the relationship between Total FDI, and the specific innovation performance variables based on fixed and random effects.

Table 4. 11 Eviews results for the effects of FDI on different kinds of patents and R&D spending (fixed effects and random effects models)

Effects of FDI on Innovation Performance: Fixed effect						
	Invention		Design		Utility	
	FE	RE	FE	RE	FE	RE
Constant	-7.72642	-5.93994	-1.02899	-3.17359	-4.137	-5.43529
FDI	0.924284	0.818374	0.54051	0.667651	0.779147	0.856115
Hausman		0.2015		0.0554		0.0755
	All Patent		R&D_Spend			
	FE	RE	FE	RE		
Constant	-5.1505	-4.37728	0.064892	0.869245		
FDI	0.874879	0.829039	0.823901	0.776216		
Hausman		0.4807		0.2773		

As per each Hausman test the random effects model is the more efficient choice. The spillover effects for all patents on Total FDI is 0.874879 meaning a 1% increase in Total FDI leads to a 0.874879% increase in the number of patents granted per region. The more sophisticated utility patents have the greater spillover effects on FDI of 0.856115, followed closely by invention patents at 0.818374 and lastly design patents at 0.667651.

4.6 The effects of Total FDI on innovation environment

We now move onto analysing the spillover effects caused by Total FDI on the innovative Environment of a region. The following formula will be calculated by these results.

$$InnEnvi_{it} = \beta_0 + \beta_1 TotalFDI_t + \beta_2 PGDP_{it} + \beta_3 EduFund_{it} + \varepsilon_{it} \qquad (4.2)$$

Similarly, to the previous formula we are striving to equate the β_1 which represents the spillover effects. $PGDP_{it} + EduFund_{it}$ are incorporated as dependent variables to feed more information to environmental factors. Please see results below as I continue analysis of most acceptable results.

Table 4. 10 Eviews Pooled, Fixed and Random effects models for the effects of Total FDI on innovative environment (including educational funding and GDP per capita)

Dependent Variable: INNENVIRON				
Pooled				
Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	-22.3092	6.01349	-3.70986	0.0003
TOTAL_FDI	2.447668**	0.20237	12.0946	0
EDUCATIONAL_FUNDS	1.776773**	0.38345	4.63362	0
PGDP	-2.02069**	0.51404	-3.93095	0.0001
Fixed				
Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	4.37775	1.03496	4.22985	0
TOTAL_FDI	0.3378848**	0.05779	5.84619	0
EDUCATIONAL_FUNDS	0.265458**	0.19904	1.33367	0.184
PGDP	1.062465**	0.25309	4.19782	0
Random				
Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	3.082637	1.130745	2.726199	0.007
TOTAL_FDI	0.40323**	0.056946	7.080975	0
EDUCATIONAL_FUNDS	0.477657**	0.191894	2.489177	0.0136
PGDP	0.765415**	0.24369	3.140851	0.0019
Hausman Test				
Probability	0			

Each of the spillover effects return statistically significant results with probabilities of less than 5%. As per the Hausman test the fixed effects model is more appropriate so we will accept spillover effects due to FDI of 0.337884. The inclusion of educational funds omits all data for the 2012 period meaning only 7 time periods have been used for all variables, please see appendix for calculations omitting educational funds but incorporating all 8 time periods.

To analyse the variable specific effects, table 4.15 has been compiled as followed.

Table 4. 11 Eviews results for the effects of FDI on Education, Academia and Human Capital (fixed effects and random effects models)

Effects of FDI on Innovation Environment:						
	Education			Academia		
	Pooled	FE	RE	Pooled	FE	RE
Constant	5.547802	5.596603	5.582675	-22.4808	0.933876	0.615982
FDI	0.131056**	0.128163**	0.128989**	1.764034**	0.375912**	0.394759**
Adj R^2	0.422312**	0.934662**	0.244213**	0.556241**	0.998119**	0.338887**
Hausman			0.9268			0
	Human Capital					
	Pooled	FE	RE			
Constant	-1.24227	1.686889	1.080917			
FDI	0.694564**	0.52091**	0.556835**			
Adj R^2	0.704394**	0.977411**	0.480832**			
Hausman			0.0523			

The level of human capital is the most reactive environment-based variable to FDI spillover with coefficient of 0.556835 with regards to the more relevant random effects model discovered after the Hausman test. Number of academic citations prove more reactive than education to Total FDI on a percentage basis with spillover coefficients of 0.375912 and 0.128989 respectively, relevant to the most suitable model.

4.7 The effects of innovative performance on innovative environment

To measure the effect, the innovative performance has on building the innovative performance of a region the following formula is calculated.

$$InnEnvi_{it} = \beta_0 + \beta_1 InnPer_{it} + \beta_2 PGDP_{it} + \beta_3 EduFund_{it} + \varepsilon_{it} \quad (4.3)$$

The following data has been formulated.

Table 4. 12 Eviews pooled, fixed and random effects model results for the effects of innovative performance on innovative environment

Dependent Variable: INNENVIRON				
Pooled				
Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	44.6247	8.354523	5.341384	0
INNPERFORM	2.56356**	0.166718	15.37666	0
EDUCATIONAL_FUND	-3.30407**	0.585555	-5.64262	0
PGDP	-2.59945**	0.46251	-5.62031	0
Fixed				
Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	13.0938	1.403541	9.329143	0
INNPERFORM	0.31576**	0.066396	4.755838	0
EDUCATIONAL_FUND	-0.42877	0.224359	-1.9111	0.0576
PGDP	1.10621**	0.263806	4.193276	0
Random				
Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	14.0972	1.461646	9.644773	0
INNPERFORM	0.42646**	0.064874	6.573765	0
EDUCATIONAL_FUND	-0.36792	0.218422	-1.68442	0.0936
PGDP	0.67470**	0.250941	2.688698	0.0078
Hausman Test				
Probability	0			

Each spillover effect of Innovation environment to innovation performance holds statistical reliability and as per the Hausman test the fixed effects model holds the most statistical relevance. The coefficient is 0.315767. Similarly, to the previous section you can find in the appendix a table omitting educational funds.

4.8 Analysis as per Ranking

4.8.1 The effects of Total FDI on innovative performance (including GDP per capita)

The below table 4.17 shows the Pooled, Fixed and random results relevant to Total FDI based on the below formula 4.4.

$$InnPer_{it} = \beta_0 + \beta_1 TotalFDI_t + \beta_2 PGDP_{it} + \varepsilon_{it} \quad (4.4)$$

The researcher ran the models several times with different categories corresponding to the previously outlined ranking. As per the table 4.17 you can see the statistically significant probability figures in green and highlighted red regarding results outside the acceptable criteria. Depending on the results of the Hausman test I have highlighted the most relevant coefficients in yellow i.e. weather fixed effect or random effects model is most acceptable. There is a broad range of statistically insignificant data for these sets.

Table 4.17 The effects of FDI on Innovation Performance considering GDP per capita based on ranking

		Geography			FDI			Technology			Edu Funds		
	All	East	Central	West	High	Medium	Low	High	Medium	Low	High	Medium	Low
Pooled													
Coefficient	1.444794**	2.119548**	2.294979**	1.422415**	1.353296**	1.866391**	0.83278**	1.199744**	1.679145**	1.344956**	2.09546**	0.991473**	0.429738
Std. Error	0.077206	0.227667	0.343635	0.090448	0.232084	0.273461	0.168834	0.168468	0.206306	0.114101	0.45017	0.187069	0.227677
t-Statistic	18.7135	9.309852	6.678532	15.72624	5.831058	6.82508	4.932543	7.121476	8.13908	11.78738	4.654817	5.300027	1.887491
Prob.	0	0	0	0	0	0	0	0	0	0	0	0	0.0629
Fixed													
Coefficient	-0.014182	0.211377	-0.009013	-0.119071	0.340364**	-0.142808	-0.19566	0.430837**	-0.166081	-0.012274	0.558053**	-0.124263	-0.299784**
Std. Error	0.068114	0.162938	0.159244	0.087481	0.160126	0.133979	0.112554	0.164768	0.096107	0.109295	0.214763	0.110372	0.137606
t-Statistic	-0.208213	1.29728	-0.056599	-1.361097	2.125605	-1.065892	-1.73836	2.614811	-1.728077	-0.112304	2.598465	-1.125853	-2.178564
Prob.	0.8353	0.1985	0.9551	0.1776	0.0376	0.2896	0.0872	0.012	0.0885	0.9108	0.012	0.2635	0.0328
Random													
Coefficient	0.142857**	0.318976**	0.053994	0.120888	0.404901**	-0.077278	-0.142401	0.468016**	-0.083742	0.12673	0.630906**	-0.084473	-0.269684**
Std. Error	0.063434	0.157217	0.157549	0.080834	0.154702	0.132311	0.109777	0.147264	0.093745	0.103582	0.210636	0.108395	0.135335
t-Statistic	2.252061	2.028882	0.34271	1.495521	2.617291	-0.584064	-1.297184	3.178078	-0.893292	1.223479	2.99525	-0.779309	-1.992718
Prob.	0.0252	0.0456	0.733	0.1385	0.0109	0.5606	0.1989	0.0025	0.3745	0.224	0.004	0.4378	0.0498
Hausman Test													
Probability	0	0.0119	0.0162	0	0.0022	0.0076	0.009	0.0001	0	0.0001	0.2116	0.1445	0.4056

Based on the pooled data, all the spillovers are positive. All but one is statistically significant. Regarding geography, central regions return higher spillover effects than East and West. With FDI regions, which have received the medium quota of FDI has gained more from spillovers than regions of high or low, the same goes for technology. Regarding educational funds only high and medium returns are statistically significant and prove that areas of high funding gain more from FDI than areas of medium funding. The most reliable conclusions we can draw from fixed and random models is that highly educationally funded regions return more than low funded regions, furthermore, as per the statistically significant and more relevant random effects model areas of low educational funding experience negative spillover effects from FDI.

To speculate the effect, the level of advancement of the innovative environment has on the absorption rate of spillovers from FDI you can see the results for this formula as per the table 4.18. Highly innovative regions experience positive spillovers at 0.347873, regions of medium innovative environments experience negative spillover (-0.312756) effects meaning that the greater the FDI the more damage caused to innovative performance output. Low innovative regions experience twice the amount of negative spillovers as the medium regions at -0.634809.

Table 4. 18Innovation performance Spillovers based on innovative environment

	Innovative Environment		
	High	Medium	Low
Fixed			
Coefficient	0.347873**	-0.33285**	-0.61094**
Std. Error	0.138575	0.11784	0.275659
t-Statistic	2.510366	-2.8246	-2.21629
Prob.	0.0147	0.0059	0.0304
Random			
Coefficient	0.38192**	-0.31276**	-0.63481**
Std. Error	0.129329	0.117016	0.266658
t-Statistic	2.953098	-2.67275	-2.38061
Prob.	0.0043	0.0089	0.0201

4.8.2 The effects of Total FDI on innovative performance

The following table 4.19 returns more statistically significant results. This table is relevant to the below formula.

$$InnPer_{it} = \beta_0 + \beta_1 TotalFDI_t + \varepsilon_{it} \qquad (4.5)$$

For this table I will focus on the fixed and random effects models to draw some statistically significant conclusions between FDI and innovation performance. As per geography, the eastern regions return a greater amount of spillovers compared to central and western regions. As per FDI, areas of medium category return slightly more spillovers to areas of high FDI and substantially more to low FDI regions. Regarding technology, high tech regions gain more spillovers to medium tech and low-tech regions. As per educational funding, highly funded regions experience higher spillovers to lowly funded and medium funded region respectively. The more efficient model as per the Hausman test is highlighted in yellow.

Table 4. 13 The effects of FDI on Innovation Performance based on ranking

InnP = FDI													
		Geography			FDI			Technology			Edu Funds		
	All	East	Central	West	High	Medium	Low	High	Medium	Low	High	Medium	Low
Pooled													
Coefficient	1.508944**	2.153295**	2.345646**	1.469823**	1.283169**	2.17435**	0.863744**	1.004515**	1.88046**	1.413183**	3.547063**	1.466982**	1.540899**
Std. Error	0.057318	0.163033	0.281774	0.091116	0.21602	0.220839	0.167904	0.125362	0.125573	0.110285	0.301696	0.189695	0.26365
t-Statistic	26.3257	13.20773	8.324577	16.13126	5.940048	9.845847	5.144269	8.012891	14.97498	12.81394	11.75706	7.733369	5.844484
Prob.	0	0	0	0	0	0	0	0	0	0	0	0	0
Fixed													
Coefficient	1.69878**	2.342494**	2.243399**	1.118876**	2.31805**	2.108996**	0.612835	2.419837**	1.574645**	1.54298**	2.28099**	1.304346**	2.247799**
Std. Error	0.14767	0.284416	0.192557	0.249796	0.318478	0.145517	0.343886	0.26696	0.232201	0.245333	0.555265	0.340996	0.355997
t-Statistic	11.50391	8.236149	11.65057	4.479152	7.278522	14.49308	1.782091	9.064406	6.781399	6.289322	4.107932	3.825102	6.31409
Prob.	0	0	0	0	0	0	0.0796	0	0	0	0.0001	0.0003	0
Random													
Coefficient	1.601953**	2.291423**	2.249245**	1.349776**	2.091502**	2.112984**	0.707718**	1.905036**	1.687851**	1.488166**	2.622724**	1.352802**	2.090815**
Std. Error	0.105363	0.245066	0.190057	0.156623	0.284984	0.144039	0.277245	0.215272	0.190483	0.190175	0.477179	0.289288	0.321973
t-Statistic	15.20412	9.350209	11.83457	8.61799	7.339014	14.66955	2.552678	8.849445	8.860891	7.825223	5.49631	4.676309	6.493759
Prob.	0	0	0	0	0	0	0.0129	0	0	0	0	0	0
Hausman Test													
Probability	0.3493	0.7235	0.8501	0.2354	0.111	0.8472	0.641	0.0011	0.3939	0.7236	0.2288	0.7884	0.3013

4.8.3 The effects of Total FDI on innovation environment (including GDP per capita and Educational Funding)

The following table 4.20 returns more statistically significant results. This table is relevant to the below formula.

$$InnEnvi_{it} = \beta_0 + \beta_1 TotalFDI_t + \beta_2 PGDP_{it} + \beta_3 EduFund_{it} + \varepsilon_{it} \quad (4.6)$$

As per pooled data all but one result is statistically significant. The pooled data estimations show a high return between innovative environment and Total FDI for western regions, followed by Eastern and central regions respectively. Regrading FDI, highly funded regions return slightly higher spillovers as opposed to low funded regions (medium is non-significant). For technology, low tech areas return a higher rate than medium and high-tech areas. Regarding education funding the innovative environment holds a spillover coefficient of 5.910873 for highly funded areas. Medium and low funded areas experience negative spillovers for pooled data at -2.217478, -2.38275 respectively.

