FDI Spillover Channels on Chinese Provincial Economic Growth

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      ประเทศจีนได้เปิดสู่โลกภายนอกเป็นเวลาหลายปีและมีการเติบโตทางเศรษฐกิจใน
ระดับสูง การศึกษาในอดีตได้มีการวิเคราะห์ผลกระทบของเงินลงทุนทางตรงระหว่างประเทศต่อ
การเติบโตทางเศรษฐกิจในจีน อย่างไรก็ตาม ยังขาดการวิเคราะห์ผลกระทบของการลงทุนทางตรง
ระหว่างประเทศผ่านช่องทางการแพร่กระจายของการวิจัยและพัฒนา และทุนมนุษย์โดยใช้ข้อมูล
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ความสัมพันธ์ของการลงทุนทางตรงระหว่างประเทศผ่านการแพร่กระจายของการวิจัยและพัฒนา
และทุนมนุษย์ต่อการเติบโตทางเศรษฐกิจจีนโดยนำเขตเศรษฐกิจพิเศษ และเขตการค้าเสรีในจีน
มาประกอบการศึกษา ผลการวิเคราะห์ชี้ให้เห็นว่า การลงทุนทางตรงระหว่างประเทศมี
ความสัมพันธ์ในเชิงบวกต่ออัตราการเติบโตทางเศรษฐกิจจีนอย่างมีนัยสำคัญ ดังนั้น รัฐบาลควรมี
นโยบายส่งเสริมการลงทุนทางตรงจากต่างประเทศอย่างต่อเนื่อง และควรมีกำหนดนโยบายพิเศษ
เพิ่มเติมเพื่อดึงดูดการลงทุนให้เข้ามาลงทุนในจีน ผลการวิจัยยังแสดงให้เห็นว่า อัตราการเพิ่มของ
ประชากรมีส่วนช่วยรักษาการเติบโตทางเศรษฐกิจได้ นอกจากนี้ อัตราเงินเฟ้อมีส่วนในการส่งเสริม
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ลงทุนระหว่างประเทศผ่านการวิจัยและพัฒนาและทุนมนุษย์ที่มีต่ออัตราการเติบโตทางเศรษฐกิจ
เนื่องจากการขาดข้อมูลเกี่ยวกับแรงงานที่มีทักษะในระดับจังหวัด และประสิทธิภาพการวิจัยและ
พัฒนาที่ลดลงในจีน การศึกษาได้เสนอแนะให้มีการใช้นโยบายและมาตรการที่สนับสนุนการลงทุน
ทางตรงระหว่างประเทศในอุตสาหกรรมที่มีเทคโนโลยีระดับสูง รวมทั้งควรมีการกระตุ้นพัฒนาวิจัย
และพัฒนาด้านการผลิตและการถ่ายทอดเทคโนโลยีเพื่อเพิ่มการเติบโตทางเศรษฐกิจ

สาขาวิชา	เศรษฐศาสตร์และการเงิน	ลายมือชื่อนิสิต ....
	ระหว่างประเทศ	
ปีการศึกษา	2565	ลายมือชื่อ อ.ที่ปรึกษาหลัก ....
		ลายมือชื่อ อ.ที่ปรึกษาร่วม ....

China has been opened to the world over several years and make great success in economic growth. Most of the previous literatures have analyzed the determinants of economic growth and the effect of FDI on economic growth in China. However, seldom of them analyze the relationship of FDI and its spillover effect on economic growth through R&D and human capital channels using provincial data. The study employs provincial panel data during period 2006-2018 to estimate the relationship of FDI, FDI spillover from R&D and human capital, R&D, and human capital on economic growth under the consideration of Special economic Zone and Free Trade Zone in China.

The analysis suggests that FDI has a significant positive contribution on the growth rate of real GDP per capita in China. Therefore, government should maintain high inflow of FDI and make more preferential policies to attract FDI to invest in China. The result also shows that population growth rate would help promote economic growth. The government should keep the population growth rate to help stimulating growth. Moreover, the empirical result shows that current inflation is also a factor to foster economic growth. This study cannot prove the contribution of human capital, R&D and FDI spillover through human capital and R&D on growth rate due to lack of skilled labor in provincial data and the decline

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Academic Year:	2022	Advisor's Signature ....
		Co-advisor's Signature ....

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CHULALONGKORN UNIVERSITY

CHAPTER 1 INTRODUCTION

1.1 Background and Policies about FDI in China

China has adopted the Reform and Opening-up policy since 1978, at this time FDI inflow to mainland China has been increasing over time as shown in Figure 1. China joined WTO in 2001, since then Chinese economy plays a more and more important role around the world. According to World Investment Report Overview 2019, although the flow of FDI around the world decrease in 2016-2018, the inflow of FDI to China increases 4% in 2018, the total amount of FDI inflow to China is up to 1,390 billion USD, it is occupied over 10% of the total flow of FDI around the whole World. The Chinese government knows the importance of FDI as well and has formulated numerous FDI incentive policies to absorb more FDI. These main preferential policies that related to FDI in China are Special Economic Zone (SEZ) since 1980 and Free Trade Zone (FTZ) since 2013.

Figure 1 The trend of FDI inflow around the world (Billion dollars)
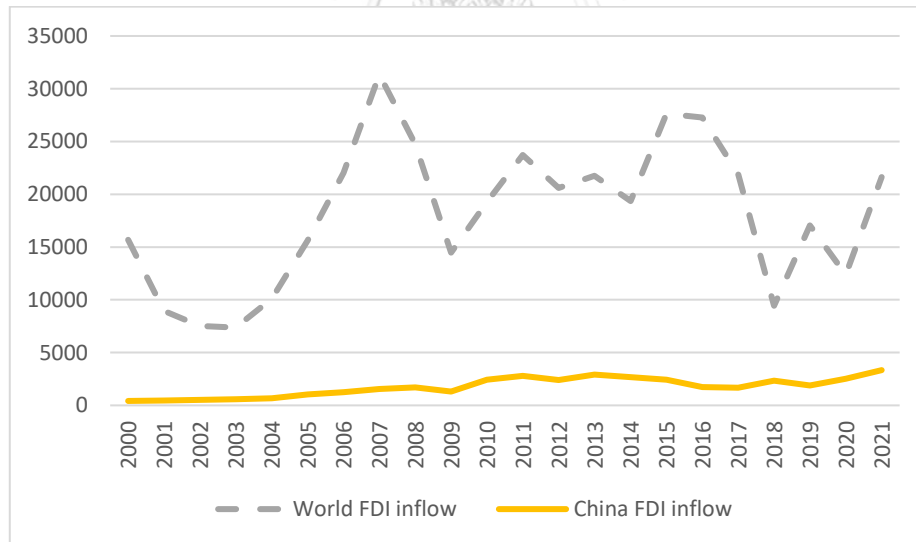
Data Source: UNCTAD

SEZ Policy was firstly adopted by the Chinese government in 1980, Deng Xiaoping regarded some areas including Zhuhai, Shenzhen, Xiamen, Shantou, and Hainan (added in 1988) these eastern coastal region as SEZ. SEZ are mainly demarcated areas, in which foreign investors will receive certain preferential policies. These preferential policies generally include tax reduction or exemption for foreign

investors, reduction of custom tariffs or some special financial incentives. And FTZ which contains Hubei, Shanghai, Tianjin, Fujian, Chongqing, Guangdong, Liaoning, Zhejiang, Henan, Sichuan and Shan'xi was been adopted since 2013. Foreign companies in the Free Trade Zone could enjoy some preferential policies including tax reduction, faster VAT refund, concentration of transportation, more relaxed entry conditions for foreign investors and so on. Moreover, each FTZ in China would have different goals so that have different policies incentive.

Although Chinese government has adopted several FDI policies to attract FDI, it is important to learn more about how FDI affect economic growth in the host countries. According to Kinoshita (1997), FDI spillover effects are further classified into demonstration effects, competition effects, linkage effects and labor mobility effects, FDI could promote economic growth by improving technological progress in the host countries through above four ways. In other words, FDI could directly promote economic growth in the host countries, moreover, it could indirectly promote economic growth through improving technological progress in the host countries. And according to Kinoshita (2000) and Borensztein et al. (1998), we usually could use R&D and human capital to represent this kind of technological progress in the host country. From the latest provincial data from China Science and Technology Statistics Yearbook as shown in Figure 2, it is clearly found that R&D expenditure do have a growth over the current year in China.

In addition, China is promoting the transformation of the economy to high-quality, which puts forward unprecedented huge demand for technological innovation. During these years, Chinese government has adopted several R&D policies to make China towards innovation center. And these R&D policies of each province basically revolves around the promotion of the growth of industries with high technology and the laws and regulations to protect these technological findings. For example, several government documents in Guangdong Province have confirmed the direction of building an innovative province, giving special tax incentives and fiscal policies to companies in the industries with high technology. Jiangsu Province also mainly invests R&D financial allocations in high-tech fields such as electronic information,

new materials, biomaterials and other high-tech fields. Shandong Province is also gradually increasing investing capital in science and technology field and improving laws and regulations on the protection of scientific and technological achievements. Shanghai has also set up a fund for high-tech industrial achievements, and provided high-tech technological achievements brought by overseas scholars with preferential policies and looser financial guarantee policies. Zhongguancun in Beijing has always been a model of national science and technology parks, mainly providing financial support and listing risk protection for high-tech companies.

Figure 2 The trend of R&D expenditure in China (ten thousand yuan)
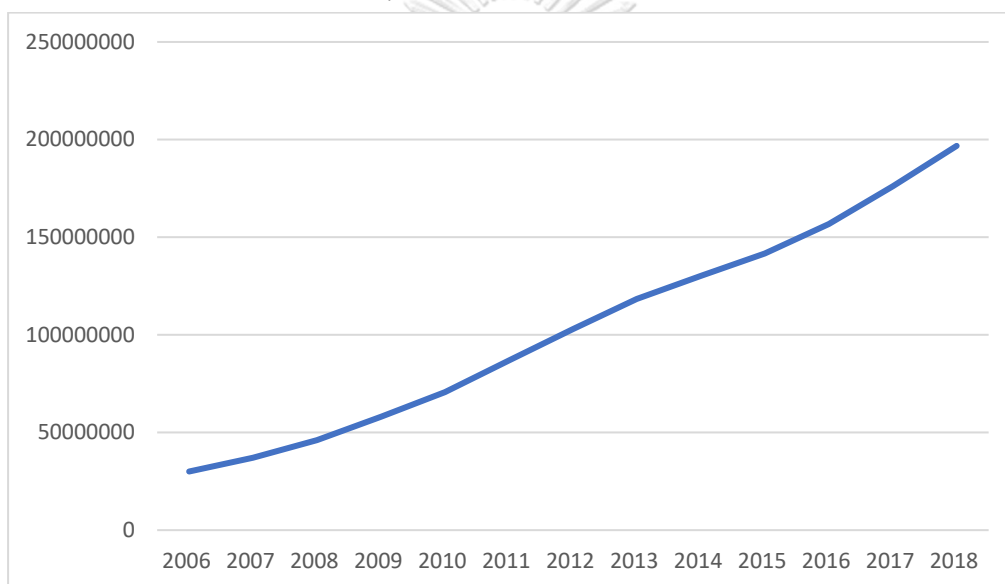
Data Source: China Science and Technology Statistical Yearbook 2006 ~ 2018

Meanwhile, China's human capital data as shown in Figure 3 also suggests that Chinese population has become more and more educated. Moreover, Chinese government has adopted several talent training policies and talent introduction policies to make sure the proportion of high-educated person in each province.

Figure 3 The average schooling years during 2006 ~ 2018
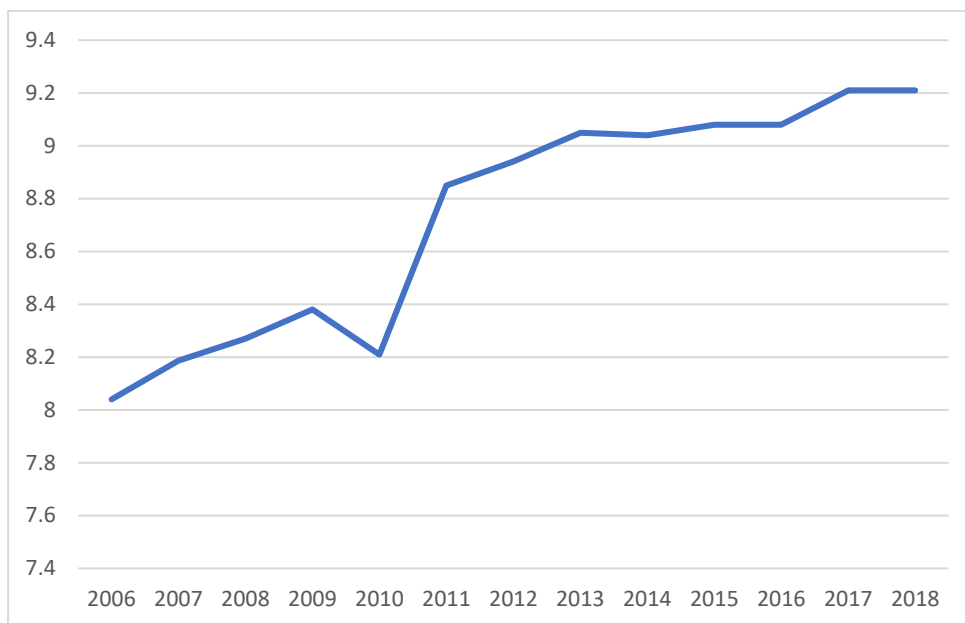
Data Source: China Statistics Yearbook, 2006 ~2018

Therefore, to find out whether the growth of China's R&D level and human capital is possibly brought about by the inflow of FDI, and not entirely the promotion of the Chinese government's own scientific research policies and personnel training policies, it still needs experimental verification.

Overall speaking, the growing trend of FDI and GDP has attracted my attention and it's meaningful to find out the relationship between FDI and economic development. Meanwhile, innovation development and human capital are both the core development policies in China, investigating the effect of FDI through R&D and human capital on economic development could help to learn more about the current FDI situation in China and give future policy implications on economic growth of China.

1.2 Objectives and Scope of the study

The objective of this paper is to analyze the effect of FDI and its spillover effects from human capital and R&D on economic development in China. The study adopts provincial data from 30 provinces in China during 2006~2018 in order to study well.

1.3 Contributions of this study

This study provides latest provincial data from China to analyze the relationship between FDI and its Spillover effect from R&D and human capital on economic growth rate in China. The empirical results would help the policy makers for better understanding the current effect of FDI and its spillover effect through R&D and Human capital these two channels and give improved suggestions. The structure of this paper is organized as follows. The third part is the Literature review, the fourth part is theoretical framework and model specification, the fifth part is empirical results, and the last part is conclusions and policy implications.

Chapter 2 LITERATURE REVIEW

This chapter concludes and summarizes the corresponding literatures. In the first section, the effects of FDI on economic development are presented. The second section shows the channels that FDI can affect growth/productivity. In the final part, the literatures using Chinese data are discussed.

2.1 The effects of FDI on economic development

Many of literatures investigate the relationship of FDI and economic development in the host countries. They find that FDI has a significant positive effect on productivity level of host countries therefore boosting economic growth somehow while comparing with domestic investment like Borensztein et al. (1998), Chakraborty and Nunnenkamp (2008) and Nair‑Reichert and Weinhold (2001).

Borensztein et al. (1998) estimate the effect of FDI on economic growth based on endogenous growth model across developing countries. In the endogenous growth model, the rate of technological progress is the main reason of the long-run growth rate of income. And these types of technological progress would be achieved by "capital deepening". However, the process of "capital deepening" depends on the threshold stock of human capital that host countries owned. Finally, their result shows that FDI is one of the most important channels of technology transfer and their contribution is bigger than domestic investment in host countries. Furthermore, they find that human capital and FDI are complementary which means that human capital could help FDI has a more effective effect on economic growth rate of host countries. Only if a country has a certain level of human capital, FDI could promote economic growth rate significantly and play a more important role than domestic investment.

Nair‑Reichert and Weinhold (2001) review that there are two theoretical models to describe the relationship of FDI and economic growth rate——neo-classical models of growth and endogenous growth models. In Neo-classical models FDI would increase investment and/or its effectiveness and therefore has long-run

horizontal effects and growth. However, it's quite inconclusive of the relationship of FDI and economic growth rate in Endogenous models. In this paper, they adopted a fresh way to analysis model which is the Mixed Fixed and Random Model for testing relationships in using Panel Data. And they provide empirical evidence to prove that FDI could improve economic growth in 24 developing countries, and it is better for FDI to improve economic growth for countries that are in a more open market.

Chakraborty and Nunnenkamp (2008) use industrial FDI data to Granger Causality tests in a panel cointegration structure in India. And the results show that the effect of FDI on growth rate is quite different across sectors. They find that FDI could promote productivity in the manufacturing sector, but FDI has an inefficient effect on the primary sector in India. Moreover, FDI in tertiary sector appears to boost manufacturing sector's growth through cross-sector spillovers.