However, when considering the environmental factors in analysis of Fixed and Random effect models the results are somewhat different. Central regions experience greater spillovers to western regions. Regions of medium FDI return a high co-efficiency of 0.324619 to low FDI regions at 0.296116. Low tech areas return greater returns than medium regions when considering the innovative environment in this case also. Areas of high educational funding experience three times the spillover effects as regions with low educational funding.

Table 4. 14 The effects of FDI on Innovation Environment based on ranking

InnE = FDI+EduFunds+PGDP													
		Geography			FDI			Technology			Edu Funds		
	All	East	Central	West	High	Medium	Low	High	Medium	Low	High	Medium	Low
Pooled													
Coefficient	2.447668**	1.87989**	1.233374**	3.148164**	1.138486**	-0.217262	1.110333**	0.369609**	0.740981**	2.124406**	3.891613**	-1.06585**	-0.762311**
Std. Error	0.202376	0.405643	0.48043	0.438516	0.142957	0.482136	0.429406	0.119906	0.105758	0.303094	0.658382	0.480659	0.319929
t-Statistic	12.09463	4.634351	2.567228	7.179138	7.963827	-0.450623	2.585741	3.082495	7.006404	7.009063	5.910873	-2.217478	-2.38275
Prob.	0	0	0.0132	0	0	0.6535	0.0122	0.0035	0	0	0	0.0294	0.0201
Fixed													
Coefficient	0.337884**	0.260456	0.481175**	0.300715**	0.196603	0.324619**	0.296116**	-0.008582	0.269501**	0.419326**	0.624449**	0.204094**	-0.008404
Std. Error	0.057796	0.134799	0.173406	0.078542	0.132591	0.13683	0.094371	0.132414	0.10511	0.086186	0.214424	0.091356	0.176092
t-Statistic	5.846193	1.93218	2.774841	3.828738	1.482786	2.372422	3.137768	-0.064813	2.564	4.865347	2.912211	2.234048	-0.047727
Prob.	0	0.0578	0.008	0.0003	0.1443	0.0205	0.0028	0.9487	0.013	0	0.0056	0.0287	0.9621
Random													
Coefficient	0.40323**	0.48674**	0.499841**	0.383268**	0.372594**	0.334516**	0.329754**	0.053135	0.405887**	0.490061**	1.272063**	0.215113**	-0.015023
Std. Error	0.056946	0.1299	0.168865	0.075906	0.120876	0.133697	0.093026	0.122081	0.091057	0.084628	0.196059	0.090755	0.162945
t-Statistic	7.080975	3.747036	2.960005	5.049232	3.082456	2.502049	3.544757	0.435247	4.457507	5.790764	6.488162	2.370268	-0.092198
Prob.	0	0.0004	0.0046	0	0.0031	0.0144	0.0008	0.6655	0	0	0	0.0202	0.9268
Hausman Test													
Probability	0	0	0.2902	0	0.0004	0.1054	0.1794	0.5923	0.0362	0.0003	0	0.0435	0.0014

4.8.3 The effects of innovation performance on innovation environment (including GDP per capita and Educational Funding)

Look at the table 4.21 to see the behaviour between innovative environment and innovative performance in subsequence to the below formula.

$$InnEnvi_{it} = \beta_0 + \beta_1 InnPer_{it} + \beta_3 EduFund_{it} + \varepsilon_{it} \qquad (4.7)$$

All the results are statistically significant. As per the pooled data results the innovative environment is most responsive to the output by means of innovation performance as opposed to eastern and central regions. Low FDI and Tech regions also show stronger increase in environmental factors relevant to performance. Regarding Educational funding, highly funded regions show greater returns (2.931775) to medium and (1.74244) low (1.421201) funded regions.

Moving onto Random and fixed effect model returns, central and western regions are more sensitive to these returns compared to eastern regions. Regarding level of received FDI the results are very similar at 0.402512 (high), 0.432605 (medium) and 0.402325 (low). Medium tech regions return much higher returns to high- and low-tech regions. There's no necessary standout category regarding this region considering educational funding also.

Table 4. 15 The effects of Innovation Performance on Innovation Environment based on ranking

InnE=InnP+EduFunds													
		Geography			FDI			Technology			Edu Funds		
	All	East	Central	West	High	Medium	Low	High	Medium	Low	High	Medium	Low
Pooled													
Coefficient	2.563563**	2.192666**	1.465278**	**2.481842	0.704977**	1.395943**	1.717497**	0.417858**	0.701765**	2.088338**	2.931775**	1.74244**	1.421201**
Std. Error	0.166718	0.167	0.168435	0.384137	0.23949	0.136806	0.630216	0.149118	0.070671	0.29304	0.166304	0.312754	0.115307
t-Statistic	15.37666	13.12973	8.699353	6.460819	2.943659	10.20384	2.725251	2.802187	9.929992	7.12647	17.62903	5.571286	12.32538
Prob.	0	0	0	0	0.0046	0	0.0084	0.0074	0	0	0	0	0
Fixed													
Coefficient	0.315767**	0.284224**	0.546709**	0.488274**	0.398139**	0.432605**	0.398766**	0.245613**	0.6851**	0.397031**	0.395621**	0.372555**	0.413178**
Std. Error	0.066396	0.102301	0.122172	0.111047	0.091936	0.128292	0.10974	0.089024	0.126494	0.102188	0.102565	0.094693	0.140624
t-Statistic	4.755838	2.778321	4.474916	4.396985	4.330606	3.372019	3.633727	2.758949	5.416056	3.885293	3.857255	3.93436	2.938171
Prob.	0	0.0072	0	0	0.0001	0.0012	0.0006	0.0087	0	0.0002	0.0004	0.0002	0.0047
Random													
Coefficient	0.426467**	0.425536**	0.599438**	0.511529**	0.402512**	0.531132**	0.402325**	0.250896**	0.694037**	0.438924**	0.629649**	0.392451**	0.580992**
Std. Error	0.064874	0.099062	0.119067	0.110469	0.091339	0.122088	0.109576	0.087743	0.103445	0.101286	0.09802	0.094158	0.12933
t-Statistic	6.573765	4.295651	5.03445	4.630536	4.406792	4.350415	3.671662	2.859452	6.709256	4.333517	6.423665	4.168026	4.492315
Prob.	0	0.0001	0	0	0	0	0.0005	0.0064	0	0	0	0.0001	0
Hausman Test													
Probability	0	0	0.1342	0.0035	0.8898	0.0423	0.2001	0.9355	0.9851	0	0	0.0402	0.0099

4.9 Lag Effect Analysis

We now move onto measuring the time effect between the innovative environment of a region and the total FDI. This will be analysed by calculating the lag effect. Firstly, a Johansen cointegration test will be measured to identify weather the variables are cointegrated or not. The Johansen cointegration test must be executed with non-stationary variables. As the innovative environment scoring is the natural log, we will use the original figures of the variables which make up the innovative environment score. When running this test with innovative environment, granted patents and R&D spending, the below results were achieved. As you can see the null hypothesis for "none" is rejected, meaning that we cannot accept that there is no cointegration, meaning there is cointegration amongst the variables.

Table 4.16 Johansen Fisher Cointegration Test

Johansen Fisher Panel Cointegration Test
Series: R_D_SPENDING GRANTED_PATENTS TOTAL_FDI
Lags interval (in first differences): 1 1

Hypothesized No. of CE(s)	Fisher Stat.* (from trace test)	Prob.	Fisher Stat.* (from max-eigen test	Prob.
None	134.5	0	55.53	0
At most 1	102.6	0	69.49	0
At most 2	74.34	0	74.34	0

Based on the results from the above Johansen test of cointegration a Vector Error Correction model is more accepted. We firstly run the model with all regions and variables included. The model allowed us to run 6 lags. We must select the smallest possible AIC value to identify the most accurate lag. Table 4.20 shows the AIC scores for how the innovative environment of a region is affected by total FDI. Highlighted in green is the smallest value, of lag 6.

Table 4.17 Innovative Environment Akaike information criterion scores per lag

All	
	AIC
1	-0.91205
2	-1.1212
3	-0.99716
4	-0.59347
5	-0.31181
6	-1.85788
7	

Analysis using lag effect returned the "Insufficient number of observations" error. If the model returns a lag of 1 or 2, we will identify this as "fast", 3 or 4 will be identifies as "medium" and 5 or 6 will be categorized as "slowly" effected.

4.9.1 Ranking Results

The researcher has run the same test numerous times depending on the category as a means of comparison and interpretation of how the innovative environment of a region is affected by FDI. When categorizing regions into level of FDI previously received the AIC scores are as below.

Table 4.18 Innovative Environment Akaike information criterion scores per lag based on FDI received

FDI					
High		Medium		Low	
	AIC		AIC		AIC
1	-3.16888	1	-0.99286	1	0.03234
2	-3.59279	2	-1.31265	2	0.127452
3	-3.43838	3	-1.27709	3	0.456292
4	-4.05818	4	-1.08472	4	0.663051
5	-3.97234	5	-1.50999	5	0.587436
6		6		6	
7		7		7	

As you can see regions which has received high and medium amounts of FDI are slowly affected. Regions which have received a low amount are quickly affected. This may be due to the fact that it is easier to influence the environment of underdeveloped areas as the scale is smaller, for example an increase of 1 academic citation in a region which previously has 4 is an increase of 25%, whereas in a developed region such as Beijing this is much less significant.

To Speculate hypothesis 6 as to whether the level of innovative performance effects the time needed to affect the innovative environment, the below table 4.25 is made.

Table 4.19 Innovative Environment Akaike information criterion scores per lag based on Innovative Performance scoring

InnPer							
High		Medium		Low*		Low+1	
	AIC		AIC		AIC		AIC
1	-3.0955	1	-1.26591	1	-1.89263	1	-0.99443
2	-3.5824	2	-1.48855	2	-1.87389	2	-1.4224
3	-3.49802	3	-1.54408	3	NA	3	-1.39739
4	-4.47843	4	-1.2367	4		4	-6.15875
5	-6.09141	5	-1.4815	5		5	
6		6		6		6	

Areas of high innovative performance are 'slowly' affected, of medium, 'medium' effected. When using the low criteria only 2 results were returned before a "Near singular matrix" Error was returned. It is difficult to accurately compare these results with the high and medium categories. For this reason, I included a category Low+1 which includes the regions of low category plus the lowest scoring medium category region (Heilongjiang), which returned more reliable results. The innovative environment of the low+1 category is slowly affected by FDI.

The below table 4.26 portrays the same results depending on level of educational funding per region.

Table 4.20 Innovative Environment Akaike information criterion scores per lag based on Educational funding

Edu Fund					
High		Medium		Low	
	AIC		AIC		AIC
1	-3.27818	1	-1.35646	1	-1.08505
2	-3.16221	2	-1.31525	2	-1.61392
3	-3.1489	3	-1.07564	3	-1.5741
4	-3.52955	4	-1.13163	4	-1.42927
5		5	-1.32058	5	-1.5975
6		6		6	

Regions of high educational funding are slowly affected; medium funded regions are quickly affected, and regions of low educational funding are also quickly affected.

The below table 4.27 is based on geography.

Table 4.21 Innovative Environment Akaike information criterion scores per lag based on geographic location

Geography					
East		Central		West	
	AIC		AIC		AIC
1	-1.82334	1	-1.26238	1	-0.15236
2	-2.03611	2	-1.85764	2	-0.11158
3	-2.26702	3	-1.67877	3	0.267034
4	-1.89631	4	-1.48645	4	0.398128
5	-1.32065	5		5	-0.07062
6		6		6	

The innovative environment of eastern regions shows a 'medium' response to total FDI. Central and western regions experience a 'fast' response. This may be caused by the scale phenomenon as mentioned in amount of FDI.

The below table 4.28 is in regard to the value of the technical market. In this case all regions are slowly affected. Although high tech regions show a slightly faster response to medium and low-tech regions.