However, some papers find ambiguous effect of FDI on economic growth rate as shown below. Chowdhury and Mavrotas (2006) suggest that it is crucial for developing countries to formulate policies that encourage private investor and it was not confirmed that FDI leads to. They use data during the period of 1969 ~ 2000 in three developing countries which are Chile, Malaysia, and Thailand with a more robust statistics technique —— the Toda-Yamamoto test for causality. (Toda-Yamamoto, 1995) Their results suggest that it is crucial for developing countries to formulate policies that encourage private investor. and it was not confirmed that FDI leads to growth. However, the causality is bi-directional in the case of Thailand and Malaysia.

Carkovic and Levine (2005) find FDI doesn't bring a significant positive effect on economic growth which means the government of host countries should re-consider preferential policies related to attracting FDI, and other measures that countries have adopted to attract FDI. From this paper, they claired that FDI could not promote economic growth with firm-level data. However, it is showed in many literatures that FDI could boost economic growth at macroeconomic level. So, this paper adopted a new statistical methodology and data which is the Generalized Method of Moments (GMM) panel estimation to reassess the relationship of FDI and economic growth rate during the period of 1960~1995.

Choe (2003) uses panel VAR model which is based HNR estimation to evaluate the causal relationship of FDI/GDI and economic growth with the data among 80 countries during the period of 1971～1995. Other growth determinants are also considered into model which is openness, growth of the labor force, and stability of the macro economy. Their results show that economic growth rate could help host countries have higher FDI inflows. The significant associations between FDI/GDI and economic growth do not prove that high FDI inflows could help host countries have higher economic growth rate.

Falki (2009) assesses the contribution of FDI inflow to economic growth based on production function in endogenous model during the period of 1980~2006 in Pakistan. By applying production function in endogenous growth theory and regression analysis, Finally, their results announce that FDI has a negative static insignificant relationship between Pakistan's GDP and FDI inflows.

In General, most of literatures regard FDI could bring significantly positive effect on economic growth rate. Like Borensztein et al. (1998), Chakraborty and Nunnenkamp (2008) and Chowdhury and Mavrotas (2006). However, some papers also find different results. For example, Nair - Reichert and Weinhold (2001) finds that FDI and domestic investment would have a strong relationship with current economic growth, however, it is not an effective determinant for future growth. Carkovic and Levine (2005) finds that FDI didn't bring a significantly positive effect on growth which means the government of host countries should re-establish new preferential policies to attract FDI investment. Choe (2003) research the significant associations between FDI/GDI and economic growth and they find it is not the truth that FDI inflows could bring economic growth of the host countries. Falki (2009) proves that FDI has a negative statistically insignificant relationship between Pakistan's GDP and FDI inflows.

2.2 FDI spillover and economic growth

From above literatures review, it is known that most of literatures mention FDI can promote economic growth with various data around the world. However, FDI can not only promote economic growth directly and it can also indirectly affect economic growth rate. And the determinants of FDI spillover can be generalized in

six kinds: Technology licenses, vertical linkages, demonstration effect, the impact of FDI on host country market structure, human capital and R&D according to Blomström et al. (2001). In this study, the authors try to estimate the effect of FDI on economic growth through the improvement of total factor productivity that brought from FDI to host countries. Dunning (1994) mentions that FDI will affect domestic enterprises through different mechanisms such as imitation-demonstration effect, competition effect, and labor mobility effect therefore improving the technological progress of this industry. Meanwhile, according to Kinoshita (1997), FDI spillover effects are further classified into demonstration effects, competition effects, linkage effects and labor mobility effects, FDI could promote economic growth by improving technological progress in the host countries through above four ways. And according to Kinoshita (2000) and Borensztein et al. (1998), the authors use R&D and human capital to represent this kind of technological progress in the host countries. Borensztein et al. (1998) mention that FDI could promote economic growth in the host countries with a high level of human capital. In other words, human capital could help FDI to promote economic growth in the host countries. Kinoshita (2000) suggests R&D could help host countries to absorb advanced technology easier. Therefore, it can be concluded that the literatures about FDI spillover on economic growth though improving R&D and human capital in the host countries are found.

For FDI spillover through R&D channel, Coe and Helpman (1995), Lichtenberg and van Pottelsberghe de la P (1996), and Kinoshita (2000) examine the relationship of R&D spillover and economic growth. Overall speaking, domestic R&D expenditure can bring significantly positive effect on host countries' economic growth in some situation, however, the effect of R&D spillover from FDI on economic growth depends on host countries' absorptive ability.

Coe and Helpman (1995) show that a country's technological progress depends on its own R&D expenditure and R&D expenditure of its trading partners. Based on the innovation-driven growth model, they estimate 21 OECD countries and Israel using pooled data. In their opinion, a country's technological progress depends on its own R&D as well as that of its trading partners. Increase the productivity level of a country by developing its own R&D to produce tradable and non-tradable goods and

services so that existing resources are used more efficiently. Their results show that both foreign and domestic R&D do have a positive effect on TFP. However, foreign R&D seem have a more effective effect than domestic R&D. And foreign R&D have a more effective effect on TFP while in a more open market.

Lichtenberg and van Pottelsberghe de la P (1996) put forward a more accurate model to assess the relationship of R&D spillover and TFP. Then, they add two new potential channels that can influence TFP based on Coe, D. T., & Helpman, E. (1995), that is import and outward FDI. Their results show that import and outward FDI does affect host countries' TFP and output. However, inward FDI does not have a strong effect on TFP.

Kinoshita (2000) examines the importance of FDI in firm R&D and technology diffusion using firm-level data on Czech manufacturing during 1995 to 1998. Using the interaction term of R&D expenditure and foreign presence of the industry to represent absorptive capacity, he regards that foreign joint ventures (FORGN) and foreign influence in the industry (FOR) have no significantly positive effect on productivity growth. But only when FOR interacts with R&D can it have contribution to output. It follows that R&D subsidies should be combined with the promotion of foreign investment. Second, it might be beneficial for host governments to focus on oligopoly industries to absorb FDI, as the spillover effect are greater if the domestic industry is competitive in research activities.

For human capital channel, Noorbakhsh et al. (2001), Wei (2008) and Borensztein et al. (1998) examine the effect of human capital and FDI on economic growth. Basically speaking, most of the literatures regard human capital could help FDI promoting economic growth, however, it still has some limitations.

Wei (2008) finds that if economic performance of poor areas wants to catch up with well-developed areas, they should look up to higher education. They use provincial data to estimate the relationship of human capital and economic growth. Their results show that it doesn't have strong evidence to prove human capital could directly promoting its economic growth in that province. However, they find that a province's initial human capital stock has a significant positive impact on later

fixed asset accumulation. Therefore, the impact of human capital on economic growth rate might be indirectly generated by physical capital investment in China.

And from Noorbakhsh et al. (2001), they regard human capital is one of the most essential ways of FDI to affect economic growth rate. And it becomes more and more important in the future. Therefore, they use human capital stock as variable to measure the relationship between HK and FDI during the period of 1980-1994 including 36 developing countries. Finally, they find human capital could significantly promote FDI and Host countries that only depending on low costs to attract FDI investment would be harmful to the development of high technology industries in host countries.

2.3 Empirical studies of China

In the last part of literature review, we focus on the literature about FDI and FDI spillover on economic growth using Chinese data. We divided the literatures using Chinese data into 3 parts——firm-level studies, industry-level studies, and region-level studies.

Wei and Liu (2006) and Hu et al. (2005) use firm-level data. Wei and Liu (2006) use firm level data of the Chinese manufacturing sector from 1998~2001 to assess productivity spillover from R&D, exports, and FDI. Their results show that OECD invested firms become more and more important among inter-industry spillovers. And R&D spillover, exports and FDI presence in the Chinese manufacturing sector all bring a positive effect on inter and intra-industry productivity spillovers.

Hu et al. (2005) collect firm-level data to estimate the performance of R&D activities of firms. Meanwhile, they also estimate the FDI presence across China's iron ore mining industry and show that FDI does have a positive effect on domestic firms in China's iron ore mining industry.

Tang and Zhang (2016) use industry-level data. Tang and Zhang (2016) estimate the role of absorptive ability in the impact of foreign direct investment on host country exports of manufactured goods during the period of 2005-2012. Their results show that absorptive ability is an essential determinant of China to benefit from FDI. And China's effective absorptive ability mainly due to well-designed foreign direct investment policies and high-quality infrastructure. Secondly, human capital and R&D

investment appear to be more effective for China to capture the spillover effects from FDI on export quality.

Su and Liu (2016), Yao (2006), Zhang (2017), Ouyang and Fu (2012) and Chun-Chien and Chih-Hai (2008) use region-level data to estimate the determinants of economic growth rate in China. Su and Liu (2016) investigate the determinants of economic growth in China using city-level data from 1991~2010. Their result suggests that FDI could help contribute to economic growth and these effects would be stronger while in a city where has high-level human capital. So, they conclude that human capital is a facilitator to the diffusion of technology transfer.

Yao (2006) use Chinese data to estimate the relationship of FDI and economic growth with the consideration of exports. This paper uses 28 provinces panel data in China during period of 1978 to 2000 and adopted a steadier way which is Dynamic panel data estimation to run the regression model. The result shows that exports and FDI could significantly help promote economic growth in mainland China and suggests that two development policies which are strategy focusing promoting export and promoting FDI. And these kind of development policies are the good model of other transitional economies.

Zhang (2017) uses provincial R&D data during the period of 2004 to 2012 to estimate the performance of investment. Its results indicate that spillovers from FDI contribute positively to the performance of R&D activities. And it also indicates that complementary policy for FDI will reduce the potential negative effects from knowledge spillovers.

Ouyang and Fu (2012) use city-level data which covers 96% of China from the period of 1996 ~ 2004 to estimate the effect of FDI on economic growth rate. Moreover, it also tries to estimate the relationship of inland industrial development and coastal FDI which reflects the inter-regional spillover on economic growth. They use OLS and 2SLS these two statistics ways to run model and use two-year lagged FDI as instrumental variables where one-year lagged FDI is the variable that represent FDI in their estimation. In their result, they find the FDI of coastal cities has a significantly positive effect on economic growth of inland cities. Which reflects the existence of inter-regional spillover effect.

Chun-Chien and Chih-Hai (2008) use provincial data from 1996 ~ 2004 to examine the effect of R&D, regional R&D spillover, international R&D spillover and FDI on provincial economic growth in mainland China. Moreover, they also estimate absorptive capacity of R&D and FDI on economic growth rate. They use RE model, FE model and GMM to run the regression. The empirical results find that knowledge capital, including R&D capital and technology imports all have a significantly positive impact on provincial economic growth. The analysis also shows that there are R&D spillovers and international knowledge spillovers. In addition, the absorptive capacity of a region is considered as the key ability to absorb FDI and imports, thereby promoting regional economic growth. They also mention that China's economic growth benefits from numerous and low-cost labor.

In general, there are several previous literatures have examined the relationship of FDI and its spillover through R&D and human capital on economic growth, and they have different results. However, seldom of them analyze the relationship of FDI and its spillover from R&D and human capital in China with provincial data. So, this study tries to combine R&D and human capital these two channels from FDI spillover to measure the effect of FDI and FDI spillover through R&D and human capital on economic growth using the latest provincial data during 2006~2018.

Chapter 3 GOVERNMENT POLICIES AND FDI IN CHINA

The chapter analyzes FDI policies in mainland China and discuss the current situation of FDI and FDI spillover effect from R&D and human capital in recent China. Then, some representative provinces are selected to show examples of policies adopted. Finally, the preliminary correlation analysis will be analyzed and given mix finding using correlation coefficients and scatter diagrams.

3.1 FDI policies in mainland China

The reform and opening up has opened the gate for large-scale FDI to enter China. With the deepening of the globalization process, the level of China's attraction and actual use of foreign capital constantly improving. Moreover, the central government in China has established many policies that promoting FDI in China since 1980.

In general, China's FDI policies can be divided into three time periods. The first stage is mainly from the reform and opening up since 1980, when China tried to introduce foreign investment and the government's main FDI policy is to support the eastern coastal areas. In 1980, the central government has established five SEZ in the eastern coastal areas and implemented preferential FDI policies in these areas to attract foreign capital. The second stage of China's introduction of foreign investment is started after 1990. In this stage, the efficiency of FDI investment in eastern China was improved. The government began to arrange FDI investment in major cities across the country. The policy during this period is mainly based on National Economic and Technological Development Zone (NETDZ). This policy covers all 31 provinces and cities in China. The third stage started after 2010. At this stage, China's FDI focused on deepening the quality of FDI and increasing open areas. The main policy is the Free Trade Zone, which was first launched in several pilot provinces selected by the government. There are also other policies made by each province to promote FDI and these three policies are the major FDI policies in China.

3.1.1 Special Economic Zone (SEZ)

At first, it starts with the specific preferential conditions to enterprises in SEZ. China established and developed five SEZ in Shenzhen, Zhuhai, Shantou, Xiamen

and Hainan, and this mainly comes from the experience of other countries and regions in the establishment of special economic zones since 1980. Some preferential policies in SEZ are as follows:

1) The corporate income tax rate in SEZ is lower than other companies in other provinces of mainland China.

2) Companies with investments of more than $5 million USD or in high-tech industries will receive some additional financial help.

3) For investors who have invested in SEZ for more than five years and want to make new investments, certain tax deductions will be given for the investors in the newly entered part after 5 years.

4) The legal profits obtained by joint venture companies in SEZ and the legal income of corresponding foreign employees can be remitted in accordance with foreign regulations.

5) Part of the specific means of production required by enterprises in the SEZ can be exempted from import duties.

Table 1 Special Economic Zone in China

Established Year	Name of SEZ	Province	location
1980	Shenzhen Special Economic Zone	Guangdong	Eastern China
1980	Zhuhai Special Economic Zone	Guangdong	Eastern China
1980	Xiamen Special Economic Zone	Fujian	Eastern China
1981	Shantou Special Economic Zone	Guangdong	Eastern China
1988	Hainan Special Economic Zone	Hainan	Eastern China

Source: MINISTRY OF COMMERCE, PEOPLE'S REPUBLIC OF CHINA

When SEZ was first established, because only these five regions in China enjoyed these preferential policies and loose opening scope, it has attracted many foreign investors and Hong Kong, Macau, and Taiwan investors to set up companies and conduct business investment in these SEZ in the early days. In a little amount of time, it has brought a lot of job opportunities and capital flow to these SEZ, which has attracted the attention of people from other parts of China, and everyone has come to SEZ to seek job opportunities and business opportunities. Therefore, preferential policies of SEZ have greatly promoted the economic development of SEZ by increasing job opportunities and capital inflow in SEZ in the early stage.

3.1.2 National Economic and Technological Development Zone (NETDZ)

NETDZ are state-level modern industrial parks first established since 1984 in mainland China. As of June 2021, the number of NETDZ in China has increased to 230. Most of them are located in central cities such as provincial capital cities, municipalities, and autonomous regions. Government concentrated efforts are made to build comprehensive infrastructure, A high-level investment environment, through the absorption and utilization of FDI and becomes a key area for the development of foreign economic and trade in the city where it is located and its surrounding areas. And below are some preferential policies in NETDZ:

1) The production and operation income of companies established in the zone is subject to corporate income tax at 15%. Among them, companies with a longer operating period will be taxed in a step-by-step manner to encourage the evergreen development of companies.

2) The foreign companies in the zone remit the profits they get from the enterprises abroad, and are exempted from remittance tax.

3) Foreign businessmen who have not established institutions in China but have dividends, interest, rent, royalties, and other income in the zones will be given the preferential treatment of corporate income tax reduction. Among them, the people's government of the place where the zone is located shall decide on the preferential conditions for the provision of funds and equipment or the transfer of advanced technologies that require more tax reductions or exemptions.

4) Some certain production materials imported by enterprises in the zone for their own use are exempt from customs duties and import taxes.

5) Foreign businessmen who work in the enterprises in the zone or live in the zone, carry imported household items and means of transportation for their own use, are exempt from customs duties and import taxes within a reasonable amount in some special situation.

NETDZ aims to attract foreign investment and develop industries with high technology by setting up special preferential policies in the NETDZ. It helps local government increase fiscal revenue and strengthen the technological level of this region. The advantages of industrial agglomeration in NETDZ also facilitate companies

to improve their technical level and strengthen talent communications to a certain extent, thereby affecting the regional economy.

3.1.3 Free Trade Zone (FTZ)

FTZ was first adopted in Shanghai since 2013 for achieving a higher standard of international investment and trade liberalization and create a new pattern of opening up to the outside world. FTZ in China has different specific preferential policies which is decided by the local government to attract FDI according to geographical advantage and regional characteristics. For example, China (Guangdong) Pilot FTZ highlights the goal of deep cooperation between Guangdong, HongKong and Macao. Below are some special incentive policies of this FTZ:

1) China (Guangdong) Pilot FTZ implements a deeper opening to Hong Kong and Macao, mainly focusing on tertiary sectors, especially in financial and business sector. Access restrictions on investors from Hong Kong and Macao should be suspended, canceled, or relaxed in some cases.