Table 4.22 Innovative Environment Akaike information criterion scores per lag based on level of technology

Technology					
High		Medium		Low	
	AIC		AIC		AIC
1	-2.91564	1	-1.28967	1	-0.09955
2	-2.87691	2	-1.56303	2	-0.23023
3	-3.43711	3	-2.08893	3	0.015147
4	-3.94874	4	-2.01859	4	0.613857
5		5	-3.29569	5	1.138666
6		6		6	

4.10 Hypotheses Results

As per previous research there has been mixed findings on whether to expect positive or negative spillovers depending on the level of advancement of the domestic market to take advantage. Studies such by (Blomstrom & SjoKholm, 1999) and (Buckley, Clegg, & Wang, 2002) suggest expecting positive spillover effects, however studies by (Aitken & Harrison, 1999) and (Konings, 2000) returned negative spillovers. Because of the level of advancement of China in the most recent decades we expect positive correlation between FDI and the innovative performance. As per the correlation matrix this result is strong at 0.8626 (table 4.8). The panel data result when incorporating GDP per capita is strong positive at 1.444794 (table 4.9) meaning that for every 1% increase of Total GDP the innovative performance of a region increased by 1.444794%. As per the literature review the most reliable findings for these phenomimes must come from fixed effects or random effects data. The random effects model returns some positive spillovers of 0.142857 (table 4.9). The fixed effect model returns insignificant results for this. When omitting GDP per capital we are returned with a statistically significant, strong positive fixed effects result of 1.69878 (table 4.10). As per the Hausman test the random effects is more reliable and also confirms the same with spillovers of 1.601953 (table 4.10). Based on the most statistically reliable model from these results we can state that when the total FDI increases by 1% to a region the innovative performance of that region increases by 1.601953%.

The previous research for this is similar to hypothesis 1. Some studies return positive spillover and others returned negative spillover. We expect positive spillovers due to the advancement of the Chinese market. As per the correlation matrix these variables return strong positive correlation of 0.8171 (table 4.8). As per the pooled effect model incorporating control variables of educational funding and GDP per person, we returned a strong positive spillover covariance of 2.447668 (table 4.14). The random effects model returned a covariance of 0.40323 (table 4.14). The more efficient fixed effects model returned a covariance of 0.337884 (table 4.14), proving the hypothesis.

Previous research of this labels low-tech regions to receive low spillovers and high and medium tech regions to expect high spillovers. (Girma, Greenaway, & Wakelin, 2001) generally, found that high technology capabilities lead to positive FDI spillovers however it depends on the industry. Research by (Sawada, 2010) found positive spillovers at first but as the technology level increased, the spillovers levelled off. The previous research portrays contrasting results depending on the region. To prove this hypothesis, we ran the model using innovation performance, FDI and GDP per capita as the moderator, three different times for high-tech, medium-tech and low tech-regions. Using this model for fixed and random effects we can only draw conclusions for high tech regions as this is the only statistically significant data available, at 0.430837 (table 4.17) for the more efficient fixed effects model. We ran the model again omitting GDP per capita. Where statistically significant results were returned, proving our hypothesis. High tech regions hold a spillover of 2.419837 (table 4.19) on the more reliable fixed effects model. Medium and low-tech regions experience spillover of 1.687851 and 1.488166 respectively (table 4.19) when implementing the more efficient random effects model. These results prove that high tech regions experience higher spillover effects to medium and medium to low.

The previous research for this supports that regions which have received high levels of FDI will be in a better position to absorb spillovers as opposed to lower regions. The random effect model was most suitable for each category. Regions which have received medium amount of FDI experience slightly higher spillover effects at 2.112984 vs high receivers of 2.091502 (table 4.19), thus, disproving this hypothesis. There is some accuracy to the hypothesis as low receivers of FDI experience significantly lower spillovers to medium and higher at 0.707718 (table 4.19). However, as medium regions experience lower spillovers to medium regions this can be disproved. This phenomenon may be similar to that as found in the study by (Sawada, 2010) for technology but in this case, regions which have received medium amounts of FDI increases and then levels off as it enters high status of FDI.

This hypothesis is supported by the threshold effects for regions taking advantage by FDI according to the literature review as per studies by (Huang, Liu, & Xu, 2012). There are few statistically significant results for this hypothesis. When measuring for the relationship between independent variable FDI and dependent variable Innovative Performance using per capita GDP as a moderator we receive statically relevant results for high receiving regions and low receiving regions only. The results somewhat support the hypothesis, regions which have received high amounts of educational funding returns a coefficient of 0.630906, low receiving regions return a negative coefficient of -0.269684 (table 4.17). The hypothesis expects a weak positive relationship between educational funding and FDI however, the results are more extreme than expected and experience negative spillover effects, meaning that for an increase in Total FDI the innovative performance of a region of low educational funding decreases. The most reliable results considering regions of medium receiving of educational funding is from the model which omits GDP per capita as a moderator. This result disproves the theory as regions of medium educational funding experience smaller spillover to low regions of 1.352802 vs 2.090815 (table 4.19).

As per previous studies inspecting threshold effects and rates of absorption, we expected these hypothesis'. The results from this hypothesis proved that regions which have previously received low amounts of FDI showed a quick response time of the innovative environment to FDI. Medium and high-status regions showed a slow lag time of lag 5 and 4 respectively (table 4.24). This proves initially a fast absorption rate of which then slows down and levels off for medium and high receiving regions.

This hypothesis was disproved as per table 4.25. The researcher found that regions of high innovative environment were slowly affected by FDI, regions of medium FDI had a medium response time. As previously mentioned, the Vector Error Correction model could not return highly reliable results for areas or low FDI. For the low+1 category there is a slow response. These results portray a type of levelling off effect, there initially is a slow response to the innovative environment for region of low innovation performance, then fast for medium and once the regions attain a certain level of innovation performance the speed of absorption slows down again.

This hypothesis was disproved as per table 4.26, regions which received high levels of educational funding returned a slow lag time. Medium regions return a quick reaction time of one lag and low regions returned a quick reaction time of 2 lags. Regions initially responded with a quick rate, the absorption speeded up as medium status is attained and once areas reach high status it takes much larger amounts of FDI to affect the speed of absorption.

5. Discussion

5.1Theoretical contribution

With regards to FDI theory this paper strengthens the current frameworks. The confirmation of hypothesis 1 and 2 concludes and strengthens (Dunning, The eclectic paradigm as an envelope for economic and business theories of MNE activity, 2000)'s OLI model theory that location specific advantages are vital for domestic regions to experience positive spillovers from FDI. This paper also contributes to the existence of technology and education gaps in regional capabilities of FDI spillover absorption rates.

With regards to new contributions this paper discovered that the innovative performance of low educational funded regions actually experiences negative spillover effects. This paper also identified regions of high, medium and low level innovative environments in China. Furthermore, discovering that a certain innovative environmental level must be first attained in order for a firms' innovative performance to positively benefit from FDI. These are valuable theoretical contributions as provincial governments can focus on attaining a certain level of innovative environment before beginning FDI attraction campaigns.

Regarding lag time this paper confirms that regions which have previously received high levels of FDI are quickly effected. If a region has previously experienced high output of innovative performance, they will be slowly effected, whereas low and medium regions are effected on a medium time scale, uncovering that it takes a much larger amount of FDI to benefit regions with currently have high innovative performance on the same scale. Similarly, with educational funding, concluding that underdeveloped regions are much more sensitive to the speed in which spillovers take place. This confirms initially fast absorption rates followed by a slowing down effect, identifying a levelling off effect between FDI and innovative performance.

5.2 Managerial implications

According to the results of my study there is a range of conclusions and suggestions for several parties for consideration of future strategy

5.2.1 Domestic Firms

The study can provide information for how domestic firms can position themselves strategically to benefit from spillovers of a foreign firm's presence. The takeaways for domestic Chinese firms are as follows.

With the intention of maximising the benefits of spillovers effects from a foreign firm's presence, domestic firms should set up in areas with sufficient level of human and infrastructural capabilities to benefit. These areas include following criteria.

1 Eastern regions experience nearly double (94%) the amount of spillovers from FDI as opposed to FDI.
2 Regions of which have previously received high and medium amounts of FDI experience around 140% the amount spillover effects as opposed to regions which have received low amounts of FDI.

Domestic firms hoping to benefit from FDI spillovers should avoid setting up in the following regions as the presence of foreign firms causes negative effects on the innovative performance.

1 Regions categorized as having low and medium innovative environments
2 Regions categorized as receiving a low amount of educational funding.

Domestic firms should look into setting up in regions of high innovative environment status. To gain a first mover advantage on this, domestic firms can identify future prosperous regions for attaining high innovative environmental status based on the amount of inward FDI into these regions. Considering the results from the lag time analysis, the innovative environment of regions of low FDI and low innovative performance respond at a much quicker rate to FDI.

5.2.2 Foreign Corporations

This research provides valuable information for foreign companies to consider when selecting which regions to consider when entering China by means of FDI. MNC's will want to avoid exposure of their ideas to domestic firms to ensure competitive advantage.

To avoid high levels of FDI spillovers by means of spillover effects (reverse engineering, demonstration effects) and protect internal innovative ideas foreign firms may want to consider setting up in areas where low spillover effects occur.

1 Western regions provide less spillovers to the innovative environment.
2 Setting up in low and medium tech regions provides more barriers to spillovers as opposed to high tech regions. This may be an effective strategy for a region to enter. However, the companies must research the

human capital capabilities of the specific region in carrying out the desired activities.

3 Similar for regions of low and medium levels of educational funding (human capital capabilities should be considered)

They must also be sure that the region in which they are conducting these activities have adequate human capital capabilities. For knowledge intensive activities they will want to enter a region of high innovative environment status.

The first mover advantage I mentioned for domestic firms can also be considered for MNC's. First mover advantage can also be cheaper as the lack of demand for the region may keep the price low until the innovative environment attains a higher and more desirable status.

5.2.3 Government

This research can provide valuable insights into the most effective approach necessary for national, provincial and local governments FDI policy. There is culture in prioritising FDI and the aggressive means of attracting FDI to certain regions may cause more damage than harm, "governments at all levels compete with each other to attract FDI by introducing preferential tax rates and land policies." (Wang, Wei, Deng, & Yu, 2017). Worryingly, this research has founded that in certain regions, FDI causes negative spillover effects to FDI. This additional competition to certain regions may pose negative effects to the region's economy. The following regions should avoid aggressive means of FDI acquisition.

1 Regions which have receive low levels of educational funding
2 Regions categorized as having a low-level status of innovative environment.

This information also portrays the importance of educational funding on the absorption rate. A local region would be better off investing in education until the region has attained an adequate level of human capital, then ensuring positive spillover effects between FDI and the innovative performance before pursuing a campaign to attract FDI.

Governmental policy and budgetary allocation can also be tailored towards improving the innovative environment of a region (Education, Academia and human capital) which in turn will increase the level of positive spillover effects from FDI.

6. Conclusion

6.1 Research Summary

This research used a total of 2,900 input variables over an eight-year time period. This data has been collected from national, regional and reliable third-party sources. The reasoning for use of variables and the relationship of these variables with the research question has all be backed up by academic research. Considering the diversity amongst the 30 provincial level regions of China, the study uses further data sets as a means of categorical selection. In attaining the results this study included a correlation matrix, pooled data models, fixed effects models and random effects models to measure the relationship between FDI and the innovative performance or innovative environment. As per the literature review the strongest model for making a conclusion will be the most efficient model as identified by the Hausman test between the fixed effect or random effects models. The correlation coefficient conveys the relationship between the independent and dependent variables in the model. When the correlation coefficient is positive, this relationship is positive and when negative the relationship is negative. A correlation coefficient of X between an independent and a dependent variable means that when the independent variable increases by 1% the dependent variable increases by X%.

Lag time is measured between 1 and 6, 1 and 2 lags being quick effect, 3 being medium effect and 4, 6 being slowly affected.

6.2 Research Limitations

With the previous studies on this topic there are some research limitations to be noted for this study.

The amount of FDI is grouped together, this meant that there was insufficient data available to speculate whether FDI my means of merger, acquisition or joint venture effects the outcome.

Another drawback is that the research is only available for 8 periods. It was difficult to acquire reliable information for earlier years. Furthermore, the statistical yearbook for some regions were yet to be published which caused the most recent data to be for 2016.

This previous reason may have also affected the analysis of lag time as the Vector Error Correction model returns a maximum of 6 lags. With more time periods there the potential for more specific results

Due to regional diversity it is difficult to factor in the differences in implementation of policies for each region.

There can always be inclusion of many more moderating factors which may affect the innovation performance or environment other than FDI which can play part in the outcome of results.

Using value of technical market calculation for technology does not necessarily portray the infrastructural capabilities of firms in the region. It portrays the market value which is only depicted by supply and demand which may be lacking.

The academic citation variable only included the 160 most active institutions which omitted many of the underdeveloped institutions and regions in the analysis.

Using patents as a variable for the innovative performance is an effective source in identifying the output of innovative activities. However, this does carry some drawbacks. For example, each patent does not necessarily carry the same innovative weight and quality of patents does not necessarily mean quality of innovation.

6.3 future research

Based on these limitations the research will outline potential studies for future research.

Due to difficulty of accessible data and time constraints the time period was restricted to 8 time periods. Future research could implement a much greater span of time. This would not necessarily draw greater conclusions for measuring the effect between FDI and innovation however it would return a more accurate identification of lag time.

Mentioned throughout the study is the diverse political landscape in regions in China. Considering each region tends to interpret laws in a different manner, "This is partly because Chinese laws tend to be intentionally vague, thereby empowering local officials to interpret rules themselves." (Koty, 2019). A further suggestion would be to analyse the manner in which FDI policies are implemented in a region and categorize these. Then identify whether this is increases or hinders the spillover effects. (for example, regions with high levels of technology transfer vs low levels)

Another suggestion would be to look deeper into the internal structures of the firms. Speculate how ownership structure, organisational structure or culture effects the rate of FDI spillover absorption.

Considering there was only 160 of the most active institutions it would have increased the accuracy of the results to gain access to the entirety of the peer reviewed published journals

Run the model for each region, observe the spillover rates and then identify similarities these regions may have based on the political, economic social and technological factors.

Go further as to compare towns or cities in the research. Considering local authorities are gaining more and more autonomy, diversity amongst cities within regions may portray differing outcomes.

Measure by industry as opposed to region to identify industry specific effects.

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Appendix

A Collected data for FDI and Innovation performance variables

Year	Region	Total FDI	Investment	Imports	Granted Pate	invention-1year	utility	design	R&D Spendin	PGDP
2016	Beijing	243,354,697	**13,028,580**	230326117	106067	46091	44710	15266	2,548,433	118198
2015	Beijing	277,770,102	**12,996,350**	264773752	99325	40602	45773	12950	2,440,875	106497
2014	Beijing	362,221,026	**9,040,850**	353180176	86732	35308	44071	7353	2,335,010	99995
2013	Beijing	374,422,431	**8,524,180**	365898251	65213	23237	36301	5675	2,130,618	94648
2012	Beijing	356,516,829	**8,041,600**	348475229	51066	20695	24672	5699	1,973,442	87475
2011	Beijing	337,613,301	**7,054,470**	330558831	45148	20140	19628	5380	1,648,538	81658
2010	Beijing	252,648,917	**6,363,580**	246285337	38182	15880	16579	5723	1,061,357	73856
2009	Beijing	172,474,670	**6,120,940**	166353730	24973	11209	10141	**3623**	1,137,030	66940
2016	Tianjin	68,477,703	**10,100,450**	58377253	40393	5844	31046	3503	3,499,551	115053
2015	Tianjin	84,254,315	**21,134,440**	63119875	37903	5185	28486	4232	3,526,665	107960
2014	Tianjin	100,162,177	**18,866,760**	81295417	27696	4624	20122	2950	3,228,057	105231
2013	Tianjin	96,325,820	**16,828,970**	79496850	24994	3279	18759	2956	3,000,377	100105
2012	Tianjin	82,338,039	**15,016,330**	67321709	19597	3141	13677	2779	2,558,685	93173
2011	Tianjin	71,950,245	**13,056,020**	58894225	14780	3326	8961	2493	2,107,772	85213
2010	Tianjin	55,463,944	**10,848,720**	44615224	11604	2528	6718	2358	1,392,212	72994
2009	Tianjin	42,958,370	**9,019,850**	33938520	7445	1930	3988	1527	1,238,392	62574
2016	Hebei	24,246,812	**8,146,970**	16099842	32506	4927	19762	7817	3,086,608	43062
2015	Hebei	25,949,825	**7,368,840**	18580985	30537	4247	19103	7187	2,858,051	40255
2014	Hebei	31,176,653	**7,009,490**	24167163	21686	3840	14253	3593	2,606,711	39984
2013	Hebei	30,623,462	**6,672,500**	23950962	18464	2286	13038	3140	2,327,418	38909
2012	Hebei	26,996,533	**6,031,680**	20964853	15390	2008	10795	2587	1,980,850	36584
2011	Hebei	30,291,146	**5,260,160**	25030986	11583	1933	7490	2160	1,586,189	33969
2010	Hebei	23,869,897	**4,365,970**	19503927	10576	1469	6838	2269	1,078,941	28668
2009	Hebei	17,631,510	**3,693,160**	13938350	7102	954	4515	1633	933,016	24581
2016	Shanxi	9,061,638	**2,332,416**	6729222	10033	2382	6532	1119	976,283	35532
2015	Shanxi	9,130,399	**2,869,852**	6260547	9999	2411	6037	1551	1,008,950	34919
2014	Shanxi	10,243,804	**2,951,860**	7291944	9244	2432	5569	1243	1,247,027	35070
2013	Shanxi	10,602,075	**2,806,670**	7795405	8792	1559	5708	1525	1,237,698	34984
2012	Shanxi	10,530,858	**2,503,790**	8027068	7231	1332	4689	1210	1,069,590	33628

2011	Shanxi	11,390,713	**2,072,780**	9317933	5157	1297	3036	824	895,891	31357
2010	Shanxi	8,587,620	**714,210**	7873410	5127	1114	3096	917	675,657	26283
2009	Shanxi	6,224,730	**493,150**	5731580	3363	739	1967	657	603,934	21522
2016	Inner Mongolia	11,211,033	**3,966,720**	7244313	5823	848	3981	994	1,279,853	72064
2015	Inner Mongolia	10,447,433	**3,366,290**	7081143	5596	871	3757	968	1,186,261	71101
2014	Inner Mongolia	12,140,253	**3,977,480**	8162773	4370	797	2908	665	1,080,287	71046
2013	Inner Mongolia	12,546,571	**4,644,560**	7902011	3745	458	2494	793	1,004,406	67836
2012	Inner Mongolia	11,232,009	**3,943,190**	7288819	3064	549	1894	621	858,477	63886
2011	Inner Mongolia	11,082,201	**3,838,270**	7243931	2467	569	1415	483	701,635	57974
2010	Inner Mongolia	8,779,875	**3,384,560**	5395315	2198	364	1276	558	474,299	47347
2009	Inner Mongolia	7,442,440	**2,983,850**	4458590	1578	262	762	554	390,612	39735
2016	Liaoning	46,493,150	**2,999,020**	43494130	26081	7708	15515	2858	2,420,637	50791
2015	Liaoning	50,421,303	**5,185,160**	45236143	25344	6731	15706	2907	2,418,803	65354
2014	Liaoning	82,676,423	**27,423,350**	55253073	22119	6569	13432	2118	3,242,303	65201
2013	Liaoning	78,996,142	**29,039,960**	49956182	21801	3975	15582	2244	3,331,303	61996
2012	Liaoning	72,924,094	**26,793,150**	46130944	21080	3830	14852	2398	2,894,569	56649
2011	Liaoning	69,260,885	**24,267,390**	44993495	19985	3973	13584	2428	2,747,063	50760
2010	Liaoning	58,363,537	**20,750,100**	37613437	17900	3164	12067	2669	1,913,437	42355
2009	Liaoning	44,963,350	**15,443,900**	29519450	12562	2357	8585	1620	1,654,323	35149
2016	Jilin	16,525,365	**2,274,490**	14250875	10624	3057	6179	1388	908,602	53868
2015	Jilin	16,391,108	**2,127,470**	14263638	9066	2428	5638	1000	861,541	51086
2014	Jilin	22,569,625	**1,966,430**	20603195	7502	2240	4533	729	789,431	50160
2013	Jilin	20,912,319	**1,819,490**	19092829	6157	1434	3914	809	698,136	47428
2012	Jilin	20,228,975	**1,648,650**	18580325	5843	1496	3472	875	604,326	43415
2011	Jilin	18,544,465	**1,481,250**	17063215	5301	1583	2993	725	488,723	38460
2010	Jilin	13,649,753	**1,280,420**	12369333	4760	1202	2806	752	355,405	31599
2009	Jilin	9,757,240	**1,139,770**	8617470	3341	785	1931	625	329,615	26595
2016	Heilongjiang	17,321,979	**5,818,330**	11503649	18648	4947	11707	1994	884,925	40432
2015	Heilongjiang	18,425,371	**5,448,750**	12976621	19264	4345	12502	2417	880,392	39462
2014	Heilongjiang	26,653,598	**5,087,910**	21565688	16982	4024	11036	1922	955,820	39226

2013	Heilongjiang	27,260,678	**4,613,310**	22647368	20035	2454	12435	5146	950,335	37697
2012	Heilongjiang	27,055,078	**3,899,960**	23155118	20088	2238	9689	8161	906,170	35711
2011	Heilongjiang	24,097,730	**3,248,040**	20849690	12701	2418	5855	4428	838,042	32819
2010	Heilongjiang	11,896,139	**2,661,510**	9234629	7221	1953	4391	877	728,451	27076
2009	Heilongjiang	8,509,390	**2,362,000**	6147390	5449	1512	3212	725	627,240	22447
2016	Shanghai	268,930,059	**18,514,000**	250416059	64825	20681	34101	10043	4,900,778	116562
2015	Shanghai	271,786,511	**18,459,000**	253327511	63108	20086	33131	9891	4,742,443	103796
2014	Shanghai	274,465,975	**18,200,000**	256265975	56475	17601	30704	8170	4,492,192	97370
2013	Shanghai	253,888,190	**16,800,000**	237088190	49650	11614	29859	8177	4,047,800	90993
2012	Shanghai	245,056,785	**15,200,000**	229856785	50773	10644	29543	10586	3,715,075	85373
2011	Shanghai	240,474,772	**12,600,000**	227874772	50179	11379	23351	15449	3,437,627	82560
2010	Shanghai	199,357,670	**11,121,000**	188236670	50508	9160	21821	19527	2,377,472	76074
2009	Shanghai	146,417,580	**10,500,000**	135917580	35783	6867	13158	15758	2,365,150	69165
2016	Jiangsu	214,786,280	**24,542,960**	190243320	231599	41518	117827	72254	16,575,418	96887
2015	Jiangsu	231,190,359	**24,274,690**	206915669	255227	40952	119513	94762	15,065,065	87995
2014	Jiangsu	249,894,737	**28,174,160**	221720577	216376	36015	100810	79551	13,765,378	81874
2013	Jiangsu	255,259,738	**33,259,220**	222000518	242526	19671	98246	124609	12,395,745	75354
2012	Jiangsu	255,197,528	**35,759,560**	219437968	270492	16790	77944	175758	10,803,107	68347
2011	Jiangsu	259,122,567	**32,131,730**	226990837	205013	16242	53413	135358	8,998,944	62290
2010	Jiangsu	223,758,039	**28,497,770**	195260269	142215	11043	41161	90011	5,513,458	52840
2009	Jiangsu	164,863,490	**25,322,980**	139540510	89174	7210	21939	60025	5,707,105	44253
2016	Zhejiang	86,289,636	**17,577,480**	68712156	223622	28742	123744	71136	9,357,877	84916
2015	Zhejiang	87,411,952	**16,960,240**	70451712	238214	26576	124465	87173	8,535,689	77644
2014	Zhejiang	97,509,969	**15,797,250**	81712719	198517	23345	99508	75664	7,681,473	73002
2013	Zhejiang	101,201,444	**14,158,980**	87042464	204583	13372	106238	84973	6,843,562	68805
2012	Zhejiang	104,107,483	**16,223,270**	87884213	188031	11139	84826	92066	5,886,071	63374
2011	Zhejiang	108,426,344	**15,398,070**	93028274	132626	11571	56030	65025	4,799,069	59249
2010	Zhejiang	86,295,713	**13,225,840**	73069873	117368	9135	47617	60616	2,723,447	51711
2009	Zhejiang	65,594,760	**10,876,850**	54717910	81537	6410	25295	49832	3,301,031	43842
2016	Anhui	30,733,299	**14,767,120**	15966179	58131	12440	38773	6918	3,709,224	39561

2015	Anhui	29,193,808	**13,619,450**	15574358	63151	15292	41094	6765	3,221,422	35997
2014	Anhui	30,031,708	**12,339,780**	17691928	54376	11180	36748	6448	2,847,303	34425
2013	Anhui	27,955,375	**10,687,720**	17267655	49792	5184	36003	8605	2,477,246	32001
2012	Anhui	21,174,151	**8,638,110**	12536041	44496	4241	27191	13064	2,089,814	28792
2011	Anhui	20,855,477	**6,628,870**	14226607	33721	3066	16128	14527	1,628,304	25659
2010	Anhui	16,874,944	**5,014,460**	11860484	16927	2026	8839	6062	1,040,238	20888
2009	Anhui	10,675,400	**3,884,160**	6791240	8910	1111	4226	3573	907,544	16408
2016	Fujian	61,342,856	**8,194,650**	53148206	68690	8718	42110	17862	3,882,632	74707
2015	Fujian	63,849,212	**7,683,390**	56165822	63061	7170	34086	21805	3,469,810	67966
2014	Fujian	71,070,537	**7,114,990**	63955547	40161	5730	21013	13418	3,153,831	63472
2013	Fujian	69,525,441	**6,678,960**	62846481	37996	3426	22152	12418	2,791,966	58145
2012	Fujian	64,443,103	**6,337,740**	58105363	30461	2941	17708	9812	2,381,656	52763
2011	Fujian	56,885,756	**6,201,110**	50684646	22889	2977	12697	7215	1,943,993	47377
2010	Fujian	43,092,951	**5,802,790**	37290161	18784	1945	9664	7175	1,161,171	40025
2009	Fujian	32,067,950	**5,737,470**	26330480	11682	1224	4939	5519	1,144,347	33437
2016	Jiangxi	20,670,569	**10,440,560**	10230009	31796	2238	17939	11619	1,797,561	40400
2015	Jiangxi	18,756,077	**9,473,210**	9282867	24436	1914	13408	9114	1,474,968	36724
2014	Jiangxi	19,156,244	**8,450,740**	10705504	14437	1639	7637	5161	1,284,642	34674
2013	Jiangxi	16,130,942	**7,550,960**	8579982	10080	1033	5913	3134	1,106,443	31930
2012	Jiangxi	15,125,353	**6,824,310**	8301043	8016	923	4734	2359	925,985	28800
2011	Jiangxi	15,651,557	**6,058,810**	9592747	5763	892	3088	1783	769,834	26150
2010	Jiangxi	13,303,954	**5,100,840**	8203114	4617	679	2588	1350	589,366	21253
2009	Jiangxi	9,433,840	**4,023,540**	5410300	2940	411	1515	1014	582,649	17335
2016	Shandong	114,085,323	**16,825,560**	97259763	97779	19090	66068	12621	14,150,035	68733
2015	Shandong	112,983,022	**16,300,900**	96682122	100624	19404	68776	12444	12,917,718	64168
2014	Shandong	147,415,864	**15,195,120**	132220744	79161	16881	53555	8725	11,755,482	60879
2013	Shandong	146,394,558	**14,053,150**	132341408	78601	10538	58938	9125	10,528,097	56885
2012	Shandong	129,187,789	**12,352,670**	116835119	76956	8913	59084	8959	9,056,007	51768
2011	Shandong	121,333,728	**11,160,220**	110173508	60441	7453	43443	9545	7,431,254	47335
2010	Shandong	94,099,018	**9,168,330**	84930688	53240	5856	36391	10993	5,269,241	41106