2) Allow Hong Kong and Macao investors to set up wholly owned international shipping companies in China (Guangdong) Pilot FTZ to operate international maritime shipping services.

3) Hong Kong and Macao service investors are allowed to set up intermediary service agencies for studying abroad at their own expense in China (Guangdong) Pilot FTZ.

4) Support Hong Kong and Macao-funded travel agencies (limited to 5 each) established in China (Guangdong) Pilot FTZ to operate group travel business for mainland residents going abroad (outside) (excluding Taiwan).

5) Implement the Guangdong-Hong Kong-Macao certification and mutual recognition system for related testing business, implement "one certification, one test, and three places pass"; moderately liberalize Hong Kong and Macau certification agencies to enter China (Guangdong) Pilot FTZ to carry out certification and testing business, and compare the mainland certification Institutions, inspection institutions and laboratories, the same treatment shall be given to joint venture and wholly-owned certification institutions, inspection institutions and

laboratories established in the mainland by Hong Kong and Macao service suppliers.

6) To learn and make the identification measures for Hong Kong, Macau and foreign high-level talents in China (Guangdong) Pilot FTZ, provide convenience for high-level talents to enter and exit the country, stay and reside in China, and provide special policies in project application, innovation and entrepreneurship, evaluation incentives, service guarantees, etc.

And Shanghai FTZ could receive more relaxed policies mainly focus on financial area. Below are some special preferential policies about promoting FDI in China (Shanghai) Pilot FTZ:

1) Qualified foreign financial institutions and private capital are allowed to set up wholly owned banks and joint venture banks in the zone.

2) While improving supervision, allow eligible Chinese-funded banks in the zone to open offshore businesses; allow enterprises in the zone to set up free trade accounts, implement separate accounting, and separate domestic and overseas businesses.

3) Relax restrictions on foreign shareholding in international shipping companies.

4) Foreign investors can set up a Sino-foreign joint venture talent intermediary agency with no more than 70% of the equity. And Hong Kong and Macao investors can set up a wholly owned talent intermediary agency.

5) For some foreign-funded companies in the construction industry and entertainment industry, the previous restrictions on the proportion of foreign capital will be canceled or relaxed.

And below are the table which shows the specific provinces where adopted FTZ in China during 2013 ~ 2017.

Table 2 Free Trade Zone in China during 2006~2017

Established Year	Name of FTZ	Province	location
2013	China (Shanghai) Pilot FTZ	Shanghai	Eastern China
2015	China (Tianjin) Pilot FTZ	Tianjin	Eastern China
2015	China (Fujian) Pilot FTZ	Fujian	Eastern China
2015	China (Guangdong) Pilot FTZ	Guangdong	Eastern China
2017	China (Liaoning) Pilot FTZ	Liaoning	Eastern China
2017	China (Zhejiang) Pilot FTZ	Zhejiang	Eastern China
2017	China (Hubei) Pilot FTZ	Hubei	Central China
2017	China (Chongqing) Pilot FTZ	Chongqing	Western China
2017	China (Sichuan) Pilot FTZ	Sichuan	Western China
2017	China (Shan'xi) Pilot FTZ	Shan'xi	Western China

Source: MINISTRY OF COMMERCE, PEOPLE'S REPUBLIC OF CHINA

The government formulates different trade opening goals based on the current situation of foreign investment, the degree of opening to the outside world, and the corresponding industrial and geographical advantages of provinces where FTZ established. The establishment of this kind of FTZ according to provincial characteristics can help the province continue to strengthen and deepen the previous international trade and investment cooperation, so as to better serve the transformation of economic growth.

3.1.4 Other policies

Some other provinces where didn't belong to SEZ and FTZ areas also make policies including but not limited to continue to expand the investment field and further open up the domestic market to absorb more FDI. Moreover, the central government also tries to make new policy to actively encourage FDI move to the central and western regions of China since 2001. The current policies to encourage foreign businessmen to invest in the central and western China mainly include:

1) The central and western regions can independently choose advantageous industries. After being approved by the central government, they can enjoy the policy of encouraged projects in the "Guiding Catalogue". The establishment conditions and market openness of restricted and limited foreign equity ratio projects can be appropriately relaxed compared with the eastern region.

2) Appropriately increase the domestic matching fund loans to absorb foreign investment for the development of central and western China. Foreign government loans and preferential loans from international financial institutions can also be used preferentially for project construction in the central and western China.

3) Some preferential tax policies before special economic zones can also be gradually relaxed for the introduction of FDI in the central and western regions.

4) Encourage foreign-funded enterprises that have already invested in the eastern region to continue investing in the central and western regions.

The policy which encourages foreign investors to invest in the central and western China aims to balance the current uneven distribution of FDI. To a certain extent, it can help the central and western China to accelerate the speed of attracting foreign investment and thus achieve a faster economic growth rate.

After considering policy of NETDZ covers whole China and it's difficult to compare the impact of this policy on economic growth, so, this study would focus on the effect of SEZ and FTZ these two policies on economic growth. And below is the Table 3 that describe the 30 provinces when adopted these two FDI policies. This study wants to know whether SEZ can still maintain corresponding advantages in attracting foreign investment in the period from 2006 to 2018 compared with the early stage (many other literatures estimate SEZ policy during 1978~2006 and find a positive contribution to economic development) after it has been implemented for over 30 years. Meanwhile, this study also wants to explore whether the newly established FTZ since 2013 can help China's opening-up policy to achieve a new pattern and lead the regional economic development.

Table 3 30 provinces in China when adopted these two SEZ and FTZ

Provinces	SEZ	FTZ	Provinces	SEZ	FTZ
Beijing	-	-	Henan	-	-
Tianjin	-	2015	Hubei	-	2017
Hebei	-	-	Hunan	-	-
Shanxi	-	-	Guangdong	1980	2015
Inner Mongolia	-	-	Guangxi	-	-
Liaoning	-	2017	Hainan	1988	-
Jilin	-	-	Chongqing	-	2017
Heilongjiang	-	-	Sichuan	-	2017
Shanghai	-	2013	Guizhou	-	-
Jiangsu	-	-	Yunan	-	-
Zhejiang	-	2017	Shaanxi	-	2017
Anhui	-	-	Gansu	-	-
Fujian	1980	2015	Qinghai	-	-
Jiangxi	-	-	Ningxia	-	-
Shandong	-	-			

Source: MINISTRY OF COMMERCE, PEOPLE'S REPUBLIC OF CHINA

3.2 FDI current situation in China

Since Reform and Open up, FDI largely inflows to China. And after 2001, China joined WTO, China's FDI has basically maintained an upward trend. From Figure 4, it is shown that although the amount of FDI will sometimes drop to a certain extent due to some reasons, from the general trend, FDI inflows in China is rising steadily. However, it has fluctuate after 2014 and due to the adjustment of China's economic structure, some low-end manufacturing foreign-funded enterprises have turned to countries with lower costs since 2015, resulting in a certain degree of decline in foreign capital inflows according to Xia (2017).

Figure 4 FDI inflows to China 2006 ~ 2018 (ten thousand dollars)
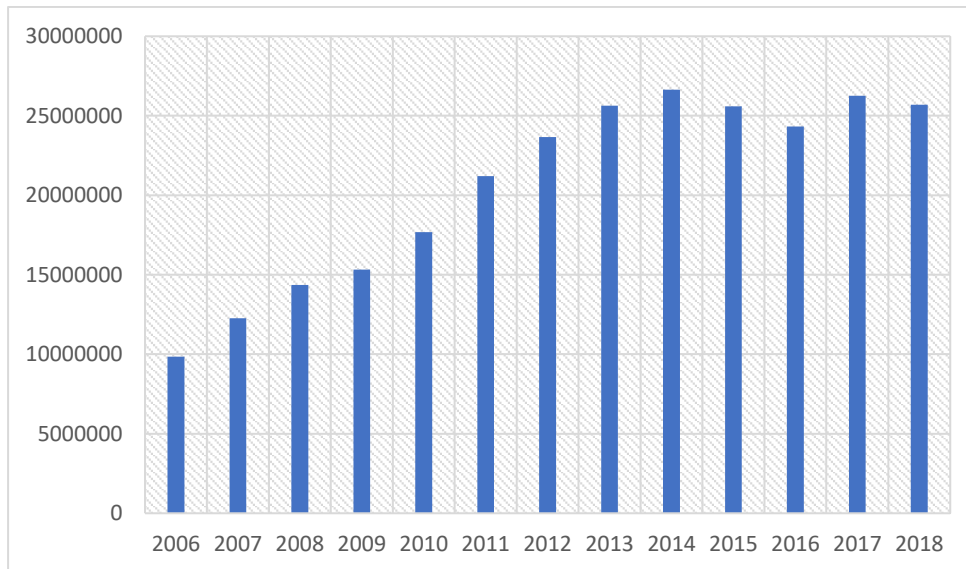
Data Source: China Statistics Yearbook

Moreover, the trend of FDI/GDP with the growth rate of real GDP per capita in China also grows in a similar way as shown in Figure 5. It is shown in Figure 5 that both the trend of FDI/GDP and the growth rate of real GDP per capita have a downward trend during 2006 ~ 2018. Since the financial crisis in 2008, the economy of China and even the world has been greatly affected. The investment psychology of most investors tends to be conservative, and the operating income of most companies is not as good as expected. As a result, China's overall economic growth cannot maintain the same high growth rate as before.

Figure 5 The trend of FDI/GDP and the growth rate of GDP per capita in China
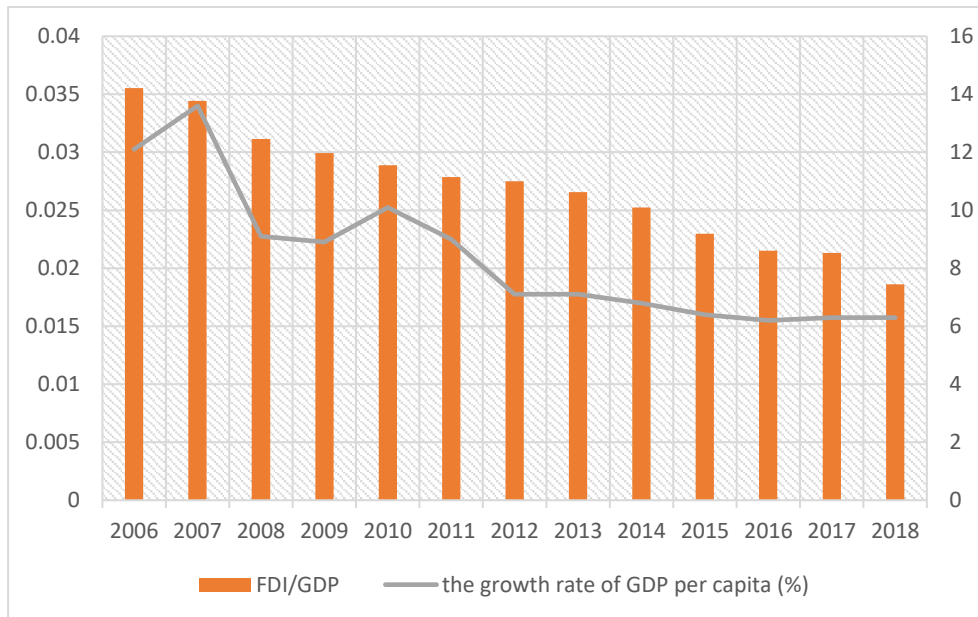
Although China has adopted several policies to attract FDI and try to balance FDI inflows of each province. However, FDI still has obvious geographical orientation in China based on different economic foundation and regional characteristics. Since the opened up and reform, FDI has mainly gathered in three economic circle —— the Pearl River Delta, the Yangtze River Delta and the Bohai Delta as shown in Figure 6. Meanwhile, the provinces included in these three economic circles are also China's economic models, representing the highest level of China's economy, and also bears the heavy responsibility of taking the lead in achieving modernization. Figure 6 shows the distribution of accumulated FDI inflows during 2006 ~ 2018 and it is shown an obvious more east and less west distribution. And this kind of unbalanced distribution of FDI mainly comes from the unbalanced natural resources, initial level of economic development and policy preference.

Figure 6 The Spatial Distribution of FDI in Mainland China

FDI inflows during 2006~2018 /ten thousand dollars	color
>30,000,000	
10,000,000~30,000,000	
5,000,000~10,000,000	
2,000,000~5,000,000	
<2,000,000	
No data	
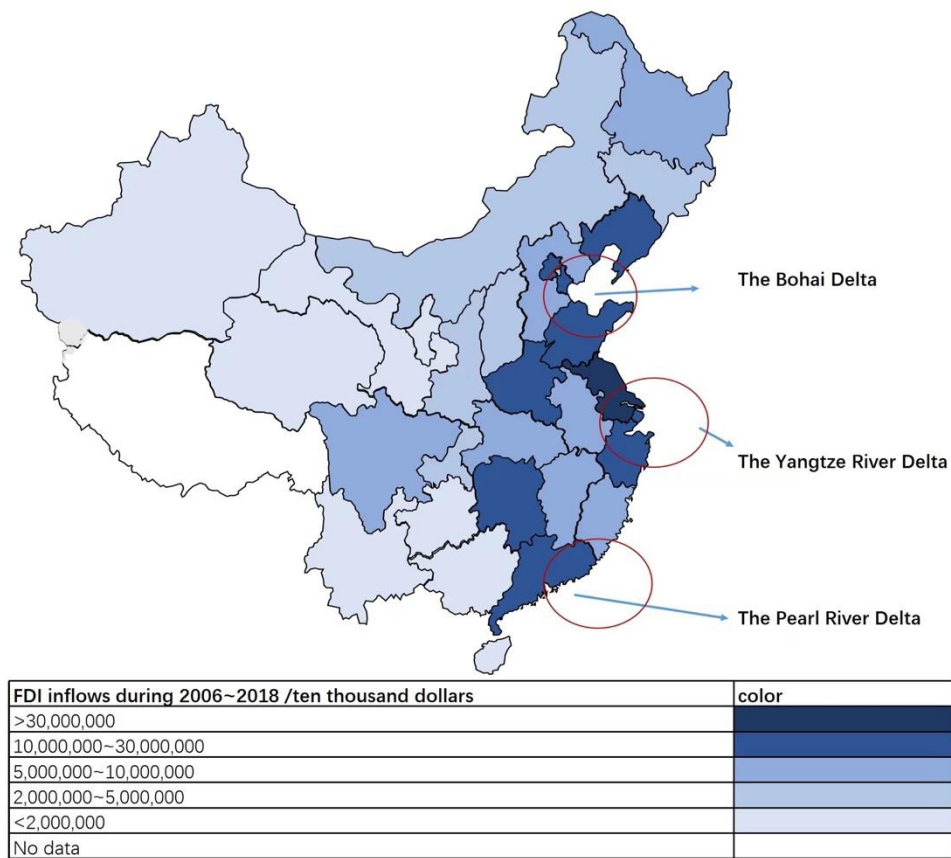
Data Source: China Statistics Yearbook 2006~2018

As the eastern region of China was the first to implement SEZ to attract FDI, and the coastal transportation is very convenient, coupled with the strong economic strength, rich resources and comparative geographical advantage, FDI in eastern China has obvious accumulation advantages. For example, Guangdong Pilot FTZ where nears Hongkong and Macau aims at strengthening the cooperation with Hongkong and Macau and give several preferential policies to investors from Hongkong and Macau. Jiangsu where nears Taiwan has implemented several preferential policies to Taiwan investors and encourage Taiwan investors to invest in Jiangsu since 1991. Shandong where nears Japan and South Korea has actively undertaken the transfer of industries from Japan and South Korea and set up institutions to strengthen scientific and technological cooperation with Japan and South Korea since 2001.

Compared with the eastern China, the infrastructure and economic conditions in the central and western China are relatively backward, so the number of FDI that can be attracted is limited.

Consider the structure of FDI usage, more and more FDI inflows to the tertiary industries in recent years. It is shown in Table 4, we can see that most FDI focus on secondary industry in 2006. However, the actual usage of FDI is mainly concentrated in the tertiary industry in 2018 which accounts for over 60%. FDI most only focus on manufacturing in 2006 and now is focus more on tertiary industries like Real estate and Leasing and Business in 2018.

Overall speaking, FDI inflows to China's primary industry has been at a relatively low station. Although the amount of FDI in primary industry has increased slightly in recent years, the proportion has fluctuated and declined. Then, the FDI inflows to the secondary industry has maintained a downward trend year by year. At last, the FDI inflows to the tertiary industry have grown rapidly. The first reason of the distribution from FDI is because the tertiary industry in China and the world is developing rapidly and has a good rate of return. Second, due to the rising cost of domestic factors in China, the foreign capital that originally flowed into labor-intensive industries began to outflow, and transfer to neighboring Vietnam, India, and other Southeast Asian and South Asian countries.