2009	Shandong	67,572,730	**8,010,070**	59562660	35754	4106	22635	9013	4,567,136	35894
2016	Henan	45,400,710	**16,993,120**	28407590	50248	7914	32197	10137	4,096,962	42575
2015	Henan	46,805,568	**16,086,370**	30719198	49193	6811	32592	9790	3,688,252	39123
2014	Henan	40,516,058	**14,926,880**	25589178	35257	5384	23539	6334	3,372,310	37072
2013	Henan	37,426,356	**13,456,590**	23969766	29802	3493	21153	5156	2,953,410	34211
2012	Henan	34,180,130	**12,117,770**	22062360	26782	3173	18680	4929	2,489,651	31499
2011	Henan	23,464,758	**10,082,090**	13382668	19979	3182	13032	3765	2,137,236	28661
2010	Henan	13,548,842	**6,246,700**	7302142	17503	2462	11048	3993	1,485,875	24446
2009	Henan	10,929,620	**4,798,580**	6131040	11794	1498	6630	3666	1,334,943	20597
2016	Hubei	23,478,321	**10,128,890**	13349431	44185	10880	27209	6096	4,459,622	55665
2015	Hubei	25,288,774	**8,948,010**	16340764	39532	8517	25298	5717	4,072,726	50654
2014	Hubei	24,325,117	**7,927,920**	16397197	31201	7766	19801	3634	3,629,506	47145
2013	Hubei	20,432,338	**6,888,470**	13543868	29563	4855	19655	5053	3,117,987	42826
2012	Hubei	18,231,163	**5,665,910**	12565253	24477	4052	15876	4549	2,633,099	38572
2011	Hubei	18,707,364	**4,655,030**	14052334	19925	4050	11147	4728	2,107,553	34197
2010	Hubei	15,540,465	**4,050,150**	11490315	18497	3160	10431	4906	1,429,050	27906
2009	Hubei	10,929,880	**3,657,660**	7272220	11904	2025	6285	3594	1,205,733	22677
2016	Hunan	21,403,014	**12,852,080**	8550934	34992	7909	18452	8631	3,929,647	46382
2015	Hunan	21,729,119	**11,564,410**	10164709	34266	6967	18467	8832	3,525,450	42754
2014	Hunan	21,154,451	**10,265,850**	10888601	29253	6776	15967	6510	3,100,446	40271
2013	Hunan	19,058,932	**8,704,820**	10354112	24939	4160	15205	5574	2,703,987	36943
2012	Hunan	16,626,872	**7,280,340**	9346532	23472	3613	13274	6585	2,290,877	33480
2011	Hunan	15,190,277	**6,150,310**	9039967	16811	3353	8732	4726	1,817,773	29880
2010	Hunan	11,884,811	**5,184,410**	6700401	14559	2606	7861	4092	1,137,692	24719
2009	Hunan	9,255,300	**4,597,870**	4657430	8477	1920	4218	2339	1,096,144	20428
2016	Guangdong	380,102,911	**23,406,890**	356696021	266146	45740	118157	102249	16,762,749	74016
2015	Guangdong	406,348,718	**27,025,120**	379323598	246325	38626	105254	102445	15,205,497	67503
2014	Guangdong	457,774,973	**27,277,510**	430497463	191154	33477	83202	74475	13,752,869	63469
2013	Guangdong	480,544,782	**25,327,190**	455217592	172622	22276	77503	72843	12,374,791	58833
2012	Guangdong	434,075,473	**24,105,780**	409969693	151529	20084	65946	65499	10,778,634	54095

2011	Guangdong	403,869,232	**22,328,470**	381540762	132324	22153	51402	58769	8,994,412	50807
2010	Guangdong	352,731,424	**21,026,460**	331704964	123894	18242	43900	61752	6,268,811	44736
2009	Guangdong	272,426,040	**20,286,880**	252139160	85957	13691	27438	44828	5,523,733	39436
2016	Guangxi	25,589,468	**888,450**	24701018	14252	4553	6535	3164	827,248	38027
2015	Guangxi	24,878,651	**1,722,080**	23156571	14715	5159	7091	2465	769,190	35190
2014	Guangxi	17,222,616	**1,001,190**	16221426	11748	4017	6138	1593	848,808	33090
2013	Guangxi	14,834,322	**700,080**	14134242	8522	1933	5044	1545	817,063	30741
2012	Guangxi	14,765,238	**748,530**	14016708	6293	1295	3422	1576	702,225	27952
2011	Guangxi	11,912,018	**1,013,810**	10898208	4670	902	2564	1204	586,791	25326
2010	Guangxi	9,047,833	**912,000**	8135833	3855	634	2167	1054	358,915	20219
2009	Guangxi	6,914,690	**1,035,330**	5879360	2802	426	1506	870	324,191	16045
2016	Hainan	11,438,241	**2,215,610**	9222631	1929	373	1171	385	79,819	44347
2015	Hainan	12,689,599	**2,465,670**	10223929	2027	383	1148	496	111,841	40818
2014	Hainan	13,361,498	**1,915,580**	11445918	1634	417	848	369	111,010	38924
2013	Hainan	13,089,548	**1,810,600**	11278948	1262	380	691	191	93,567	35663
2012	Hainan	12,827,186	**1,641,190**	11185996	1146	449	499	198	78,093	32377
2011	Hainan	11,795,290	**1,580,870**	10214420	889	396	334	159	57,760	28898
2010	Hainan	7,851,007	**1,522,760**	6328247	796	272	305	219	18,334	23831
2009	Hainan	4,516,040	**943,040**	3573000	736	190	330	216	22,616	19254
2016	Chongqing	33,441,099	**11,341,841**	22099258	43832	6138	30428	7266	2,374,859	58502
2015	Chongqing	30,045,063	**10,765,050**	19280013	39994	5044	25444	9506	1,996,609	52321
2014	Chongqing	42,660,239	**10,629,460**	32030779	25955	3964	15885	6106	1,664,720	47850
2013	Chongqing	32,493,415	**10,597,150**	21896265	24789	2321	16623	5845	1,388,199	43223
2012	Chongqing	25,214,621	**10,578,620**	14636001	20298	2360	13432	4506	1,171,045	38914
2011	Chongqing	19,952,596	**10,576,610**	9375986	16086	2426	8749	4911	943,975	34500
2010	Chongqing	11,307,697	**6,369,560**	4938137	12802	1865	6704	4233	672,418	27596
2009	Chongqing	7,624,230	**4,191,780**	3432450	7810	1143	3274	3393	564,856	22920
2016	Sichuan	29,902,444	**8,543,810**	21358634	63462	11367	31813	20282	2,572,607	40003
2015	Sichuan	28,532,472	**10,436,810**	18095662	66198	10350	31420	24428	2,238,051	36775
2014	Sichuan	36,017,117	**10,653,280**	25363837	50543	9105	24060	17378	1,960,112	35128

2013	Sichuan	33,200,412	**10,574,810**	22625602	47287	5682	24730	16875	1,688,902	32617
2012	Sichuan	31,225,072	**10,550,540**	20674532	42324	4566	19665	18093	1,422,310	29608
2011	Sichuan	29,724,214	**11,027,330**	18696884	29636	4460	12533	12643	1,044,666	26133
2010	Sichuan	20,866,229	**7,012,990**	13853239	33278	3270	12724	17284	809,767	21182
2009	Sichuan	14,128,530	**4,129,330**	9999200	20740	2204	6561	11975	817,664	17339
2016	Guizhou	1,924,215	**967,390**	956825	10264	1875	6525	1864	556,853	33246
2015	Guizhou	2,692,204	**419,410**	2272794	14650	2036	7007	5607	457,303	29847
2014	Guizhou	1,839,719	**465,650**	1374069	10561	1501	5207	3853	410,132	26437
2013	Guizhou	1,980,856	**576,730**	1404126	8186	1047	3916	3223	342,541	23151
2012	Guizhou	2,170,489	**491,160**	1679329	6200	776	3155	2269	315,079	19710
2011	Guizhou	2,417,902	**515,410**	1902492	3425	635	1885	905	275,217	16413
2010	Guizhou	1,522,081	**295,460**	1226621	3241	596	1936	709	217,791	13119
2009	Guizhou	1,081,240	**133,640**	947600	2203	441	1234	528	187,695	10971
2016	Yunnan	9,279,046	867,000	8412046	12166	2259	8063	1844	741,847	31093
2015	Yunnan	10,867,646	2,992,000	7875646	11704	2125	7437	2142	619,588	28806
2014	Yunnan	13,525,957	2,706,000	10819957	8780	2079	5438	1263	516,572	27264
2013	Yunnan	12,147,181	2,515,000	9632181	6915	1423	4322	1170	454,278	25322
2012	Yunnan	13,185,361	2,189,000	10996361	5864	1312	3456	1096	384,430	22195
2011	Yunnan	8,293,859	1,737,540	6556319	4494	1301	2217	976	299,279	19265
2010	Yunnan	7,153,373	1,329,020	5824353	4177	1006	2026	1145	180,687	15752
2009	Yunnan	4,470,520	936,180	3534340	3099	652	1338	1109	151,147	13539
2016	Shaanxi	19,121,442	5,011,780	14109662	49726	8774	17084	23868	1,844,216	51015
2015	Shaanxi	20,330,925	4,621,180	15709745	34041	7503	16151	10387	1,725,829	47626
2014	Shaanxi	17,610,256	4,175,570	13434686	24747	6812	15405	2530	1,606,946	46929
2013	Shaanxi	13,580,404	3,678,000	9902404	21588	4885	13936	2767	1,401,480	43117
2012	Shaanxi	9,082,858	2,936,090	6146768	15023	4133	9158	1732	1,192,770	38564
2011	Shaanxi	9,967,075	2,354,830	7612245	12541	4018	6958	1565	966,768	33464
2010	Shaanxi	7,713,526	1,820,060	5893466	11286	3139	6093	2054	710,176	27133
2009	Shaanxi	5,927,770	1,510,530	4417240	6632	1887	3446	1299	582,497	21947
2016	Gansu	2,886,298	115,880	2770418	8007	1340	5075	1592	509,228	27643

2015	Gansu	2,600,565	460,360	2140205	6982	1308	4478	1196	486,077	26165
2014	Gansu	3,766,553	455,420	3311133	5523	1238	3538	747	464,410	26433
2013	Gansu	5,950,075	391,290	5558785	4764	812	3205	747	400,743	24539
2012	Gansu	5,699,307	372,100	5327207	3743	785	2344	614	337,785	21978
2011	Gansu	6,955,040	385,240	6569800	2535	704	1536	295	257,916	19595
2010	Gansu	6,284,378	519,210	5765168	2071	552	1131	388	208,652	16113
2009	Gansu	3,643,870	513,830	3130040	1396	349	809	238	189,931	13269
2016	Qinghai	174,093	14,950	159143	1326	240	883	203	77,940	43531
2015	Qinghai	347,505	55,000	292505	1281	271	687	323	65,029	41252
2014	Qinghai	640,089	50,100	589989	716	207	357	152	92,528	39671
2013	Qinghai	649,202	93,723	555479	521	110	285	126	89,540	36875
2012	Qinghai	634,485	205,780	428705	517	91	218	208	84,197	33181
2011	Qinghai	430,926	168,932	261994	569	101	147	321	81,965	29522
2010	Qinghai	542,064	219,300	322764	293	70	134	89	60,210	24115
2009	Qinghai	549,910	215,000	334910	374	41	89	244	41,322	19454
2016	Ningxia	1,019,371	253,630	765741	2774	657	1947	170	239,624	47194
2015	Ningxia	945,828	169,680	776148	1983	560	1267	156	200,453	43805
2014	Ningxia	1,353,210	220,850	1132360	1623	442	1048	133	186,518	41834
2013	Ningxia	808,568	143,040	665528	1270	243	899	128	167,494	39613
2012	Ningxia	779,428	203,840	575588	888	184	547	157	143,696	36394
2011	Ningxia	1,034,406	348,090	686316	650	140	418	92	118,879	33043
2010	Ningxia	1,132,247	342,260	789987	1123	103	307	713	73,020	26860
2009	Ningxia	691,300	231,750	459550	919	61	267	591	77,591	21777
2016	Xinjiang	2,456,339	400,760	2055579	7156	950	4828	1378	390,946	40564
2015	Xinjiang	2,625,815	452,500	2173315	8721	910	5049	2762	366,180	40036
2014	Xinjiang	4,608,552	417,000	4191552	5583	950	3850	783	357,812	40648
2013	Xinjiang	5,774,656	481,000	5293656	5063	605	3244	1214	314,257	37553
2012	Xinjiang	6,232,362	407,950	5824412	3523	540	2382	601	273,425	33796
2011	Xinjiang	6,328,798	334,850	5993948	2796	456	1974	366	223,352	30087
2010	Xinjiang	4,398,878	237,420	4161458	2675	302	2012	361	167,254	25034
2009	Xinjiang	3,228,970	215,700	3013270	1935	189	1260	486	140,932	19942