Table 4 Comparison of the inflows of FDI in 2006 and 2018 in China

	Year	2006		2018	
	Industry	Amount (billion dollars)	Percentage(%)	Amount (billion dollars)	Percentage(%)
Primary Industry	Agriculture, forestry, animal husbandry and fishery	5.99	0.95	8.01	0.6
Secondary Industry	Mining industry	4.61	0.73	12.28	0.9
	Manufacturing	400.77	63.59	411.74	30.5
	Production and supply of electricity, gas and water	12.81	2.03	44.24	3.3
	Construction industry	6.88	1.09	14.88	1.1
Tertiary Industry	Transportation Warehousing and Postal Industry	19.85	3.15	47.27	3.5
	Information transmission computer services and software industry	10.7	1.7	116.61	8.6
	Wholesale and retail trade	17.89	2.84	97.67	7.2
	Accommodation and Catering Industry	8.28	1.31	9.01	0.7
	Financial industry	2.94	0.47	87.04	6.4
	Real estate	82.3	13.06	224.67	16.6
	Leasing and Business Services	42.23	6.7	188.75	14
	Scientific research, technical services and geological exploration	5.04	0.8	68.13	5
	Water conservancy, environment and public facilities management industry	1.95	0.31	4.74	0.4
	Resident services and other service industries	5.04	0.8	5.62	0.4
	Education	0.29	0.05	0.74	0.1
	Health, social security and social welfare	0.15	0.02	3.02	0.2
	Culture, sports and entertainment	2.41	0.38	5.23	0.4
	Public Administration and Social Organization	0.07	0.01	0.001	0

Source: China Statistics Yearbook, 2006~2018

In summary, although FDI in China has shown a steady increasing trend during the period, the growth rate has been slow, and both FDI/GDP and GDP per capita growth rate have shown a downward trend after 2007. Moreover, the distribution of FDI in China has a serious regional uneven problem, which is mainly reflected in the

sufficient absorption of FDI in the eastern coastal areas, but the serious lack of FDI investment in the western areas. Meanwhile, the industry distribution of FDI in China is uneven, mainly concentrated in the secondary and tertiary industries and showing a trend of gradually increasing to the tertiary industry.

3.3 FDI on Domestic R&D and human capital

According to Coe and Helpman (1995) and Kinoshita (2000), the progress of a country's technology not only comes from local R&D, but also the result of foreign technology transfer and diffusion through FDI, and many empirical studies have shown that the inflows of FDI has indeed produced unexplained external economic effects, that is, technological spillover effects. In this study, both R&D and human capital are employed to measure this kind of spillover effect from FDI. The technological spillover effect can help host countries to absorb advanced technology easier in four ways, those are demonstration, competition, linkage, and labor mobility.

For demonstration, Multinational corporations could introduce new equipment, new products, or new methods into the host countries' market, moreover, they could also bring non-materialized technologies such as product selection, sales strategies and management concepts, making them have stronger "technical advantages" and "management advantage" than local companies, and thus gained huge market share and profits. Therefore, it has provided a demonstration for local companies, so that local companies would imitate multinational companies in order to improve their own competitiveness. In a fact, lots of Chinese Internet companies have learned from the products of foreign companies to launch localized versions of these Internet products in China. For example, in 2000, Baidu was established to be a search engine website and finally becomes the most trafficked search engine sites in China which is to learn from Google. Google was established in 1998 which entered Chinese market formally in 2006 (Actually the website of google could be used in China can be dates to 2000). And the founder of Baidu was former employee of Google. Then Google officially announced its withdrawal from China in 2010 due to Google disagree with policies and regulations against censorship imposed by the Chinese government. Because of the leadership of the Internet technology in the

United States, a large number of products leading the Internet trend in the world have appeared in the United States. Moreover, because of China's strict Internet censorship system, these international Internet companies cannot enter China or choose to exit after entering China. This has given some new inspiration to many Chinese technicians who have been exposed to these new Internet products. They have created Chinese versions of these Internet products which is to learn by watching from advanced American internet companies and finally competed with these American companies such as Google and Baidu and fortunately they succeed to occupy the vast majority of the Chinese market.

For competition, in order to use foreign capital to promote the development of their own economy, host countries often formulate relevant preferential policies and gradually open up some industries with high barriers and high monopoly to multinational companies. Therefore, domestic-owned enterprises in these industries will have "catch-up awareness", then try to increase technology investment and improve resource allocation, therefore promoting the improvement of local technology efficiency. Take mobile phone industry in China as an example, it is shown in Figure 7 and Figure 8 that, there is no existence of Chinese mobile brand with the top market share around the world. However, in 2018, the world market share of Chinese mobile phone brands accounted for more than 30%, and three Chinese brands were on the TOP 5 market share mobile phone brand list. With the rise of smart phones such as iPhone in 2007, Nokia and Motorola gradually withdraw from the mobile phone market. The Chinese mobile brand like Huawei, Xiaomi and Oppo grasp the chance with the development of smart phone. In the fierce competition with foreign brands, these Chinese brands have learned to invest a lot of research and development in order to produce technological products that can seize market share, such as fast charging technology for modern people's fast-paced life and beauty camera technology for modern aesthetics. And in this high-intensity competition, these Chinese brands use high-quality products and relatively low prices to quickly seize the global market. It is precisely because of this competition with foreign companies that these Chinese brands can have higher efficiency and stronger technical standards.

Figure 7 The worldwide market share in Mobile industry of 2006
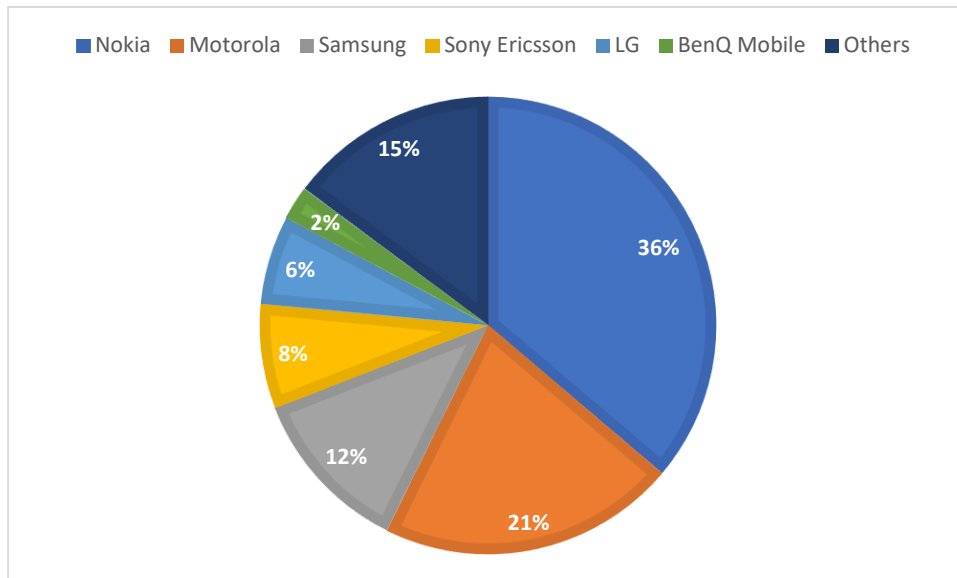
Source: Gartner 2006

Figure 8 The worldwide market share in Mobile industry of 2018
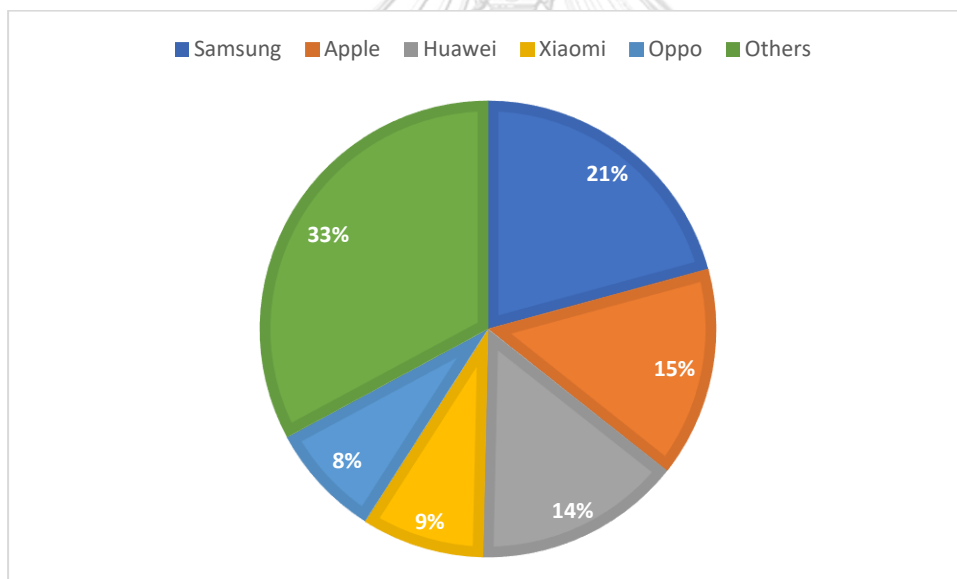
Source: IDC 2018

For linkage spillover, it means that the entry of foreign-funded enterprises can make their suppliers or customers in the host country more effective. For example, if the host country suppliers cannot meet the technical standards of multinational companies, multinational companies will often provide technical support to help them establish new technical standards in order to reduce costs, and even jointly develop certain technologies. Here take an example in the new energy vehicle industry of China, with the development of mass production of new energy vehicles

like Tesla since 2020, China has spawned several supplier companies supplying batteries for new energy vehicles like Contemporary Amperex Technology Co., Ltd. Tesla officially announced Contemporary Amperex is the batteries supplier in 2020, since then, 2020 operating income of Contemporary Amperex has increased 9.9% over 2019 operating income according to their financial report 2020. The cooperation between Tesla and Contemporary Amperex helps Contemporary Amperex to occupy the global new energy battery market therefore Contemporary Amperex could have more abundant cash flow to have a chance to overcome the technical barriers of new energy batteries.

For labor mobility, due to the relatively low level of human capital in the host country, especially in developing countries, multinational companies engaged in high-tech production and R&D need to provide necessary training for local employees. Therefore, the competitive advantage possessed by the technology of the subsidiaries of multinational corporations cannot be fully consolidated in the equipment but can emerge with the flow of human resources. As mentioned above, many founder of Chinese internet companies were the former employee of corresponding American internet companies. And these American internet companies have trained lots of high-level employee with strong IT technology therefore they have confidence and ability to create their own business using technology, experience and familiarity with the market and new products acquired at the previous American internet companies.

Based on these spillover fact, FDI inflows would help improve R&D level and human capital in host countries. Meanwhile, the improvement of R&D and human capital could also improve host countries' absorptive ability, therefore adsorbing advanced technology more effective. Thus, forming a positive cycle between FDI, R&D and human capital. Next comes to the actual situation of R&D and human capital in China over the years with the inflow of FDI. Because of financial crisis in 2008, China's domestic economy faces greater downward pressure and innovation activities are more affected by the economic boom than general economic activities. It might lead to the growth of R&D investment has slowed down a bit.

Figure 9 The R&D expenditure and R&D/GDP in China during 2006 ~ 2018
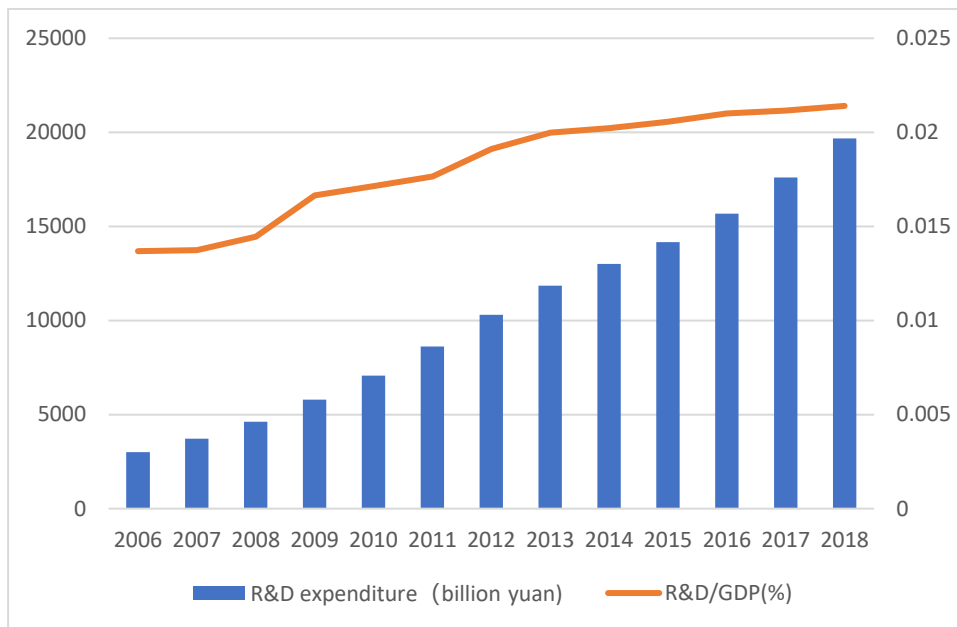
Data Source: China Statistics Yearbook 2006 ~ 2018

According to Figure 9, the amount of R&D expenditure in China is increasing year by year as well as R&D/GDP. From 2006 to 2013, China's R&D expenditure entered a stage of rapid growth and R&D/GD grows rapidly. However, from 2014 to 2018, the growth rate of R&D expenditure slowed down again and R&D/GDP also towards stable. It means after China's GDP increased, R&D expenditures did not keep up. This also reflects from the side that China's investment in R&D expenditure is not large enough.

With the continuous optimization and upgrading of the domestic economic environment and scientific research environment, more and more foreign-funded enterprises are optimistic about China's market and scientific research atmosphere, and China has seen a sharp surge in the number of R&D institutions founded by foreign-funded businesses. According to Ministry of Commerce, at the end of 2017, more than 2,000 regional headquarters and R&D facilities operated by multinational corporations are located in China. Shanghai has the largest number of foreign-funded R&D centers in China and most foreign-funded R&D centers concentrated in Beijing, Shanghai and Shenzhen.

Meanwhile, Axalta Coating Systems, the largest manufacturer of liquid and powder coatings, declared the launch of its Asia-Pacific R&D center in Shanghai,

Johnson & Johnson announced in December 2017 that it would settle in Zhangjiang, the first "JLabs" global biomedical incubator outside North America. General Electric Company (China) R&D Center cooperates with Shanghai Jiaotong University to establish a full-time engineering master training base and joint laboratory. These foreign-funded R&D centers in China not only invest a lot of R&D investment, but also train a group of local employees who meet the standards and are equipped with high-tech knowledge.

For further examine the existence of FDI spillover, it still needs to do empirical test. From these examples mentioned above, more and more multinational companies have set up their R&D center and headquarters in mainland China with the inflow of FDI. And these multinational companies also provide crowds of employee that have experienced vocational training already. With the flow of these employees and technical communication between MNCs and local companies in mainland China, it would push local companies in China become more and more effective in a way.

3.4 The difference of economic growth, FDI, R&D and human capital in eastern, middle, and western China

The situation of economic development is so different in the eastern, middle, and western China. FDI, R&D and human capital development also show different trend in the eastern, middle, and western China. Below some representative provinces in the eastern, middle, and western China are chosen and analyzed.

For the eastern China, where is the most advanced area in China and its representative economic circles are the Pearl River Delta, the Yangtze River Delta and the Bohai Delta which at previous we have mentioned that FDI has mainly gathered in. So, in the eastern China, three provinces are selected to represent three economic circles, those are Beijing of the Bohai Delta, Shanghai of the Yangtze River Delta and Guangdong of the Peral River Delta. And in the central China, Hunan and Hubei are two representative provinces where are the top developed provinces in the central China. Finally, Chongqing and Sichuan, where are the most developed provinces in western China, represent the area. All the statistics of these

representative provinces in the Eastern, Central and Western China are shown in Table 11 ~ 13 of the Appendix.

Figure 10 The trend of growth rate of real GDP per capita in representative provinces
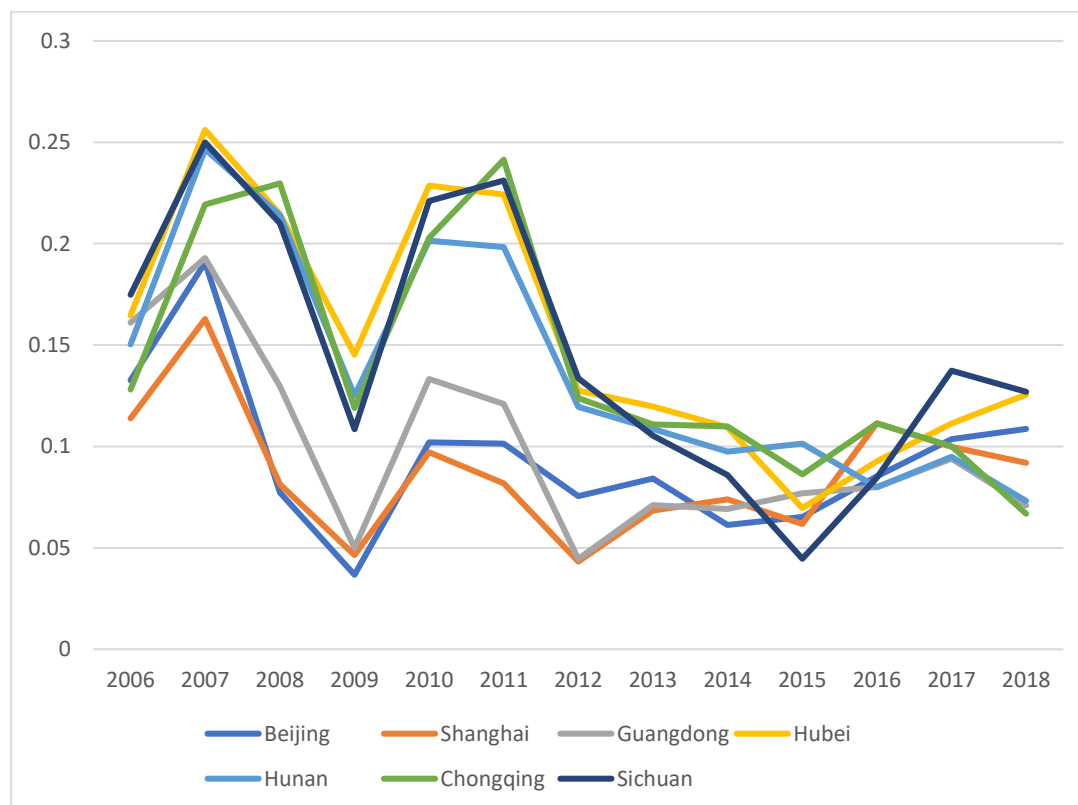
Data Source: China Statistics Yearbook

From above Figure 10, the growth rate of real GDP per capita of Beijing, Shanghai, Guangdong where represent the eastern China have the lowest growth rate compared to the representative provinces of central and western China. It reflects the economic growth rate of the central and western China has been higher than that of the eastern China for many years. Through this way, the gap between the eastern and the western China continues to narrow, and the coordination of regional development is gradually enhanced.

The data shows the unbalanced regional development has existed since 1949. Roughly speaking, the economic performance of the eastern China has been always developed than that of the central and western China. This difference in economic development became even greater after China announced the reform and opening up in 1978. The regional economic development gap is caused by the differences

between one region and another in terms of physical, economic, social, cultural and institutional environments. The main reason for this phenomenon could be generalized into three points.

The first reason is the natural environment resources of eastern and western China are very different. Although the central and western China has a vast territory and a larger area than the eastern region, deserts and barren mountains and other extremely harsh areas account for the majority. Therefore, the transportation and other infrastructure in the central and western China are significantly behind the eastern China. Moreover, although the western China is rich in mineral resources, the land in the western region is barren, the grain production rate is low, and there is a lack of water all year round, while the eastern region is rich in land, rich in water resources, and has a high yield of cultivated land and foreign countries are easier to connect eastern China due to the more developed transportation facilities and coastal advantage.

Figure 11 The trend of FDI/GDP in representative provinces
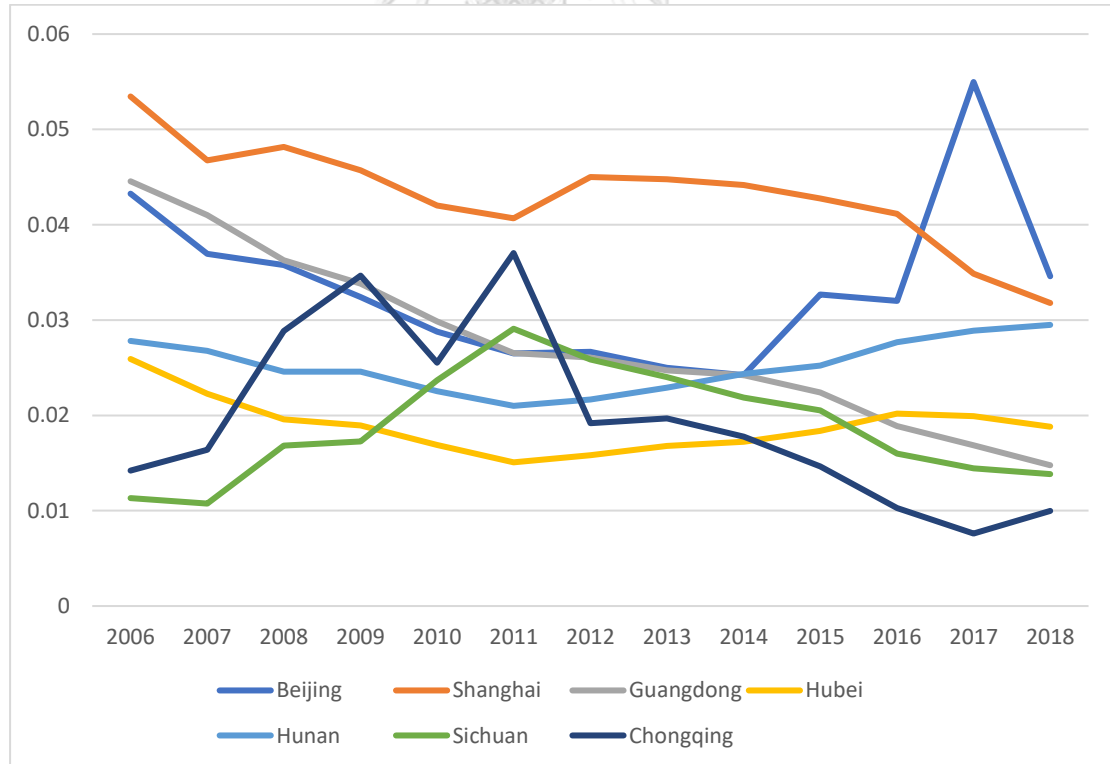
Data Source: China Statistics Yearbook

From Figure 11, the trend of FDI/GDP in the representative provinces of the eastern China is relatively higher than the representative provinces in the central and

western China. As stated earlier FDI has mainly gather in the eastern China. Because of abundant natural resources, convenient transportation, and coastal characteristics in eastern China, FDI tends to invest in the eastern China.

Due to various natural environments and geographical differences, China's industrial layout generally presents the basic characteristics of light in the east and heavy in the west, with light and mixed industries in the east taking the lead, and heavy industries in the west taking a larger proportion. Differences in industrial structure and different transportation conditions lead to huge differences in the level of economic output in different regions.

The second reason is the differences between R&D development and human capital development. Since the reform and opening up, people in the eastern China are generally more open and more in line with international standards than those in the central and western regions. People in the eastern China, especially the coastal areas, would look up to education more. The trend of average schooling years of the representative provinces in eastern China is relatively higher than the representative provinces in central and western China as shown in Figure 12.

Figure 12 The trend of average schooling years in representative provinces
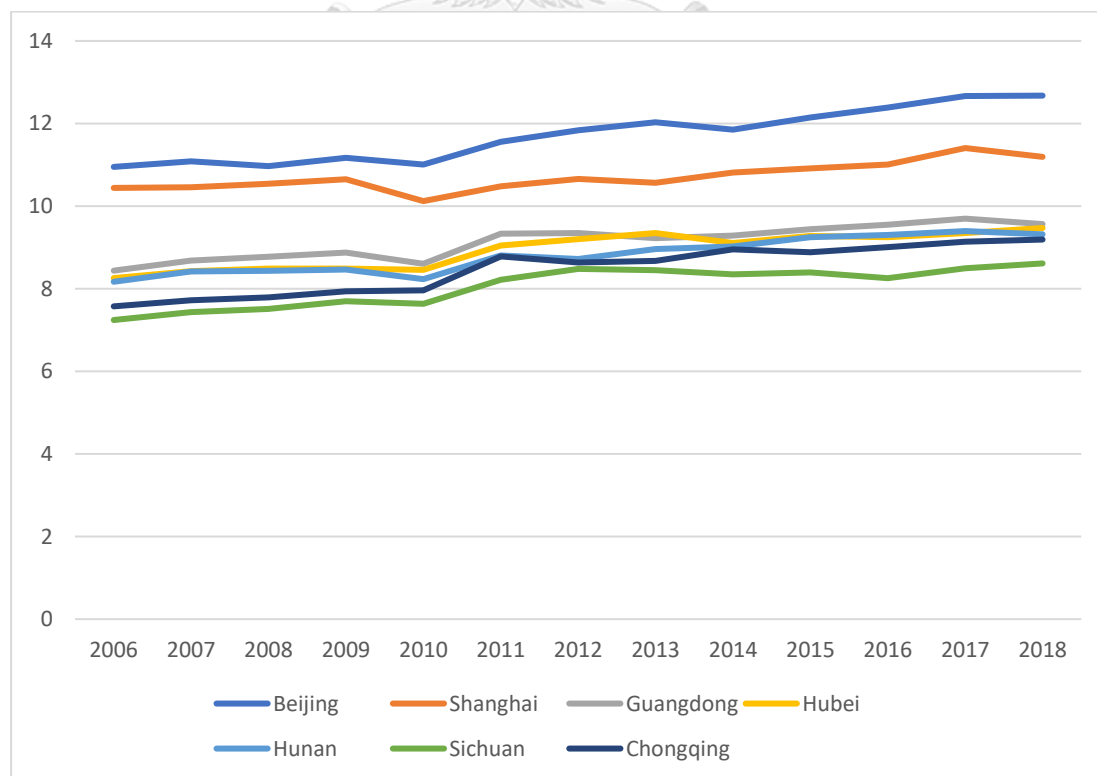
Data Source: China Statistics Yearbook

Moreover, large inflows of MNCs which accompanied by FDI to eastern China has also cultivated a large number of high-quality talents who have undergone vocational training. These talent pools are also more inclined to flow between the eastern China to make people in eastern China more and more educated. Meanwhile, eastern China also has several human capital policies to improve their human capital level, while central and western China cannot provide such rich talent introduction conditions. For example, Guangdong introduce high-level and high-skilled talents, full-time undergraduates or above, talents with senior professional titles, talents with intermediate and senior skill certificates, and students of "world-class universities and world-class disciplines". Guangdong would give these talents with corresponding level of subsidy, lower price of Talent Housing, and more relaxed entry policy like reducing the number of years required to pay social security in order to become a local account holder in Guangdong. Moreover, Guangdong government also encourages overseas talents to work and start a business in Guangdong with financial support since 2010. And Guangdong is catching up on the lack of education and training development such as introduce famous universities from Hong Kong and Macau to set up campuses in Guangdong (The Hong Kong University of Science and Technology Guangdong Campus in 2023, The Chinese University of Hong Kong, Shenzhen in 2014). Shanghai government also adopted Shanghai Pujiang Talent Program which is a talent subsidy project implemented by Shanghai government to support foreign returnees since 2005. Overseas students who come to Shanghai to engage in entrepreneurship, scientific research, and artistic creation can apply for subsidy funds through this plan, and the subsidy amount ranges from 100,000 yuan to 500,000 yuan per person. Moreover, Shanghai government also encourages high-level overseas students who graduated from the top 50 universities in the world by cancelling the social security payment base and payment time requirements and they can directly settle down after working full-time in Shanghai. While normal Chinese undergraduates need more strict requirements to settle down in Shanghai. And Beijing is the education center and R&D center of China and has the best educational resources. Meanwhile, Beijing also has talent introduction plan to absorb superior talents from abroad such as Beijing Overseas Talent Aggregation Project

which is established in 2009. There is a one-time reward of 1 million yuan per person along with preferential treatment bill in enterprise listing, tax incentives, household registration, and children's schooling these areas for qualified overseas returnees of this project.

Coupled with the communications with foreign countries since 1978, and the continuous deepening of international economic cooperation, eastern people's ideas are open and active, with a sense of innovation in the times, and adapt to today's market economic system. However, people in the central and western regions are closed and conservative in thinking, with profound traditional culture and some old concepts are deeply rooted. The education level lags behind the eastern region, especially the quality of science and technology and culture is far lower than that of the eastern region. And this can also be seen from the R&D expenditure in representative provinces in eastern, central and western China.

Figure 13 The trend of R&D/GDP in representative provinces
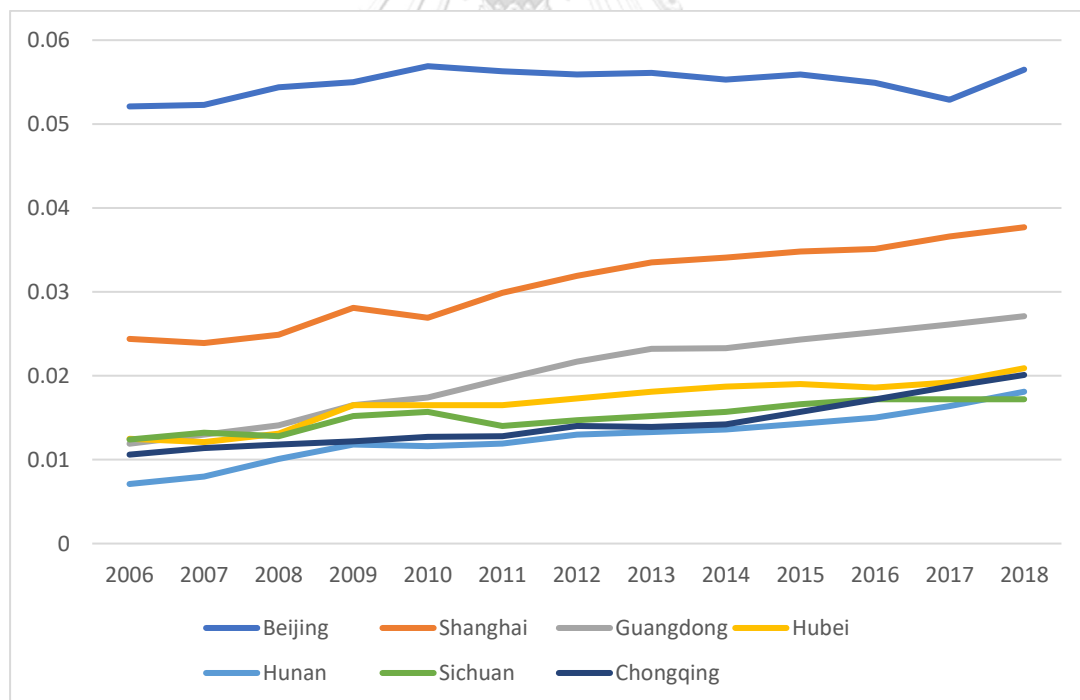
Data Source: China Statistics Yearbook

According to Figure 13, the trend of R&D/GDP in representative provinces in the eastern China is much higher than the representative provinces in the central and western China. This is not only because several multinationals' R&D centers and headquarters have set up in the eastern China and make local firms in eastern China

pay more attention to improve the R&D level by increasing R&D expenditure as mentioned earlier. But also, the government of eastern China has adopted several R&D policies to make sure the R&D development in their region. For example, Guangdong government has established many policies to push Guangdong into an innovative province and focus more on high-tech industries:

1) In July 1993, the Guangdong Provincial Committee of China and the Guangdong Provincial People's Government issued "Several Regulations on Supporting the Development of High-tech Industries", which formulated relevant establishment of operating mechanisms to adapt to the development of high-tech industries, increased investment, taxation, international economic and technological cooperation, exchange and introduce talents, etc., give preferential treatment and support to high-tech enterprises in taxation, import and export, and construction land.

2) In April 1997, the Guangdong Provincial Committee of China and the Guangdong Provincial People's Government issued "Several Regulations on Further Supporting the Development of High-tech Industries", straightening out the development mechanism of high-tech industries, and reaffirming the continued implementation of 12 preferential policies for high-tech industries' fiscal and taxation policies stipulate the increase of financial support for high-tech industries, and regulations on foreign investment and trade issues related to the expansion of high-tech products.

3) In September 2008, the Guangdong Provincial People's Government promulgated the "Guangdong Provincial Action Plan for Building an Innovative Guangdong", which regards independent innovation as the strategic core of the province's economic and social development, and proposes to build Guangdong into an innovative environment, a complete innovation system, and an innovative mechanism. An innovative province that is healthy, gathers innovative talents, has many innovative achievements, notable innovation benefits, and has a strong ability to support and lead independent innovation.

Shanghai established "Several Provisions of Shanghai Municipality on Promoting the Transformation of High-tech Achievements" and this file plays a model in the

whole China. Below are some special preferential policies of it about promoting FDI and R&D:

1) The government has set up a special fund to provide loan interest discounts or financing guarantees for identified transformation projects of high-tech achievements. The municipal government arranges 600 million yuan of venture capital funds to engage in venture capital, giving priority to supporting recognized high-tech achievement transformation projects.

2) Within three years from the date of recognition, the local revenue part of tax shall be refunded by the finance according to the regulations, in the next two years, 50% shall be refunded by the finance according to the regulations.

3) Overseas students and overseas experts bring high-tech achievements to Shanghai for transformation projects and these projects can enjoy preferential loan discounts and financing guarantees after being identified.

Beijing has set up the first High-tech Industry Development Pilot Zone in China which is called Zhongguancun Science Park and below are some important preferential policies in Zhongguancun Science Park:

1) 1 million to 4 million yuan of financial support would be given to the construction of productivity promotion centers and accelerators after expert review and approval of municipal projects.