B Collected data for innovative environment

Year	Region	Education	Academia	Human Cap	EduFunds
2016	Beijing	5028	195314	51143	11934724
2015	Beijing	5218	180079	50773	11171250
2014	Beijing	5429	177573	57761	10937374
2013	Beijing	5469	164109	58036	9998366
2012	Beijing	5534	145147	53510	N/A
2011	Beijing	5613	131483	49829	7373843
2010	Beijing	6196	118711	43056	6134448
2009	Beijing	6410	107081	41546	5289432
2016	Tianjin	4058	12435	78336	5365129
2015	Tianjin	4185	11596	84291	5605736
2014	Tianjin	4283	12126	79014	6326265
2013	Tianjin	4346	10701	68175	5699615
2012	Tianjin	4358	10024	60681	N/A
2011	Tianjin	4329	9333	47828	4136097
2010	Tianjin	4412	8580	34073	2920970
2009	Tianjin	4432	7279	30074	2381672
2016	Hebei	2191	2810	82971	14203834
2015	Hebei	2141	1615	79452	12861641
2014	Hebei	2098	4829	75142	10861672
2013	Hebei	2108	4502	65049	10298143
2012	Hebei	2063	5094	55979	N/A
2011	Hebei	2006	3984	51498	8447882
2010	Hebei	1951	3791	38819	7192734
2009	Hebei	1871	4594	36418	6145261
2016	Shanxi	2439	2751	29450	7942196
2015	Shanxi	2504	2410	28927	8442363
2014	Shanxi	2519	1495	35775	7036233
2013	Shanxi	2474	2336	34024	6918247
2012	Shanxi	2351	1984	31542	N/A
2011	Shanxi	2202	2070	32476	5494903
2010	Shanxi	2132	1702	30172	4508195
2009	Shanxi	2050	1360	32703	3809096
2016	Inner Mongolia	1937	0	30126	7624806
2015	Inner Mongolia	2035	0	29190	7072130
2014	Inner Mongolia	2156	0	27068	6393778
2013	Inner Mongolia	2137	0	26990	6121559
2012	Inner Mongolia	2042	0	21509	N/A
2011	Inner Mongolia	1920	0	17645	5040005

2010	Inner Mongolia	1884	0	14582	4143731
2009	Inner Mongolia	1794	0	12307	3187733
2016	Liaoning	2845	11140	49254	9206907
2015	Liaoning	2876	12739	49097	8781171
2014	Liaoning	2933	12154	63374	8700533
2013	Liaoning	2903	12269	59090	9302062
2012	Liaoning	2811	13242	52064	N/A
2011	Liaoning	2712	12341	47513	7809413
2010	Liaoning	2671	12161	47661	6242615
2009	Liaoning	2659	11638	48112	5349184
2016	Jilin	3048	9062	23469	6439837
2015	Jilin	3169	10059	23202	5975239
2014	Jilin	3168	11435	24395	5353180
2013	Jilin	3033	9890	23709	5480347
2012	Jilin	2889	8966	24365	N/A
2011	Jilin	2807	8786	17884	4293877
2010	Jilin	2716	7262	19394	3445611
2009	Jilin	2695	6455	14671	3006988
2016	Heilongjiang	2427	13177	32219	7336607
2015	Heilongjiang	2518	13358	31762	7040039
2014	Heilongjiang	2555	14185	37509	6278812
2013	Heilongjiang	2529	14483	37296	6006258
2012	Heilongjiang	2441	13147	36256	N/A
2011	Heilongjiang	2409	13361	39661	4838173
2010	Heilongjiang	2447	11695	32156	4048565
2009	Heilongjiang	2420	11045	27658	3486163
2016	Shanghai	3327	44902	98671	11218946
2015	Shanghai	3330	41866	94981	10131153
2014	Shanghai	3348	39832	93868	9892212
2013	Shanghai	3421	37912	92136	9069715
2012	Shanghai	3481	33403	82355	N/A
2011	Shanghai	3556	31553	79147	7106255
2010	Shanghai	4300	27624	66089	5582736
2009	Shanghai	4393	28195	67420	4937339
2016	Jiangsu	2937	50680	451885	24020855
2015	Jiangsu	2896	44873	441304	22463773
2014	Jiangsu	2858	44579	422865	20800931
2013	Jiangsu	2814	39995	393942	19862835
2012	Jiangsu	2786	35624	342262	N/A
2011	Jiangsu	2824	33629	287447	15882132
2010	Jiangsu	2819	28736	252396	13146233
2009	Jiangsu	2786	26082	222625	11054890
2016	Zhejiang	2355	17812	321845	18908104
2015	Zhejiang	2414	15344	316672	17568215
2014	Zhejiang	2408	16539	290339	16079755

2013	Zhejiang	2363	15241	263507	14490439
2012	Zhejiang	2288	15960	228618	N/A
2011	Zhejiang	2218	16262	203904	12069078
2010	Zhejiang	2285	14605	185100	10625688
2009	Zhejiang	2303	11997	150888	8911507
2016	Anhui	2259	11464	99451	12357931
2015	Anhui	2309	10374	96791	11578495
2014	Anhui	2245	10053	95287	10457811
2013	Anhui	2203	8735	86000	10413043
2012	Anhui	2101	6845	73356	N/A
2011	Anhui	2007	5673	56275	8172010
2010	Anhui	1841	5325	39542	5990868
2009	Anhui	1742	4782	37649	4873316
2016	Fujian	2438	7619	102250	10473975
2015	Fujian	2508	6049	99180	10028329
2014	Fujian	2513	5047	110892	8928771
2013	Fujian	2435	4504	100200	8228012
2012	Fujian	2301	4302	90280	N/A
2011	Fujian	2200	3841	75503	6344839
2010	Fujian	2144	3393	55535	5341118
2009	Fujian	2039	2873	46433	4479126
2016	Jiangxi	2698	2085	34924	10468837
2015	Jiangxi	2654	1855	31321	9732898
2014	Jiangxi	2527	1688	28803	8930127
2013	Jiangxi	2381	1459	29519	8284996
2012	Jiangxi	2295	1458	23877	N/A
2011	Jiangxi	2212	1414	23969	6307866
2010	Jiangxi	2162	1157	20427	4494597
2009	Jiangxi	2118	1105	19959	3776516
2016	Shandong	2620	14335	241761	22422970
2015	Shandong	2516	12875	241395	20632259
2014	Shandong	2421	13576	230800	18847752
2013	Shandong	2304	13006	227403	17796161
2012	Shandong	2238	11116	204398	N/A
2011	Shandong	2191	11595	180832	13727939
2010	Shandong	2202	9268	132519	10395900
2009	Shandong	2153	8182	129892	8397429
2016	Henan	2352	6096	132731	18902582
2015	Henan	2293	4616	131051	17411099
2014	Henan	2203	5628	134256	16385611
2013	Henan	2114	5291	125091	15577127
2012	Henan	2012	5013	102846	N/A
2011	Henan	1901	5041	93833	11821418
2010	Henan	1839	3247	73224	9111164
2009	Henan	1774	2558	69647	7633496
2016	Hubei	2950	23118	96340	13009264

2015	Hubei	3038	20812	86813	11435059
2014	Hubei	3121	20681	91456	9874547
2013	Hubei	3144	19614	85826	8972278
2012	Hubei	3078	18768	77087	N/A
2011	Hubei	2991	18948	71281	6844038
2010	Hubei	2906	17314	53892	5869164
2009	Hubei	2829	17750	50425	5194495
2016	Hunan	2251	15218	86440	13781959
2015	Hunan	2215	13594	83821	12223238
2014	Hunan	2160	12462	77428	11285463
2013	Hunan	2106	12213	73558	10784551
2012	Hunan	2087	13054	69784	N/A
2011	Hunan	2054	12722	57478	7987607
2010	Hunan	2051	10259	43098	6497608
2009	Hunan	2040	10255	38041	5660684
2016	Guangdong	2431	24111	423730	33675376
2015	Guangdong	2434	21466	411059	30474906
2014	Guangdong	2356	19656	424872	27356552
2013	Guangdong	2199	17924	426330	24775503
2012	Guangdong	2082	16593	424563	N/A
2011	Guangdong	1978	15498	346260	18846365
2010	Guangdong	2037	13067	275976	15327348
2009	Guangdong	1952	12026	228907	12843085
2016	Guangxi	2279	1476	19402	10914241
2015	Guangxi	2178	1238	19000	10111559
2014	Guangxi	2052	1448	22793	8586224
2013	Guangxi	1939	1377	20700	7794191
2012	Guangxi	1834	1193	20845	N/A
2011	Guangxi	1688	1079	20155	5938482
2010	Guangxi	1530	852	14750	4941416
2009	Guangxi	1436	753	12042	3873253
2016	Hainan	2258	0	2688	3068767
2015	Hainan	2290	0	3325	2809962
2014	Hainan	2317	0	3484	2413904
2013	Hainan	2253	0	2882	2222868
2012	Hainan	2218	0	2767	N/A
2011	Hainan	2079	0	1587	1732237
2010	Hainan	2036	0	1302	1422673
2009	Hainan	2001	0	1046	1175474
2016	Chongqing	3059	10406	47392	8863208
2015	Chongqing	3071	9230	45129	7971003
2014	Chongqing	3017	9093	43797	6979973
2013	Chongqing	2894	8217	36605	6565622
2012	Chongqing	2734	7998	31577	N/A
2011	Chongqing	2522	7166	27652	5039550
2010	Chongqing	2413	5754	22488	4068437

2009	Chongqing	2317	4842	23279	3309977
2016	Sichuan	2314	21877	60146	17620946
2015	Sichuan	2312	19931	56841	16409562
2014	Sichuan	2244	19954	62145	14508458
2013	Sichuan	2140	17472	58148	13805525
2012	Sichuan	2037	15178	50533	N/A
2011	Sichuan	1904	15089	36839	10244130
2010	Sichuan	1790	12620	38452	8951781
2009	Sichuan	1732	11183	44370	8088479
2016	Guizhou	2005	0	15774	10335342
2015	Guizhou	1819	0	14916	9277347
2014	Guizhou	1690	0	15659	7700061
2013	Guizhou	1535	0	16049	6799795
2012	Guizhou	1392	0	12135	N/A
2011	Guizhou	1254	0	9564	4510531
2010	Guizhou	1109		8736	3669550
2009	Guizhou	1043	0	7234	3094113
2016	Yunnan	1889	1928	17166	11886446
2015	Yunnan	1819	1708	16381	10455388
2014	Yunnan	1731	3475	12980	9199396
2013	Yunnan	1662	3224	11811	9006912
2012	Yunnan	1566	1923	12321	N/A
2011	Yunnan	1520	2036	10335	6582935
2010	Yunnan	1391	1712	8192	5336317
2009	Yunnan	1298	1335	6790	4408081
2016	Shaanxi	3540	26265	45362	10049114
2015	Shaanxi	3628	23390	45052	9674438
2014	Shaanxi	3652	22122	50753	9101672
2013	Shaanxi	3612	20540	45809	8926920
2012	Shaanxi	3525	19041	36728	N/A
2011	Shaanxi	3378	18628	30829	6838342
2010	Shaanxi	3208	17177	27782	5143635
2009	Shaanxi	3045	15205	25897	4637457
2016	Gansu	2189	2931	12610	6706137
2015	Gansu	2194	2918	12578	6134547
2014	Gansu	2219	3958	14380	5181631
2013	Gansu	2193	3594	12472	4811034
2012	Gansu	2145	3227	11445	N/A
2011	Gansu	2041	3239	9307	3608174
2010	Gansu	1882	2792	8655	3106736
2009	Gansu	1806	1923	10239	2761110
2016	Qinghai	1319	0	1750	2162973
2015	Qinghai	1275	0	1285	2073501
2014	Qinghai	1220	0	2068	1976886
2013	Qinghai	1162	0	2039	1569408
2012	Qinghai	1133	0	2020	N/A

2011	Qinghai	1082	0	1833	1552462
2010	Qinghai	1119	0	1829	1062206
2009	Qinghai	1080	0	1551	785820
2016	Ningxia	2225	0	5686	2072544
2015	Ningxia	2244	0	5470	1963258
2014	Ningxia	2255	0	5799	1697964
2013	Ningxia	2195	0	4817	1578935
2012	Ningxia	2107	0	4196	N/A
2011	Ningxia	1912	0	3967	1313862
2010	Ningxia	1868	0	2692	994671
2009	Ningxia	1721	0	3568	813071
2016	Xinjiang	1780	0	7310	7823914
2015	Xinjiang	1759	0	7188	7132774
2014	Xinjiang	1749	0	6688	6349792
2013	Xinjiang	1681	0	6668	5989856
2012	Xinjiang	1596	0	6202	N/A
2011	Xinjiang	1521	0	6723	4605867
2010	Xinjiang	1467	0	5942	3655998
2009	Xinjiang	1430	0	5023	2959264