2) Provide financial support of RMB 500,000 and RMB 1,000,000 to municipal and national engineering technology research centers that have passed the certification.

3) Financial support for enterprises in the park. For enterprises that obtain loans for technological transformation, new product development and fixed asset investment, a one-time discount of 50% of the total interest with a maximum of 200,000 yuan will be given after the enterprise submits an application and is approved by experts.

4) Technology-based small and medium-sized companies that have been filed with the Science and Technology Service Department of the park before applying for listing but fail to be listed will be given a certain percentage of financial subsidies for the listing financial expenses incurred, with a maximum of 1.5 million yuan.

While the western and central China doesn't have enough financial support to develop and make R&D policies in their region compared to the eastern China.

The third reason for the uneven regional economic development is national policy. In the early stage of reform and opening up, China implemented a strategy of unbalanced regional economy that was inclined to the eastern China. This is an adjustment to the policy of balanced development of regional economy in China during the planned economy period. In order to break the balanced development of the planned economy, the strategy of unbalanced development of regional economy was implemented. It tries to promote economic growth in the eastern China first then affecting the whole China later. The whole strategy is based on Deng Xiaoping who raised that allow some people and some regions to get rich first, and then achieve common prosperity. This kind of regional uneven development is only a process phenomenon "allowed" in the first half of the whole development. So, at the first stage of the whole development, the basic guiding ideology is efficiency priority, advocating "gradient development", making the eastern and western economies Developmental disparities are further exacerbated.

However, during the period of 2006 ~ 2018, Chinese government has noticed the weakness of regional unbalanced development and understand if the development income gap between the eastern and central western China further widens, it would make whole China trapped inside the social unrest. Therefore, Chinese government tries to make policies to alleviate the exacerbation of regional development imbalance. For example, government encourages FDI investments to transfer to the central and western region like what we mentioned above. And In 1999, Chinese government raised the plan West Development which proposed to narrow the gap of income within whole China and give financial support and preferential policies to the central and western China. Below are some preferential policies of West Development:

(1) Increase investment in construction funds. The amount of central fiscal construction money used in the central and western region should be increased. Loans from national policy banks and preferential loans from foreign capital prioritize the construction of central and western China as much as possible. For

the major infrastructure construction projects newly arranged by the state in the western China, there will be no funding gap from central fiscal. The central government will adopt various methods to promote the construction of the central and western China.

(2) Prioritize construction projects. Water conservancy, transportation, energy and other infrastructure, development and utilization of superior resources, distinctive high-tech and military-to-civilian technology industrialization projects are given priority in the central and western region.

(3) Increase fiscal transfer payments. Gradually expand the size of the central government's general transfer payments to the central and western area as its financial resources rise. In the distribution of specific financial aid for areas including agriculture, social security, education, research and technology, health, family planning, culture, and environmental preservation, the central and western region is inclined. The arrangement of the poverty alleviation funds from the central government will be mainly used in the poverty-stricken areas in western China. The state-approved initiatives for converting cropland to grassland and forests, protecting natural forests, and preventing and controlling desertification all require financial and grain subsidies, which are mostly provided by the federal government. Appropriate subsidies will be given by the central finance to local fiscal revenues affected by the implementation of projects such as natural forest protection.

(4) Increase financial credit support. In accordance with the independent principle of commercial credit, the bank has boosted credit investment in the development of fundamental industries in central and western China, concentrating on assisting in the building of big and medium-sized energy projects, including the construction of railways, trunk roads, electric power, oil, and natural gas pipelines.

With these policies to support central and western China, the growth rate of real GDP per capita of the central and western China has been higher than that of the eastern China for many years as shown in Figure 8. It also reflects the catch-up effect that regions with low initial GDP levels have higher GDP growth rates in a way.

3.5 Correlation analysis in provincial data

This section gives a preliminary correlation analysis between FDI and R&D, FDI and human capital province by province using scatter diagram and correlation coefficients. The study has shown the mix correlations between FDI, R&D and human capital.

For the correlation coefficient of FDI/GDP and RD/GDP, FDI/GDP and human capital as measured by the average schooling years are shown as below. The study denotes the correlation is highly positively correlated when the coefficient is more than 0.8, the correlation is highly negatively correlated when the coefficient is lower than -0.8. And the correlation coefficient which is lower than 0.4 and higher than -0.4 is no correlation. Meanwhile, the scatter diagrams between FDI/GDP and RD/GDP, FDI/GDP and the average schooling years which represents human capital are shown in Figure 14 ~ Figure 43 province by province in Appendix. Overall speaking, scatter diagrams are shown the same pattern as what correlation coefficients indicated and it can also ensure the accuracy of the correlation coefficients analysis as follows.

3.5.1 The correlation of FDI/GDP and RD/GDP in 30 provinces

Table 5 shows the correlation and coefficient of FDI/GDP and RD/GDP of 30 provinces in China. It is found that there are 2 provinces which are Anhui and Henan in central China have highly positive correlation between FDI/GDP and RD/GDP and it is also shown a positive correlation in Figure 25 and 29 in Appendix. And there are 6 provinces which are Zhejiang, Hainan, Inner Mongolia, Fujian, Jiangsu and Guangdong, mostly in eastern China have highly negative correlation between FDI/GDP and RD/GDP as well as shown in Figure 18, 23, 24, 26, 32, and 34 in Appendix.

In general, there are total 4 provinces which are Anhui, Henan, Hebei and Heilongjiang have positive correlation between FDI/GDP and RD/GDP and these four provinces are mostly in the central China. And 14 provinces in China all have negative correlation between FDI/GDP and RD/GDP and most provinces gathered in Eastern China. Moreover, there are 12 provinces cannot find clear correlation as shown in Table 5. It seems like in some central and western China, FDI/GDP and RD/GDP tend to have more closely positive correlation. And FDI/GDP and RD/GDP tend to have more closely negative correlation in some eastern China.

Table 5 The correlation of FDI/GDP and RD/GDP in 30 provinces

province	Area	correlation	coefficient
Anhui	Central	highly +	0.89
Henan	Central	highly +	0.88
Hebei	Eastern	+	0.53
Heilongjiang	Central	+	0.47
Hunan	Central	no clear correalation	0.25
Shanxi	Central	no clear correalation	0.23
Ningxia	Western	no clear correalation	0.19
Shan'xi	Western	no clear correalation	0.14
Sichuan	Western	no clear correalation	0.07
Tianjin	Eastern	no clear correalation	0.01
Xinjiang	Western	no clear correalation	-0.06
Jiangxi	Central	no clear correalation	-0.11
Liaoning	Eastern	no clear correalation	-0.19
Jilin	Central	no clear correalation	-0.23
Guizhou	Western	no clear correalation	-0.24
Qinghai	Western	no clear correalation	-0.33
Yunnan	Western	-	-0.5
Hubei	Central	-	-0.54
Gansu	Western	-	-0.56
Chongqing	Western	-	-0.63
Beijing	Eastern	-	-0.73
Shandong	Eastern	-	-0.75
Shanghai	Eastern	-	-0.77
Guangxi	Western	-	-0.78
Zhejiang	Eastern	highly-	-0.83
Hainan	Eastern	highly-	-0.9
Inner Mongolia	Western	highly-	-0.93
Fujian	Eastern	highly-	-0.97
Jiangsu	Eastern	highly-	-0.98
Guangdong	Eastern	highly-	-0.98

Source: calculated by the author

3.5.2 The correlation of FDI/GDP and human capital in 30 provinces

Table 6 shows the correlation and coefficient of FDI/GDP and human capital of 30 provinces in China. It is found that there are 2 provinces which are Henan and Anhui in central China have highly positive correlation between FDI/GDP and human capital

in China as well as positive correlation in Figure 25 and 29 in Appendix. And there are 7 provinces which are Qinghai, Zhejiang, Hainan, Fujian, Inner Mongolia, Jiangsu, and Guangdong mostly gathered in eastern China have highly negative correlation between FDI/GDP and human capital as well as negative correlation in Figure 18, 23, 24, 26, 32, 34, and 41 in Appendix.

Overall speaking, there are total 6 provinces in China have positive correlation in FDI/GDP and human capital and mostly gathered in central and western China as shown in Table 6. And there are 17 provinces mostly gathered in eastern China have negative correlation in FDI/GDP and human capital as shown in Table 6. It seems like it tends to be positive correlation of FDI/GDP and human capital in some central and western provinces. And it tends to be negative correlation of FDI/GDP and human capital in some eastern China.

In summary, it is shown that although the total amount of FDI gathered in the eastern China, FDI/GDP and RD/GDP, FDI/GDP and human capital tend to have negative correlation in eastern China from above analysis. However, FDI/GDP and RD/GDP, FDI/GDP and human capital tend to have positive correlation in some provinces in central China. It means the FDI channel through R&D and human capital are more easily found in some central provinces. However, most other provinces especially eastern provinces in China have shown a weak FDI spillover effect from human capital and R&D. To examine the overall FDI spillover channels from human capital and R&D in whole China still needs to do empirical regression.

Table 6 The correlation of FDI/GDP and human capital in 30 provinces

province	Area	correlation	coefficient
Henan	Central	highly +	0.85
Anhui	Central	highly +	0.8
Hebei	Eastern	+	0.5
Heilongjiang	Central	+	0.47
Shan'xi	Western	+	0.43
Sichuan	Western	+	0.41
Ningxia	Western	no clear correalation	0.38
Hunan	Central	no clear correalation	0.35
Shanxi	Central	no clear correalation	0.27
Beijing	Eastern	no clear correalation	0.14
Guizhou	Western	no clear correalation	-0.03

Yunan	Western	no clear correalation	-0.05
Liaoning	Eastern	no clear correalation	-0.31
Chongqing	Western	-	-0.42
Xinjiang	Western	-	-0.44
Hubei	Central	-	-0.51
Jilin	Central	-	-0.52
Tianjin	Eastern	-	-0.58
Shandong	Eastern	-	-0.6
Shanghai	Eastern	-	-0.68
Jiangxi	Central	-	-0.73
Guangxi	Western	-	-0.76
Gansu	Western	-	-0.77
Qinghai	Western	highly -	-0.8
Zhejiang	Eastern	highly -	-0.82
Hainan	Eastern	highly -	-0.88
Fujian	Eastern	highly -	-0.89
Inner Mongolia	Western	highly -	-0.9
Jiangsu	Eastern	highly -	-0.92
Guangdong	Eastern	highly -	-0.93

Source: calculated by the author

Generally speaking, this chapter analyze the main FDI policies and the situation of FDI, R&D and human capital using national data. Then analyze some representative provincial data to understand the unbalanced distribution of FDI, R&D and human capital development. It shows that FDI inflows incline to eastern China during the earlier period due to the unbalanced distribution of natural resources, infrastructure, economic development and policies incentive. However, Chinese government also tries to set up several policies to alleviate this unbalanced development lately. This combination of complicated policy roles and aggregation advantages would have mixed effects in the regression results. Finally, the correlation of FDI, R&D and human capital in provincial data is examined and it is found that most provinces especially eastern provinces in China have shown a weak FDI spillover effect from human capital and R&D.

Chapter 4 THEORETICAL FRAMEWORK AND MODEL SPECIFICATION

This Chapter is to analyze theoretical framework and deduce to model specification of this study.

4.1 Theoretical framework

To examine the effect of FDI and its spillover effect on regional economic growth rate, the production function firstly be specified which is based on Balasubramanyam et al. (1994) and Chen (2015) and Ouyang and Fu (2012) as shown below:

$$Y = Af(K, L, F, X)$$

Where:

Y= gross domestic product (GDP) in real terms of the province,

K=domestic capital stock in the province,

L=labor input in the province,

F=stock of foreign capital in the province,

X=other factors that can affect GDP in the province,

A=the total factor productivity (TFP) index of the province.

In addition to considering labor input and domestic capital stock, this production model also takes into account the impact of foreign capital stock as input and TFP index in the province on the production function. According to Balasubramanyam et al. (1994), the primary source of new technology and human capital in emerging nations is FDI. FDI in this production function can be used to capture spillovers and externalities associated with FDI. It is expected that FDI could promote economic growth to the province by bringing capital, technology, new products, trained human resources and so on.

Here A is a measure of productivity of the province which denotes technological progress. Basically speaking, endogenous growth model suggests that economic growth is depending on technological progress, accumulation of factors of production like labor input and capital input in the province.

Assuming above equation is linear while in logs, take logs and differencing then subsequent equation could be used to represent the growth rate of real GDP per capita:

$$y = \alpha + \beta k + \gamma l + \psi f + \omega x + \theta a$$

where a variable's rate of increase is indicated by a lower-case letter:

y=the growth rate of real GDP per capita

k= the rate of growth of domestic capital,

l= the rate of growth of labor,

f= the rate of growth of foreign capital,

x= the rate of growth of other factors that can affect GDP in the province,

a=technology level.

α is constant parameter, $\beta, \gamma, \psi, \omega, \theta$ are output elasticities of domestic capital, labor, foreign capital, the growth rate of other factors that can affect GDP in the province and technology level.

According to Kinoshita (2000), technology level could boost economic growth through R&D. And FDI spillover through R&D which could also affect technological progress in the province of host countries. R&D could affect the extent of FDI spillover by increasing absorptive capacity of the province to absorb advanced technology better. Meanwhile, based on Borensztein et al. (1998), technology level mainly comes from human capital, it means when the host countries accumulate more and more human capital, it would help FDI to promote economic growth. Therefore, at first assume R&D and human capital in host countries could promote economic growth directly, secondly both R&D and human capital would help host countries to absorb advanced technology from FDI easier in this study. So, the technology level function is like:

$$a = f(R\&D, HK)$$

Where R&D denotes the R&D capital, HK denotes human capital. Moreover, FDI could also affect technology level of the province through spillover effect on R&D and human capital through demonstration, labor mobility, competition, and linkage spillover. FDI would be expected to increase the productivity and efficiency of the province through above four ways. And this FDI spillover effect would be examined through 2SLS and would further explain in the model specification part.

To combine the production function and technology level function, considering the well-known and insurmountable issues that arise when attempting to estimate capital stocks, especially in developing nations, the following way to measure capital

to be used. k equals to domestic fixed asset investment in GDP, f equals to FDI in GDP, R&D equals to R&D expenditure in GDP like many previous studies. So, the growth rate of real GDP per capita of the province is like:

$$y_{it} = \beta_0 + \beta_1 \frac{I}{Y}_{it} + \beta_2 l_{it} + \beta_3 \frac{FDI}{Y}_{it} + \beta_4 \frac{RD}{Y}_{it} + \beta_5 HK_{it} + \beta_6 x_{it} + \epsilon_{it}$$

Where x captures characteristics of the province that can affect economic growth like other regional economic growth studies, I is domestic fixed asset investment, Y is GDP in the province, l is the growth rate of labor, FDI is foreign direct investment, RD is R&D expenditure, HK is human capital. Moreover, y is the growth rates of GDP per capita, ϵ is error term.

4.2 Model Specification and data

From above theoretical framework, the effect of FDI and its spillover on economic growth are based on below equation:

$$\begin{aligned} y_{it} = \beta_0 + \beta_1 \frac{I}{Y}_{it} + \beta_2 l_{it} + \beta_3 \frac{FDI}{Y}_{it} + \beta_4 \frac{RD}{Y}_{it} + \beta_5 HK_{it} + \beta_6 IF_{it} \\ + \beta_7 INFR_{it} + \beta_8 GS_{it} + \beta_9 Open_{it} + \beta_{10} SEZ_{it} + \beta_{11} FTZ_{it} \\ + \beta_{12} Y_{0it} + \epsilon_{it} \end{aligned}$$

Where i refers to a province in China, t refers to year. $\frac{I}{Y}$ equals to the ratio of domestic fixed asset investment to province GDP, l equals to province's population growth rate, $\frac{FDI}{Y}$ equals to FDI inflows relative to province GDP. Moreover, $\frac{RD}{Y}$ equals to R&D expenditure relative to province GDP, HK equals the average schooling years.

Initial income per capita, inflation, government size and openness these factors which could affect economic growth are also considered into this study to represent x based on Carkovic and Levine (2005). Here Y_0 denotes initial income per capita which equals to the logarithm of initial real per capita GDP in year 2006, IF denotes inflation which equals to average growth rate in the consumer price index, GS denotes government size which equals to government expenditure as a share of GDP, Open denotes openness which equals to exports plus imports relative to GDP.

The effect of infrastructure of the province on economic growth is considered into this study as well. INFR denotes Infrastructure which is represented by an index that is calculated as a weighted average the three standardized indicators of railways, highways and mobile telephone exchanges which could be found in the China

Statistics Yearbook.

To consider the effect of FDI policy which could help host countries to attract FDI. Here denotes SEZ equals to the Special Economic Zone and FTZ equals to the Free Trade Zone. Take variables SEZ and FTZ as dummy variables when the province has adopted the policy equals to 1, other equals to 0.

To examine the FDI spillover through R&D channel and avoid possible endogeneity in the model, IV-2SLS is used to deal with the potential endogeneity on economic growth. About literatures to choose what kind of instrumental variables would affect FDI, overall speaking they use policy dummy, market size and lagged one-year FDI/Y to be instrumental variables. However, in this study policy which aims at promoting FDI is SEZ and FTZ which are used to estimate the relationship with economic growth. And market size which is measured by initial income per capita is used to represent catch-up effect in the total regression. So, one-year lagged FDI/Y is only to be used as instrumental variable which is based on Ouyang and Fu (2012) and Ayanwale (2007). The one-year lagged FDI/Y has strong correlation with FDI/Y and would not affect economic growth in year t directly. The instrumental variable is widely used in current literatures to calculate the connection between FDI and economic expansion (Ouyang and Fu (2012); Ayanwale (2007); Kherfi and Soliman (2005)).

The first stage of 2sls and we can get this equation to represent FDI:

$$
\begin{aligned}
\frac{FDI}{Y}\hat{}_{it} = {} & \beta_0 + \beta''_1 \frac{I}{Y}_{it} + \beta''_2 l_{it} + \beta''_4 \frac{RD}{Y}_{it} + \beta''_5 HK_{it} + \beta''_6 IF_{it} \\
& + \beta''_7 INFR_{it} + \beta''_8 GS_{it} + \beta''_9 Open_{it} + \beta''_{10} SEZ_{it} \\
& + \beta''_{11} FTZ_{it} + \beta''_{12} Y_{0it} + \beta_{13} \frac{FDI}{Y}_{it-1} + \epsilon_{it}
\end{aligned}
$$

The second stage of 2sls and we can get this equation to represent economic growth:

$$
\begin{aligned}
y_{it} = {} & \beta_0 + \beta_1 \frac{I}{Y}_{it} + \beta_2 l_{it} + \beta''_3 \frac{FDI}{Y}\hat{}_{it} + \beta_4 \frac{RD}{Y}_{it} + \beta_5 HK_{it} + \beta_6 IF_{it} \\
& + \beta_7 INFR_{it} + \beta_8 GS_{it} + \beta_9 Open_{it} + \beta_{10} SEZ_{it} + \beta_{11} FTZ_{it} \\
& + \beta_{12} Y_{0it} + \epsilon_{it}
\end{aligned}
$$

Where:

i = an province in China, t = year,

$\frac{I}{Y}$ = the ratio of domestic fixed asset investment to province GDP,

l = province's population growth rate,

$\frac{FDI}{Y}$ = FDI inflows relative to province GDP,

$\frac{RD}{Y}$ = R&D expenditure relative to province GDP,

HK = the average schooling year which could be calculated like: (the quantity of illiteracy *1 +the quantity of people with primary school education*6+the quantity of people with junior school education*9+the quantity of people with high school and technical secondary education*12+the quantity of people with college degree or above*16) / total population over 6 years old.

And FDI spillover effect through human capital could use $\beta''_5 * \beta''_3$ to measure, and FDI spillover effect through R&D could use $\beta''_4 * \beta''_3$ to measure. Other variables which are control variables are the same as above and the definition is as shown in Table 7. All these data could be found in China Statistics Yearbook 2006 ~ 2018.

Table 7 The definition of variables

Variable	Definition	Hypothesis
y	The growth rate of GDP per capita	
$\dfrac{I}{Y}$	The ratio of domestic fixed asset investment to province GDP	+/-
l	Province's population growth rate	+
$\dfrac{FDI}{Y}$	FDI inflows relative to province GDP	+/-
$\dfrac{RD}{Y}$	R&D expenditure relative to province GDP	+
HK	The average schooling year	+
IF	Average growth rate in the consumer price index	+/-
INFR	An index that is calculated as a weighted average the three standardized indicators of railways, highways and mobile telephone exchanges	+
GS	Government expenditure as a share of GDP	+/-
Open	Exports plus imports relative to GDP	+/-
Y_0	The logarithm of initial real per capita GDP in year 2006	-

The impact of domestic fixed asset investment on economic growth is not completely fixed. On the one hand, the excessive scale and rapid growth of fixed asset investment can easily lead to overheating of the economy, which can lead to tremendous ups and downs. Once there is a large fluctuation in economic growth, it will inevitably lead to serious consequences such as a decline in corporate profits, an increase in bank non-performing loans, an increase in the unemployment rate, and inflation or deflation therefore resulting in economic growth decline. But on the other hand, maintaining a moderate growth in fixed asset investment and maintaining a reasonable scale of fixed asset investment in the whole society will certainly stimulate economic growth.

Province's population growth rate would promote economic growth by increasing labor supply and population density and this kind of demographic pressure is conducive to stimulating technological innovation. In this study, we suppose the population growth rate would have positive effect.

FDI could promote economic growth directly and indirectly improve host countries' absorptive ability to absorb advanced technology easier. And it would make local enterprises more effective. Here we suppose FDI would have positive effect on economic growth. Moreover, FDI spillover through human capital and R&D are supposed to have a positive effect on economic growth.

R&D and human capital represents the host countries' scientific and technological innovation ability. When host countries with more and more high level of R&D and human capital, it means host countries could absorb advanced technology easier and build their own technical barriers to promote economic growth. Here we assume both R&D and human capital could promote economic growth.

Inflation has ambiguous effect on economic growth. For positive side, there is a condition for inflation to promote economic growth is that the rate of money wages rises slowly. Because only with this condition, enterprises can obtain trade expansion profits other than loans, and enterprises can make new investments. Only then will more resources be used to produce more investment products. And this kind of rapid accumulation of investment products is going to accelerate the production capacity and labor productivity therefore increasing growth. However, on the other side, inflation can cause high expected returns on savings and excessive purchases therefore resulting in an economic downturn.

Infrastructure can be used as a special capital stock to directly promote economic growth. At the same time, it can also indirectly promote economic growth by increasing by increasing the number of production factors like investment and labor and increasing marginal productivity. Here we assume that infrastructure can promote economic growth.

Export and import have ambiguous effect on economic growth. On one side, export and import could not only make the allocation of world resources more effective, so that all trade parties can directly benefit, but also have a positive

impact on economic growth. On the other hand, imports may also be detrimental to economic growth. For example, the import of a large number of luxury goods may cause a certain decrease in the domestic savings rate and foreign exchange reserves, and may result in a negative trade balance, which will not promote economic expansion. Meanwhile, when there is no unemployment in the economy, the continued growth of exports and aggregate demand will not increase national income but will cause inflation. Unlike inflation caused by increased investment, excess demand from increased exports cannot generate productive capacity by itself and thus contributes to inflation. Therefore, resulting in economic recession.

Government expenditure has ambiguous effect on economic growth. On one side, during the period of economic expansion, the scale of the government will continue to expand, increasing general administrative expenditures will help improve administrative efficiency and have a favorable effect on economic expansion. However, when local government expenditure increases, the central government's financial capabilities would decline, as a result, the adjustment cost of government expenditure has risen sharply. Therefore, the overall effect of government expenditure on economic growth decreases, or even negatively affects.

Chapter 5 EMPIRICAL RESULTS

This chapter give descriptive statistics analysis, basic correlation analysis and regression of this study.

5.1 Descriptive Statistical Analysis

Table 8 show the full data descriptive statistics of 30 provinces in China (The name list of all provinces included in this study could be found in Table 14 in Appendix). There is total 390 observations in this regression. The minimum of the GDP growth rate is negative, it means that GDP growth rate doesn't grow every year and has some fluctuate during the period of 2006 ~ 2018 based on different situation in each province.

Table 8 Descriptive Statistics of variables

variable	N	mean	sd	min	max
the growth rate of GDP per capita	390	0.124	0.0624	-0.0211	0.283
fixed asset investment/Y	390	0.71	0.247	0.142	1.48
population growth rate	390	0.0528	0.0266	-0.01	0.118
FDI/Y	390	0.0242	0.021	0.0001	0.121
RD/Y	390	0.0147	0.0103	0.002	0.0569
the average schooling year	390	8.829	0.985	6.594	12.68
InitialGDP	390	4.189	0.223	3.785	4.74
Inflation	390	0.0007	0.0257	-0.0918	0.0554
INFR	390	0.934	0.539	0.0688	2.5
Openness	390	0.0067	0.0079	0.0004	0.0371
GS	390	0.24	0.109	0.0948	0.758

5.2 Correlation Analysis

Table 9 Correlation results

	y	I/Y	l	FDI/Y	RD/Y	HK	Y_0	IF	INFR	Open	GS
y	1.0000										
I/Y	-0.0585	1.0000									
l	-0.2653	0.345	1.0000								
FDI/Y	-0.4591	0.398	0.758	1.0000							
RD/Y	-0.2415	-0.282	-0.374	-0.254	1.0000						
HK	0.128	-0.415	-0.392	-0.414	0.282	1.0000					
Y_0	-0.254	0.527	0.764	0.745	-0.594	-0.37	1.0000				
IF	0.5416	0.0202	-0.0325	-0.0836	-0.132	0.0018	0	1.0000			
INFR	-0.1652	0.348	0.595	0.454	-0.289	-0.275	0.556	-0.0177	1.0000		
Open	-0.1918	0.407	0.737	0.62	-0.573	-0.219	0.862	0.022	0.552	1.0000	
GS	-0.1376	-0.319	-0.329	-0.173	0.553	0.247	-0.434	-0.0754	-0.557	-0.366	1.0000

From the result of correlation analysis as shown in Table 9, we can see that the coefficient of each variable are smaller than 0.8. It means the data for the entire model does not suffer from serious collinearity problems.

5.3 Regression results

The spillover effect is estimated by multiplying the coefficient of R&D and human capital in the first stage and the coefficient of FDI/Y^ in the second stage. In order to avoid the endogeneity problem and to study the spillover effects, the 2SLS method is adopted. In the 2SLS regression, lagged one-year FDI/GDP is used as an

instrumental variables which is the same as Ouyang P, Fu S (2012). Because lagged one-year FDI/Y is supposed to has strong relationship with FDI/Y but cannot affect GDP growth rate directly.

Table 10 The estimation results of 2SLS

VARIABLES	First stage FDI/GDP	Second stage Growth
$\dfrac{FDI}{Y}$	-	0.554***
	-	(3.23)
$\dfrac{RD}{Y}$	0.0447	0.704
	(0.62)	(1.29)
HK	-0.00022	-0.026***
	(-0.32)	(-5.21)
$\dfrac{I}{Y}$	0.00348	-0.125***
	(1.60)	(-9.03)
l	-0.0108	0.305**
	(-0.60)	(2.22)
Y_0	0.00045	-0.085**
	(0.11)	(-2.56)
IF	0.00910	1.065***
	(0.69)	(13.6)
INFR	-0.00031	-0.011
	(-0.29)	(-1.41)
Open	0.0386	-0.794
	(0.37)	(-1.10)

Z statistics in parentheses, * significant at 10%, ** significant at 5%, *** significant at 1 %

VARIABLES	First stage FDI/GDP	Second stage Growth
GS	-0.0084*	-0.053
	(-1.79)	(-1.50)
SEZ	-0.00066	-0.011
	(-0.45)	(-1.00)
FTZ	-0.0028*	-0.001
	(-2.05)	(-0.11)
$\frac{FDI}{Y}$(-1)	0.909***	-
	(43.8)	-
Constant	0.00098	0.787***
	(0.06)	(6.23)
Observations	360	360
Number of group	30	30
R_square	0.9056	0.5975

Z statistics in parentheses, * significant at 10%, ** significant at 5%, *** significant at 1 %

The regression results are shown in table 10, where the first column of result represents the results of the first stage of 2SLS regression, the second column of result represents the results of the second stage of 2SLS regression. The estimated parameter of $\frac{FDI}{Y}$(-1) is significant at 1% level, it proves the stable of instrumental variables in 2SLS. The empirical results based on 2SLS regression are therefore interpreted.

FDI has a statistically significant positive effect on economic growth in China. The findings show that following reform and opening up, China's savings were more readily available for investment due to the inflow of foreign direct investment income, which is helpful in bridging the actual savings gap. China's growth is directly aided by the capital inflow, which immediately creates productive capacity. It has the

same results as Su and Liu (2016), Yao (2006) and Ouyang and Fu (2012), they have proved FDI could bring positive effect on economic growth in China.

R&D has an insignificant positive effect on economic growth in China. It means that this study cannot prove the contribution of R&D on economic growth. The result is consistent with Ljungwall and Tingvall (2015) who find that R&D expenditure is not an effective key contributing factor to economic growth in China. It is found a fact by them that the efficiency of the government in allocating resources is often lower than that of the market, which in turn leads to a decline in the overall efficiency of total R&D expenditure. Therefore, the insignificant positive effect of R&D on economic growth cannot prove the existence of FDI spillover through R&D. For one reason of it could be the decline of R&D efficiency. Miyagawa and Ishikawa (2019) also mention that R&D expenditure is not enough to promote economic growth, and countries need to do more to support innovation and collaboration in carefully selected industries.

Human capital has a statistically significant negative effect on economic growth. It means that low human capital could promote economic growth in China. It has the similar result with Whalley and Zhao (2013) who find the contribution to China's economic growth is not dependent on years of schooling as in the current literature. The results show that human capital formation accelerated due to the massive expansion of education after 1999 (university enrollment in China increased nearly fivefold between 1997 and 2007), while gross domestic product (GDP) growth rates after 1999 barely Changes, resulting in (TFP) growth will decline. The results show that the mismatch of human capital in China may have intensified in recent years. These results emphasize the importance of efficient use of human capital and the amount of human capital creation in China's growth strategy. Therefore, it could not examine the FDI spillover through human capital by negative effect of human capital on economic growth in this study. It might be caused by the evaluation of human capital variables. Meanwhile, De la Fuente and Doménech (2006) also pointed out that human capital which represented by the average schooling years would have ineffective effect on economic growth due to poor data quality. However, in their study there are also negative relationship with human capital and economic growth

even they have used a new way to calculate human capital. Therefore, it might because that it's better to use skilled labor to represent the possible transfer of trained employees from MNCs to local firms to represent human capital variables. However, the statistics of skilled labor variables in provincial data are not available.

Fixed asset investment as a share of GDP has a significantly negative effect on economic growth. It means we cannot prove the contribution of fixed asset investment in this study. The result is consistent with Berthélemy and Demurger (2000) who find a negative effect of fixed asset investment on economic growth based on Chinese provincial data and national data. It might be caused by inefficiently allocated that domestic investment has largely shifted to state-owned enterprises, which means that investment is being spent in the least dynamic national economy.

Population growth rate has a significantly positive effect on economic growth. It means that the increase of population growth rate would promote economic growth in China. It is because the increase of population growth rate would increase potential labor supply therefore promoting economic growth. The result is consistent with Cai and Lu (2013) who discover that raising total factor productivity and labor force participation can both significantly raise GDP potential.

Initial GDP per capita has a significantly negative effect on economic growth which implies convergence in the sample as a whole. It means that regions with poor initial GDP per capita have higher growth rates than regions with developed per capita GDP.

Inflation has significantly positive effect on economic growth. It means the wage rate of money rises slowly in China therefore more resources are used to produce more investment products and the rapid accumulation will promote the production capacity and labor productivity therefore increasing growth. The result is consistent with Hwang and Wu (2011) who find moderate inflation benefits economic growth in China.

Infrastructure has an insignificantly negative effect on economic growth. It cannot prove the contribution of infrastructure on economic growth. The result is similar to Shi et al. (2017) who find that excessive infrastructure doesn't always translate to faster economic growth. For example, the contribution of fixed telephone

infrastructure, the use of mobile phones has diminished the usefulness of landlines. So, the conclusion is that more infrastructure is not always better.

Openness has an insignificant negative effect on economic growth. It means that we cannot conclude the contribution of export and import in this study. However, export and import would not always accelerate economic growth. For example, when the economy is at full employment, the continued growth of exports and aggregate demand will not increase national income but will cause inflation. Unlike inflation caused by increased investment, excess demand from increased exports cannot generate productive capacity by itself and thus contributes to inflation. Therefore, resulting in economic recession.

Government size has an insignificant negative effect on economic growth. It means that we cannot conclude the contribution of government expenditure in this study. One reason for this result is when local government expenditure increases, the fiscal capacity of the central government would decrease, as a result, the adjustment cost of government expenditure has risen sharply. Therefore, the overall effect of government expenditure on economic growth decreases, or even negatively affects. The result is consistent with Zhang and Zou (1998) who find government-backed fiscal decentralization has been negatively relative to provincial economic growth.

SEZ and FTZ who denote policy Special Economic Zone and Free Trade Zone here have an insignificantly negative effect on economic growth. Moreover, in the first stage of 2SLS, it also shows a negative effect on FDI. It means these two policies cannot attract FDI effectively. For one reason, it might because Special Economic Zone set up so early that it cannot maintain an advantage to attract FDI. And the period of Free trade Zone that has set up is too short to get a significantly result in regression.