C Correlation Matrix

Correlation	ACADEMIA	DESIGN	EDUCATION	GRANTED_	HUMAN_CAP	IMPORTS	INNENVIRON	INNPERFORM	INVENTION_	INVESTMENT	PGDP	R_D_SPEND	TOTAL_FDI	UTILITY
ACADEMIA	1.0000	0.6798	0.6264	0.7623	0.7673	0.7260	0.9850	0.7662	0.7988	0.7260	0.3350	0.7461	0.7471	0.7605
DESIGN	0.6798	1.0000	0.3638	0.9528	0.8918	0.7656	0.7623	0.9261	0.8634	0.7893	0.4674	0.8674	0.7889	0.9086
EDUCATION	0.6264	0.3638	1.0000	0.5141	0.4590	0.6468	0.6499	0.5132	0.6182	0.5667	0.6891	0.4960	0.6517	0.5243
GRANTED_	0.7623	0.9528	0.5141	1.0000	0.9385	0.8359	0.8454	0.9861	0.9613	0.8318	0.5859	0.9394	0.8562	0.9888
HUMAN_CAP	0.7673	0.8918	0.4590	0.9385	1.0000	0.8129	0.8618	0.9732	0.8892	0.8565	0.5242	0.9802	0.8400	0.9381
IMPORTS	0.7260	0.7656	0.6468	0.8359	0.8129	1.0000	0.7941	0.8385	0.8589	0.8368	0.6772	0.8146	0.9939	0.8203
INNENVIRON	0.9850	0.7623	0.6499	0.8454	0.8618	0.7941	1.0000	0.8574	0.8664	0.8003	0.4301	0.8431	0.8171	0.8447
INNPERFORM	0.7662	0.9261	0.5132	0.9861	0.9732	0.8385	0.8574	1.0000	0.9479	0.8563	0.6089	0.9833	0.8628	0.9850
INVENTION_	0.7988	0.8634	0.6182	0.9613	0.8892	0.8589	0.8664	0.9479	1.0000	0.8027	0.6290	0.9030	0.8723	0.9558
INVESTMENT	0.7260	0.7893	0.5667	0.8318	0.8565	0.8368	0.8003	0.8563	0.8027	1.0000	0.5573	0.8558	0.8880	0.8257
PGDP	0.3350	0.4674	0.6891	0.5859	0.5242	0.6772	0.4301	0.6089	0.6290	0.5573	1.0000	0.6146	0.6709	0.5961
R_D_SPEND	0.7461	0.8674	0.4960	0.9394	0.9802	0.8146	0.8431	0.9833	0.9030	0.8558	0.6146	1.0000	0.8424	0.9494
TOTAL_FDI	0.7471	0.7889	0.6517	0.8562	0.8400	0.9939	0.8171	0.8628	0.8723	0.8880	0.6709	0.8424	1.0000	0.8416
UTILITY	0.7605	0.9086	0.5243	0.9888	0.9381	0.8203	0.8447	0.9850	0.9558	0.8257	0.5961	0.9494	0.8416	1.0000

D Covariance matrix

Covariance	GRANTED_	INVENTION_	TOTAL_FDI	UTILITY	DESIGN	INNPERFORM	R_D_SPEND	ACADEMIA	ACADEMIA01	EDUCATION	HUMAN_CAP	IMPORTS	INNENVIRON	INVESTMENT
GRANTED_	2.2011	2.0355	2.0306	2.1709	2.3251	4.0900	1.8890	0.6253	4.2686	0.2452	1.8402	2.0558	6.9793	1.8570
INVENTION_	2.0355	2.0372	1.9902	2.0189	2.0270	3.7825	1.7470	0.7122	4.3033	0.2836	1.6775	2.0323	6.9765	1.7239
TOTAL_FDI	2.0306	1.9902	2.5553	1.9909	2.0743	3.8558	1.8252	0.8110	4.5076	0.3349	1.7748	2.6337	7.4282	2.1360
UTILITY	2.1709	2.0189	1.9909	2.1900	2.2117	4.0752	1.9043	0.5875	4.2482	0.2494	1.8348	2.0123	6.9200	1.8387
DESIGN	2.3251	2.0270	2.0743	2.2117	2.7056	4.2589	1.9338	0.5770	4.2208	0.1924	1.9388	2.0877	6.9289	1.9536
INNPERFORM	4.0900	3.7825	3.8558	4.0752	4.2589	7.8161	3.7261	1.0906	8.0860	0.4613	3.5963	3.8862	13.2341	3.6026
R_D_SPEND	1.8890	1.7470	1.8252	1.9043	1.9338	3.7261	1.8371	0.4652	3.8174	0.2161	1.7560	1.8304	6.2547	1.7455
ACADEMIA	0.6253	0.7122	0.8110	0.5875	0.5770	1.0906	0.4652	0.7898	1.5591	0.1906	0.4269	0.8474	2.9664	0.5664
ACADEMIA01	4.2686	4.3033	4.5076	4.2482	4.2208	8.0860	3.8174	1.5591	14.2475	0.7600	3.8282	4.5428	20.3949	4.1234
EDUCATION	0.2452	0.2836	0.3349	0.2494	0.1924	0.4613	0.2161	0.1906	0.7600	0.1033	0.1950	0.3447	1.2490	0.2741
HUMAN_CAP	1.8402	1.6775	1.7748	1.8348	1.9388	3.5963	1.7560	0.4269	3.8282	0.1950	1.7470	1.7812	6.1971	1.7036
IMPORTS	2.0558	2.0323	2.6337	2.0123	2.0877	3.8862	1.8304	0.8474	4.5428	0.3447	1.7812	2.7481	7.5161	2.0875
INNENVIRON	6.9793	6.9765	7.4282	6.9200	6.9289	13.2341	6.2547	2.9664	20.3949	1.2490	6.1971	7.5161	30.8073	6.6675
INVESTMENT	1.8570	1.7239	2.1360	1.8387	1.9536	3.6026	1.7455	0.5664	4.1234	0.2741	1.7036	2.0875	6.6675	2.2644

E Innovation performance pooled effects model

Dependent Variable: INNPERFORM
Method: Panel Least Squares
Periods included: 8
Cross-sections included: 30
Total panel (balanced) observations: 240

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	-4.1909	2.100444	-1.99525	0.0472
TOTAL_FDI	1.444794	0.077206	18.7135	0
PGDP	0.319984	0.258355	1.238544	0.2167

F Innovation performance fixed effects model

Dependent Variable: INNPERFORM
Method: Panel Least Squares
Periods included: 8
Cross-sections included: 30
Total panel (balanced) observations: 240

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	-11.4879	0.888373	-12.9314	0
TOTAL_FDI	-0.01418	0.068114	-0.20821	0.8353
PGDP	3.332125	0.086185	38.66264	0

G Innovation performance random effects model

Dependent Variable: INNPERFORM
Method: Panel EGLS (Cross-section random effects)
Periods included: 8
Cross-sections included: 30
Total panel (balanced) observations: 240

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	-12.7752	0.882802	-14.4711	0
TOTAL_FDI	0.142857	0.063434	2.252061	0.0252
PGDP	3.20358	0.084403	37.95597	0

H Innovation environment pooled effects model (including educational funds)

Dependent Variable: INNENVIRON
Method: Panel Least Squares
Periods included: 7
Cross-sections included: 30

Total panel (balanced) observations: 210				
Variable	Coefficient	Std.Error	t-Statistic	Prob.
C	-38.1924	4.606613	-8.29079	0
TOTAL_FDI	1.99407	0.171962	11.596	0
EDUCATIONAL_FUNDS	1.911891	0.395015	4.840041	0

I Innovation environment fixed effects model (including educational funds)

Dependent Variable: INNENVIRON				
Method: Panel Least Squares				
Periods included: 7				
Cross-sections included: 30				
Total panel (balanced) observations: 210				
Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	1.509697	0.812893	1.85719	0.0649
TOTAL_FDI	0.425843	0.056322	7.560814	0
EDUCATIONAL_FUNDS	1.06841	0.057564	18.56047	0

J Innovation environment random effects model (including educational funds)

Dependent Variable: INNENVIRON				
Method: Panel EGLS (Cross-section random effects)				
Sample: 2009 2016				
Periods included: 7				
Cross-sections included: 30				
Total panel (balanced) observations: 210				
Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	1.001401	0.954936	1.048658	0.2956
TOTAL_FDI	0.469628	0.05575	8.423795	0
EDUCATIONAL_FUNDS	1.053827	0.057421	18.35253	0

K The effect of innovation performance on the innovative environment pooled effects model

Dependent Variable: INNENVIRON
Method: Panel Least Squares
Sample: 2009 2016
Periods included: 8
Cross-sections included: 30
Total panel (balanced) observations: 240

Variable	Coefficient	Std.Error	t-Statistic	Prob.
C	-11.1114	1.434758	-7.74445	0
INNPERFORM	1.553642	0.06045	25.70108	0

L The effect of innovation performance on the innovative environment pooled effects model (including educational funds)

Dependent Variable: INNENVIRON				
Method: Panel Least Squares				
Sample: 2009 2016				
Periods included: 7				
Cross-sections included: 30				
Total panel (balanced) observations: 210				
Variable	Coefficient	Std.Error	t-Statistic	Prob.
C	44.62471	8.354523	5.341384	0
INNPERFORM	2.563563	0.166718	15.37666	0
EDUCATIONAL_FUNDS	-3.30407	0.585555	-5.64262	0
PGDP	-2.59945	0.46251	-5.62031	0

M The effect of innovation performance on the innovative environment fixed effects model

Dependent Variable: INNENVIRON				
Method: Panel Least Squares				
Sample: 2009 2016				
Periods included: 8				
Cross-sections included: 30				
Total panel (balanced) observations: 240				
Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	14.22859	0.364215	39.06643	0
INNPERFORM	0.478511	0.015443	30.98543	0

N The effect of innovation performance on the innovative environment fixed effects model (including educational funds)

Dependent Variable: INNENVIRON
Method: Panel Least Squares
Sample: 2009 2016
Periods included: 7
Cross-sections included: 30
Total panel (balanced) observations: 210

Variable	Coefficient	Std.Error	t-Statistic	Prob.
C	13.09383	1.403541	9.329143	0
INNPERFORM	0.315767	0.066396	4.755838	0
EDUCATIONAL_FUNDS	-0.42877	0.224359	-1.9111	0.0576
PGDP	1.106213	0.263806	4.193276	0

O The effect of innovation performance on the innovative environment random effects model

Dependent Variable: INNENVIRON
Method: Panel EGLS (Cross-section random effects)
Sample: 2009 2016
Periods included: 8
Cross-sections included: 30
Total panel (balanced) observations: 240

Variable	Coefficient	Std.Error	t-Statistic	Prob.
C	14.00447	0.58351	24.0004	0
INNPERFORM	0.48802	0.015381	31.72892	0

P The effect of innovation performance on the innovative environment random effects model (including educational funds)

Dependent Variable: INNENVIRON
Method: Panel EGLS (Cross-section random effects)
Sample: 2009 2016
Periods included: 7
Cross-sections included: 30
Total panel (balanced) observations: 210

Variable	Coefficient	Std.Error	t-Statistic	Prob.
C	14.09724	1.461646	9.644773	0
INNPERFORM	0.426467	0.064874	6.573765	0
EDUCATIONAL_FUNDS	-0.36792	0.218422	-1.68442	0.0936
PGDP	0.674704	0.250941	2.688698	0.0078

Q Effects of FDI on Innovation Performance variables: pooled data estimations

	Invention	Design	Utility	All Patent	R&D_Spend	InnPerf
Constant	-5.27319	-5.60491	-4.137	-3.79754	1.914054	-1.88348
FDI	0.7788	0.81179	0.779147	0.794669	0.714275	1.508944
Adj R^2	0.759866	0.620798	0.7071	0.731999	0.708398	0.743298

R Effects of FDI on Innovation Performance variables: pooled data estimations

Effects of FDI on Innovation Performance: Fixed effect						
	Invention		Design		Utility	
	FE	RE	FE	RE	FE	RE
Constant	-7.72642	-5.93994	-1.02899	-3.17359	-4.137	-5.43529
FDI	0.924284	0.818374	0.54051	0.667651	0.779147	0.856115
Adj R^2	0.889582		0.917229		0.7071	
Hausman						
	All Patent		R&D_Spend		InnPerf	
	FE	RE	FE	RE	FE	RE
Constant	-5.1505	-4.37728	0.064892	0.869245	-5.085612	-3.45233
FDI	0.874879	0.829039	0.823901	0.776216	1.69878	1.601953
Adj R^2	0.919976		0.942572	0.483864	0.936034	0.490716
Hausman		0.4807		0.2773		0.3493

S East China Correlation, covariance and probability matrix

Covariance															
Correlation															
Probability	ACADEMIA	ACADEMIA01	DESIGN	EDUCATION	GRANTED_	HUMAN_CAP	IMPORTS	INNENVIRON	INNPERFOR	INVENTION_	INVESTMENT	PGDP	R_D_SPEND	TOTAL_FDI	UTILITY
ACADEMIA	1.439														
	1.000														

ACADEMIA01	1.890	8.755													
	0.533	1.000													
	0.000	-----													
DESIGN	0.471	3.461	2.957												
	0.228	0.680	1.000												
	0.033	0.000	-----												
EDUCATION	0.302	0.433	-0.023	0.100											
	0.795	0.463	-0.043	1.000											
	0.000	0.000	0.694	-----											
GRANTED_PATEN	0.612	3.481	2.345	0.056	2.064										
	0.355	0.819	0.949	0.123	1.000										
	0.001	0.000	0.000	0.252	-----										
HUMAN_CAP	0.239	3.243	2.151	-0.011	1.875	1.880									
	0.145	0.799	0.912	-0.025	0.952	1.000									
	0.176	0.000	0.000	0.820	0.000	-----									
IMPORTS	0.821	2.638	1.436	0.154	1.340	1.141	1.274								
	0.606	0.790	0.740	0.431	0.826	0.737	1.000								
	0.000	0.000	0.000	0.000	0.000	0.000	-----								
INNENVIRON	3.871	14.321	6.059	0.824	6.024	5.352	4.754	24.368							
	0.654	0.981	0.714	0.528	0.849	0.791	0.853	1.000							
	0.000	0.000	0.000	0.000	0.000	0.000	0.000	-----							
INNPERFORM	0.933	6.962	4.411	0.080	3.970	3.786	2.538	11.760	7.902						
	0.277	0.837	0.913	0.090	0.983	0.982	0.800	0.848	1.000						
	0.009	0.000	0.000	0.403	0.000	0.000	0.000	0.000	-----						
INVENTION_1YEA	0.871	3.278	1.864	0.139	1.767	1.512	1.339	5.800	3.366	1.722					
	0.553	0.844	0.826	0.334	0.938	0.840	0.904	0.895	0.912	1.000					
	0.000	0.000	0.000	0.002	0.000	0.000	0.000	0.000	0.000	-----					
INVESTMENT	0.289	1.808	1.046	0.046	0.956	0.934	0.672	3.078	1.954	0.813	0.651				
	0.299	0.758	0.754	0.180	0.825	0.844	0.738	0.773	0.862	0.768	1.000				
	0.005	0.000	0.000	0.093	0.000	0.000	0.000	0.000	0.000	0.000	-----				
PGDP	0.319	0.761	0.290	0.090	0.339	0.252	0.309	1.422	0.647	0.371	0.188	0.159			
	0.668	0.645	0.422	0.716	0.593	0.460	0.688	0.723	0.577	0.710	0.584	1.000			
	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	-----			
R_D_SPENDING	0.321	3.481	2.067	0.024	1.907	1.910	1.199	5.736	3.932	1.598	0.998	0.308	2.025		
	0.188	0.827	0.844	0.054	0.933	0.979	0.746	0.817	0.983	0.856	0.870	0.542	1.000		
	0.079	0.000	0.000	0.620	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	-----		
TOTAL_FDI	0.770	2.562	1.373	0.145	1.288	1.109	1.202	4.587	2.458	1.278	0.674	0.295	1.170	1.142	
	0.601	0.811	0.747	0.429	0.839	0.757	0.997	0.870	0.818	0.911	0.782	0.694	0.770	1.000	
	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	-----	
UTILITY	0.528	3.455	2.151	0.055	1.977	1.834	1.244	5.873	3.885	1.694	0.931	0.346	1.908	1.203	1.957
	0.314	0.835	0.894	0.125	0.984	0.956	0.788	0.850	0.988	0.923	0.825	0.621	0.958	0.805	1.000
	0.003	0.000	0.000	0.245	0.000	0.000	0.000	0.000	0.000	0.000		0.000	0.000	0.000	-----

T Central China Correlation, covariance and probability matrix

Covariance															
Correlation															
Probability	ACADEMIA	ACADEMIA01	DESIGN	EDUCATION	GRANTED_	HUMAN_CAP	IMPORTS	INNENVIRON	INNPERFOR	INVENTION_	INVESTMENT	R_D_SPEND	PGDP	TOTAL_FDI	UTILITY
ACADEMIA	0.294														
	1.000														

ACADEMIA01	-0.035	0.785													
	-0.074	1.000													
	0.563	-----													
DESIGN	-0.072	0.223	0.807												
	-0.147	0.280	1.000												
	0.245	0.025	-----												
EDUCATION	0.002	0.054	-0.034	0.024											
	0.021	0.393	-0.244	1.000											
	0.872	0.001	0.052	-----											
GRANTED_PATEN	-0.006	0.328	0.642	-0.006	0.643										
	-0.013	0.462	0.891	-0.046	1.000										
	0.918	0.000	0.000	0.720	-----										
HUMAN_CAP	0.045	0.202	0.399	-0.021	0.403	0.344									
	0.141	0.389	0.756	-0.228	0.856	1.000									
	0.266	0.002	0.000	0.070	0.000	-----									
IMPORTS	0.083	0.172	0.137	0.022	0.185	0.106	0.201								
	0.343	0.434	0.339	0.310	0.515	0.401	1.000								
	0.006	0.000	0.006	0.013	0.000	0.001	-----								
INNENVIRON	0.305	1.005	0.516	0.059	0.720	0.570	0.383	1.940							
	0.404	0.815	0.412	0.273	0.644	0.698	0.613	1.000							
	0.001	0.000	0.001	0.029	0.000	0.000	0.000	-----							
INNPERFORM	0.014	0.538	1.114	-0.013	1.121	0.765	0.291	1.305	2.037						
	0.019	0.426	0.868	-0.057	0.979	0.913	0.454	0.656	1.000						
	0.884	0.001	0.000	0.657	0.000	0.000	0.000	0.000	-----						
INVENTION_1YEA	0.024	0.442	0.446	0.016	0.555	0.359	0.178	0.840	0.983	0.592					
	0.057	0.648	0.645	0.131	0.900	0.796	0.515	0.784	0.895	1.000					
	0.654	0.000	0.000	0.300	0.000	0.000	0.000	0.000	0.000	-----					
INVESTMENT	0.000	0.136	0.593	-0.028	0.530	0.347	0.123	0.454	0.960	0.403	0.610				
	-0.001	0.196	0.845	-0.230	0.847	0.757	0.351	0.418	0.861	0.671	1.000				
	0.994	0.120	0.000	0.068	0.000	0.000	0.005	0.001	0.000	0.000	-----				
R_D_SPENDING	0.020	0.210	0.472	-0.007	0.478	0.362	0.105	0.585	0.917	0.428	0.429	0.439			
	0.056	0.358	0.793	-0.067	0.899	0.931	0.355	0.634	0.969	0.839	0.830	1.000			
	0.660	0.004	0.000	0.601	0.000	0.000	0.004	0.000	0.000	0.000	0.000	-----			
PGDP	0.041	0.107	0.035	0.028	0.095	0.035	0.073	0.211	0.168	0.125	0.047	0.074	0.076		
	0.275	0.437	0.142	0.664	0.429	0.216	0.594	0.550	0.428	0.591	0.218	0.403	1.000		
	0.028	0.000	0.264	0.000	0.000	0.086	0.000	0.000	0.000	0.000	0.084	0.001	-----		
TOTAL_FDI	0.066	0.160	0.253	0.008	0.271	0.164	0.178	0.399	0.458	0.233	0.245	0.188	0.069	0.195	
	0.275	0.410	0.636	0.123	0.764	0.634	0.900	0.648	0.726	0.687	0.710	0.640	0.563	1.000	
	0.028	0.001	0.000	0.333	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	-----	
UTILITY	0.013	0.335	0.637	-0.002	0.668	0.424	0.203	0.769	1.168	0.585	0.546	0.500	0.107	0.287	0.703
	0.029	0.450	0.846	-0.019	0.993	0.863	0.540	0.659	0.976	0.908	0.834	0.900	0.462	0.774	1.000
	0.819	0.000	0.000	0.880	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	-----

U West China Correlation, covariance and probability matrix

Covariance															
Correlation															
Probability	ACADEMIA	ACADEMIA01	DESIGN	EDUCATION	GRANTED_	HUMAN_CAP	IMPORTS	INNENVIRON	INNPERFOR	INVENTION_	INVESTMENT	PGDP	R_D_SPEND	TOTAL_FDI	UTILITY
ACADEMIA	0.206														
	1.000														

ACADEMIA01	1.078	18.714													
	0.549	1.000													
	0.000	-----													
DESIGN	0.430	3.964	1.955												
	0.679	0.655	1.000												
	0.000	0.000	-----												
EDUCATION	0.081	0.782	0.208	0.092											
	0.586	0.595	0.490	1.000											
	0.000	0.000	0.000	-----											
GRANTED_PATEN	0.391	3.891	1.667	0.252	1.619										
	0.677	0.707	0.937	0.653	1.000										
	0.000	0.000	0.000	0.000	-----										
HUMAN_CAP	0.269	2.932	1.126	0.212	1.117	0.953									
	0.608	0.694	0.825	0.716	0.899	1.000									
	0.000	0.000	0.000	0.000	0.000	-----									
IMPORTS	0.297	4.015	1.294	0.223	1.315	1.091	1.661								
	0.509	0.720	0.718	0.570	0.802	0.867	1.000								
	0.000	0.000	0.000	0.000	0.000	0.000	-----								
INNENVIRON	1.634	23.506	5.728	1.167	5.651	4.367	5.627	30.674							
	0.650	0.981	0.740	0.693	0.802	0.808	0.788	1.000							
	0.000	0.000	0.000	0.000	0.000	0.000	0.000	-----							
INNPERFORM	0.677	6.618	2.776	0.474	2.756	2.048	2.411	9.817	4.863						
	0.677	0.694	0.900	0.707	0.982	0.951	0.848	0.804	1.000						
	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	-----						
INVENTION_1YEA	0.365	4.177	1.520	0.267	1.569	1.103	1.325	5.912	2.701	1.632					
	0.630	0.756	0.851	0.688	0.965	0.885	0.805	0.836	0.959	1.000					
	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	-----					
INVESTMENT	0.441	4.099	1.621	0.277	1.482	1.302	1.617	6.119	2.764	1.401	2.306				
	0.641	0.624	0.764	0.599	0.767	0.878	0.826	0.728	0.825	0.722	1.000				
	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	-----				
PGDP	0.060	-0.253	0.051	0.060	0.109	0.097	0.094	-0.036	0.278	0.108	0.176	0.166			
	0.326	-0.143	0.089	0.486	0.209	0.243	0.179	-0.016	0.309	0.208	0.284	1.000			
	0.002	0.183	0.409	0.000	0.050	0.023	0.095	0.883	0.003	0.052	0.007	-----			
R_D_SPENDING	0.286	2.727	1.109	0.221	1.137	0.931	1.096	4.166	2.107	1.132	1.282	0.169	0.970		
	0.641	0.640	0.805	0.740	0.908	0.969	0.864	0.764	0.970	0.900	0.857	0.422	1.000		
	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	-----		
TOTAL_FDI	0.327	4.050	1.364	0.235	1.350	1.136	1.661	5.748	2.487	1.340	1.760	0.111	1.137	1.692	
	0.553	0.720	0.750	0.594	0.816	0.895	0.991	0.798	0.867	0.806	0.891	0.209	0.887	1.000	
	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.050	0.000	-----	
UTILITY	0.386	3.837	1.604	0.269	1.646	1.148	1.370	5.640	2.836	1.614	1.476	0.139	1.189	1.392	1.727
	0.647	0.675	0.873	0.674	0.985	0.895	0.809	0.775	0.978	0.961	0.740	0.259	0.919	0.814	1.000
	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.015	0.000	0.000	-----

V Human Capital Estimation

Region	Full-time Equivalent of R&D Personnel (man-year)	Vs							
	2008			2009			2010		
National Total	**1014223**								
Large	& Medium	Designated size		L&M	Designated		L&M	Designate	Avr %
Beijing	26892	43209	60.68%	31010	41,546	33.98%	29225	43056	47.33%
Tianjin	21799	28340	30.01%	26863	30,074	11.95%	28164	34073	20.98%
Hebei	25365	27259	7.47%	37219	36,418	-2.15%	37814	38819	2.66%
Shanxi	29905	31412	5.04%	34022	32,703	-3.88%	29998	30172	0.58%
Inner Mongolia	11290	11752	4.09%	12437	12,307	-1.05%	14363	14582	1.52%
Liaoning	39987	45568	13.96%	47818	48,112	0.61%	44424	47661	7.29%
Jilin	8273	9470	14.47%	17188	14,671	-14.64%	19411	19394	-0.09%
Heilongjiang	26642	28283	6.16%	30087	27,658	-8.07%	32467	32156	-0.96%
Shanghai	36692	43815	19.41%	60695	67,420	11.08%	57346	66089	15.25%
Jiangsu	119553	155781	30.30%	184542	222,625	20.64%	201161	252396	25.47%
Zhejiang	79366	126273	59.10%	95861	150,888	57.40%	116965	185100	58.25%
Anhui	27693	32904	18.82%	33423	37,649	12.64%	34167	39542	15.73%
Fujian	32199	41784	29.77%	37964	46,433	22.31%	44062	55535	26.04%
Jiangxi	14420	17537	21.62%	20264	19,959	-1.51%	18561	20427	10.06%
Shandong	107535	124042	15.35%	122934	129,892	5.66%	119921	132519	10.51%
Henan	46407	52482	13.09%	68061	69,647	2.33%	67982	73224	7.71%
Hubei	35625	42282	18.69%	47226	50,425	6.77%	47806	53892	12.73%
Hunan	25542	32465	27.10%	32312	38,041	17.73%	35206	43098	22.42%
Guangdong	177500	197488	11.26%	224650	228,907	1.89%	258943	275976	6.58%
Guangxi	7083	9358	32.12%	10392	12,042	15.88%	11895	14750	24.00%
Hainan	417	554	32.85%	618	1,046	69.26%	862	1302	51.05%
Chongqing	20872	23174	11.03%	24098	23,279	-3.40%	21662	22488	3.82%
Sichuan	38298	45137	17.86%	42497	44,370	4.41%	34600	38452	11.13%
Guizhou	5659	6134	8.39%	7696	7,234	-6.00%	8633	8736	1.20%
Yunnan	6921	8203	18.52%	6973	6,790	-2.62%	7589	8192	7.95%
Shaanxi	24859	26600	7.00%	27911	25,897	-7.22%	27812	27782	-0.11%
Gansu	9466	10035	6.01%	10941	10,239	-6.42%	8673	8655	-0.20%
Qinghai	784	793	1.15%	1592	1,551	-2.58%	1842	1829	-0.71%
Ningxia	2831	3336	17.84%	3243	3,568	10.02%	2363	2692	13.93%
Xinjiang	4346	4489	3.29%	5244	5,023	-4.21%	5970	5942	-0.46%