Chapter 6 CONCLUSION AND POLICY IMPLICATION

6.1 Conclusions

FDI in China grows dramatically since 1980 and one of the main policies for Chinese government to promote economic growth is opening up to the world and attract different FDI in various industries. The miraculous growth rate of China's economy and the growth of FDI have attached the importance of FDI. And it's essential to find out if FDI could be effective reason for the China's economic take-off. Moreover, the study aims at investigating whether R&D and human capital could be main factors for the technological progress and FDI spillover channel on economic growth in China during the recent years. After the analysis of these FDI policies and data performance, then the current contribution of FDI, R&D and human capital in China are investigated. Then it is analyzed in provincial data which shows that the amount of FDI distributes more in Eastern China and less in Central and Western China during the period of 2006-2018. However, from preliminary correlation analysis, Eastern China tends to have negative correlation between FDI/GDP and RD/GDP, FDI/GDP and human capital. Only some central provinces like Anhui and Henan have positive correlation between FDI/GDP and RD/GDP, FDI/GDP and human capital.

FDI policies in China could be divided into three periods roughly, those are Special Economic Zone which focus more on eastern China (1980~Now), National Economic and Technology Development Zone which cover whole China (1990~Now), and Free Trade Zone which is adopted by some pilot provinces, to strengthen the level of open range to attract more FDI and improve the quality of FDI (2010~Now). The effect of NETDZ cannot be examined because it is covered whole China during the period of the study. Thus, only SEZ and FTZ are considered into this study as FDI policies dummies.

This study includes data for 30 provinces over a period of 13 years in China (during the period of 2006 ~ 2018). This data set gives a tremendous information for the

underlying good performance of economic growth in China. The main conclusion is that FDI is one factor promoting economic growth. This is because FDI can bring new products, advanced technology, new capital, and new management skills to the province. These technology and capital inflows will have a positive impact on the province's economy. Moreover, Domestic fixed asset investment is not an essential factor to the provincial economic growth. However, population growth rate is a significant factor to promote provincial economic growth. It is surprising that the SEZ and FTZ policies are not effective to attract FDI. Meanwhile, the study fails to prove the contribution of R&D, human capital and FDI spillover through human capital and R&D on economic growth might be due to data limitation in provincial level and the decline of R&D efficiency.

6.2 Policy Implications

From the empirical results, there are three points that could be improved.

First, government should keep attracting FDI and make more effective FDI policies, Current SEZ and FTZ seem ineffective to attract more FDI. It's important to maintain high inflow of FDI in order to maintain a high economic growth rate, therefore, government could make more preferential policies to attract FDI to invest in China. Moreover, R&D could promote economic growth by improving host countries' absorptive ability therefore absorbing advanced technology more easily. However, it doesn't observe its role on growth. So, more favorable policies and measures can be used to target the introduction of FDI in industries with high technology and advanced R&D level. In addition, stimulating advanced R&D level and technological transfer could accelerate economic growth.

Second, government should pay attention to keep moderate population growth rate. The result shows that high population growth rate would bring high economic growth rate. The government should encourage young people of the right age to actively bear children and maintain a certain population growth rate, so as to maintain the vitality of economic growth.

Third, the empirical results show that current inflation could be an effective factor to foster economic growth. In other word, government should not over concern about the economic recession caused by inflation. Therefore, government should

not need to excessively reduce the fiscal deficit. In addition, investment should focus on effective R&D investment in key industries or some investment in population growth.

At last, the limitation of the study is that it fails to prove the contribution of human capital and R&D on provincial economic growth as well as the existence of FDI spillover through human capital and R&D. It is because the variable which can represent provincial skilled labor is not available and it is meaningful to find an effective way to evaluate skilled labor using current provincial data. And for the effect of R&D on growth, it might be caused by the decline of R&D efficiency. Government should find out the exact industries that have no effective R&D investment output and the industries that have effective R&D investment output.

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CHULALONGKORN UNIVERSITY

APPENDIX

Table 11 The data of representative provinces in Eastern China (Economic growth rate, FDI, R&D and human capital)

Province	Year	the growth rate of real GDP per capita	FDI/GDP	R&D/GDP	the average schooling years
Beijing	2006	0.13259293	0.04326567	0.0521	10.9501053
Beijing	2007	0.19070698	0.03694761	0.0523	11.0853118
Beijing	2008	0.07719751	0.03575535	0.0544	10.9695922
Beijing	2009	0.03673714	0.03241025	0.055	11.172567
Beijing	2010	0.10199974	0.02878789	0.0569	11.0091822
Beijing	2011	0.10138302	0.02650762	0.0563	11.5549694
Beijing	2012	0.07550495	0.02668243	0.0559	11.8363227
Beijing	2013	0.08420837	0.02497895	0.0561	12.0283569
Beijing	2014	0.06128131	0.02422408	0.0553	11.8541716
Beijing	2015	0.06521006	0.03266723	0.0559	12.1464329
Beijing	2016	0.08530943	0.03200292	0.0549	12.3890948
Beijing	2017	0.1035813	0.05496943	0.0529	12.6651129
Beijing	2018	0.10861263	0.03460194	0.0565	12.6753939
Shanghai	2006	0.11379793	0.05345441	0.0244	10.4382415
Shanghai	2007	0.16283002	0.04676231	0.0239	10.454596
Shanghai	2008	0.08135916	0.04817698	0.0249	10.5454212
Shanghai	2009	0.04640368	0.04572676	0.0281	10.6469072
Shanghai	2010	0.09719055	0.04202171	0.0269	10.1217337
Shanghai	2011	0.0818807	0.04067398	0.0299	10.4833968
Shanghai	2012	0.04326111	0.04499069	0.0319	10.6543028
Shanghai	2013	0.06843873	0.04478597	0.0335	10.5615352
Shanghai	2014	0.07395609	0.04415956	0.0341	10.815604
Shanghai	2015	0.06184173	0.04276042	0.0348	10.9156564
Shanghai	2016	0.11158024	0.04114681	0.0351	11.0095984
Shanghai	2017	0.09986076	0.03487762	0.0366	11.4060976
Shanghai	2018	0.09197762	0.03178985	0.0377	11.1939667
Guangdong	2006	0.16102013	0.04455719	0.0119	8.43781379
Guangdong	2007	0.19292201	0.04102572	0.013	8.68016119
Guangdong	2008	0.1295884	0.03626753	0.0141	8.77292365
Guangdong	2009	0.04994273	0.03381272	0.0165	8.8717086
Guangdong	2010	0.13321325	0.02985261	0.0174	8.60241
Guangdong	2011	0.12104592	0.02652795	0.0196	9.33312628

Guangdong	2012	0.04457225	0.02607607	0.0217	9.34782556
Guangdong	2013	0.07113635	0.02472399	0.0232	9.22652599
Guangdong	2014	0.06924985	0.02421278	0.0233	9.28264394
Guangdong	2015	0.07689997	0.02239872	0.0243	9.43773309
Guangdong	2016	0.07990266	0.01887614	0.0252	9.55005401
Guangdong	2017	0.09397023	0.01687545	0.0261	9.69687456
Guangdong	2018	0.07094125	0.01477064	0.0271	9.56311696

Table 12 The data of representative provinces in Central China (Economic growth rate, FDI, R&D and human capital)

Province	Year	the growth rate of real GDP per capita	FDI/GDP	R&D/GDP	the average schooling years
Hubei	2006	0.16469759	0.02591571	0.0125	8.25799535
Hubei	2007	0.25609386	0.02225528	0.0121	8.42336383
Hubei	2008	0.2145483	0.01960044	0.0131	8.48550887
Hubei	2009	0.14528854	0.01893967	0.0165	8.48868231
Hubei	2010	0.22867294	0.01689628	0.0165	8.45529577
Hubei	2011	0.22426742	0.01507634	0.0165	9.04717902
Hubei	2012	0.12759584	0.01583207	0.0173	9.2015784
Hubei	2013	0.11969654	0.01681049	0.0181	9.34479504
Hubei	2014	0.10950154	0.01724361	0.0187	9.11094201
Hubei	2015	0.06962065	0.01836666	0.019	9.28218721
Hubei	2016	0.09271256	0.02017184	0.0186	9.24426137
Hubei	2017	0.11126944	0.01993521	0.0192	9.34566867
Hubei	2018	0.1255046	0.01880399	0.0209	9.4703729
Hunan	2006	0.15029413	0.02781878	0.0071	8.16876597
Hunan	2007	0.2465695	0.02678272	0.008	8.41965116
Hunan	2008	0.21413921	0.02460005	0.0101	8.43277288
Hunan	2009	0.12507039	0.02458979	0.0118	8.46534616
Hunan	2010	0.20151159	0.02253444	0.0116	8.2302205
Hunan	2011	0.19833368	0.02100117	0.0119	8.80708745
Hunan	2012	0.11948133	0.02167051	0.013	8.72140355
Hunan	2013	0.10865448	0.02289664	0.0133	8.95759876
Hunan	2014	0.09744552	0.02436551	0.0136	9.02003388
Hunan	2015	0.10142671	0.02523872	0.0143	9.24878977
Hunan	2016	0.07996756	0.02766868	0.015	9.29896985
Hunan	2017	0.0949234	0.02889064	0.0164	9.39575061

Hunan	2018	0.07315305	0.0294923	0.0181	9.31609505

Table 13 The data of representative provinces in Western China (Economic growth rate, FDI, R&D and human capital)

Province	Year	the growth rate of real GDP per capita	FDI/GDP	R&D/GDP	the average schooling years
Chongqing	2006	0.1280908	0.01422463	0.0106	7.57339206
Chongqing	2007	0.2192598	0.01639427	0.0114	7.72396518
Chongqing	2008	0.22981256	0.02886539	0.0118	7.78696377
Chongqing	2009	0.11890726	0.03467016	0.0122	7.93409936
Chongqing	2010	0.20294698	0.02553811	0.0127	7.9641412
Chongqing	2011	0.2414186	0.03703053	0.0128	8.77935214
Chongqing	2012	0.12379532	0.01918558	0.014	8.63560241
Chongqing	2013	0.11094946	0.01969796	0.0139	8.67599047
Chongqing	2014	0.10990879	0.01778297	0.0142	8.95550875
Chongqing	2015	0.08629505	0.01464568	0.0157	8.88371214
Chongqing	2016	0.11141387	0.01028377	0.0172	9.00531407
Chongqing	2017	0.10019374	0.00760574	0.0187	9.13602802
Chongqing	2018	0.06683704	0.00996282	0.0201	9.1905406
Sichuan	2006	0.17478478	0.01133821	0.0124	7.2422656
Sichuan	2007	0.24992768	0.01075018	0.0132	7.43356831
Sichuan	2008	0.20998226	0.01681486	0.0128	7.51470694
Sichuan	2009	0.10851131	0.0172804	0.0152	7.69397277
Sichuan	2010	0.22102721	0.02367948	0.0157	7.6353736
Sichuan	2011	0.23108809	0.02909061	0.014	8.2165309
Sichuan	2012	0.13357055	0.02586228	0.0147	8.47831667
Sichuan	2013	0.10541061	0.02401896	0.0152	8.44745037
Sichuan	2014	0.08589313	0.02187331	0.0157	8.34759825
Sichuan	2015	0.04462503	0.02051925	0.0166	8.3954847
Sichuan	2016	0.08471064	0.01598889	0.0172	8.25463155
Sichuan	2017	0.13742958	0.01443042	0.0172	8.49760164
Sichuan	2018	0.12704265	0.01382606	0.0172	8.61236536

Table 14 The name list of 30 Provinces in this study

Province in eastern China	Province in central China	Province in western China
Beijing	Anhui	Inner Mongolia
Tianjin	Jiangxi	Chongqing
Hebei	Hubei	Sichuan
Liaoning	Hunan	Guizhou
Shanghai	Henan	Yunnan
Jiangsu	Shanxi	Shan'xi
Zhejiang	Jilin	Gansu
Fujian	Heilongjiang	Qinghai
Shandong		Ningxia
Guangdong		Xinjiang
Hainan		Guangxi

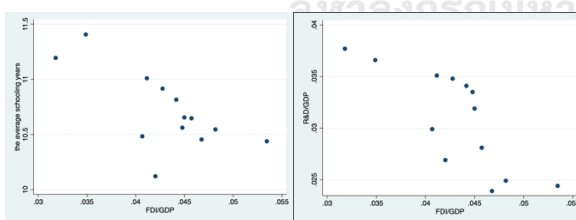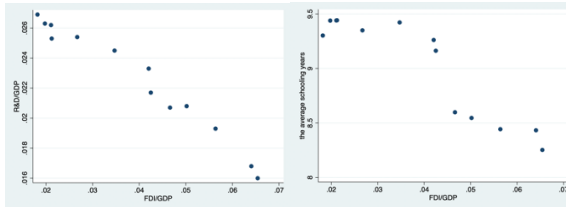*Figure 14 The correlation diagram of FDI/GDP, RD/GDP and human capital, Beijing*
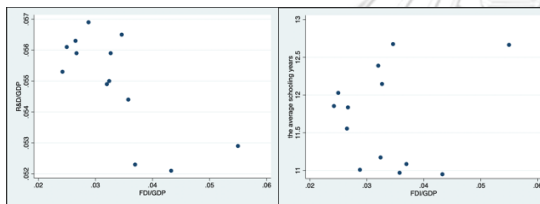
The first diagram is FDI/GDP and RD/GDP, the second one is FDI/GDP and human capital

Source: draw by the author

FDI/GDP and RD/GDP show weak negative correlation in Beijing, FDI/GDP and human capital show no correlation in Beijing.

Figure 15 The correlation diagram of FDI/GDP, RD/GDP and human capital, Tianjin
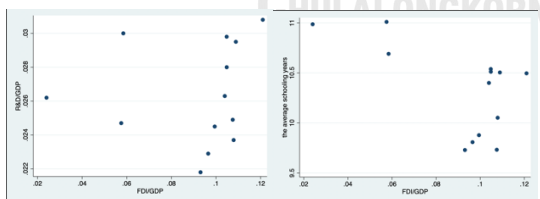
The first diagram is FDI/GDP and RD/GDP, the second one is FDI/GDP and human capital

Source: draw by the author

FDI/GDP and RD/GDP show no correlation in Tianjin, FDI/GDP and human capital show weak negative correlation in Tianjin.
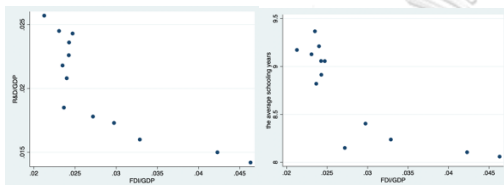
Figure 16 The correlation diagram of FDI/GDP, RD/GDP and human capital, Hebei
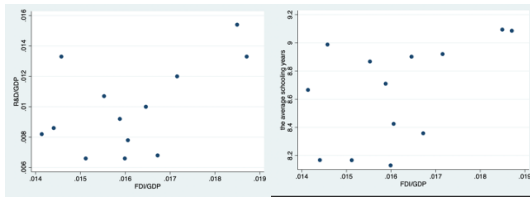
The first diagram is FDI/GDP and RD/GDP, the second one is FDI/GDP and human capital

Source: draw by the author

FDI/GDP and RD/GDP show weak positive correlation in Hebei, FDI/GDP and human capital show weak positive correlation in Hebei.
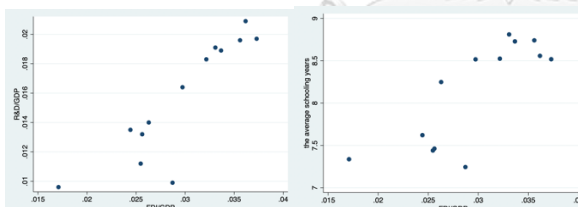
Figure 17 The correlation diagram of FDI/GDP, RD/GDP and human capital, Shanxi
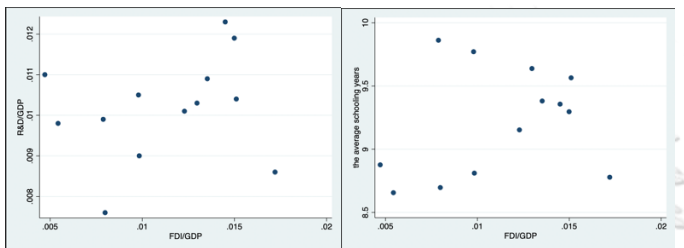
The first diagram is FDI/GDP and RD/GDP, the second one is FDI/GDP and human capital

Source: draw by the author

FDI/GDP and RD/GDP show no correlation in Shanxi, FDI/GDP and human capital show no correlation in Shanxi.

Figure 18 The correlation diagram of FDI/GDP, RD/GDP and human capital, Inner Mongolia
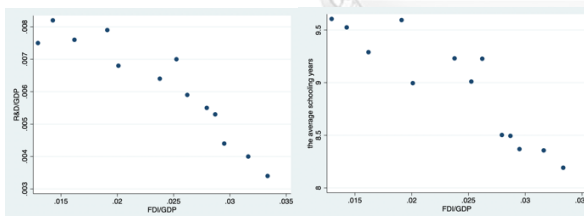
The first diagram is FDI/GDP and RD/GDP, the second one is FDI/GDP and human capital

Source: draw by the author

FDI/GDP and RD/GDP show negative correlation in Inner Mongolia, FDI/GDP and human capital show negative correlation in Inner Mongolia.
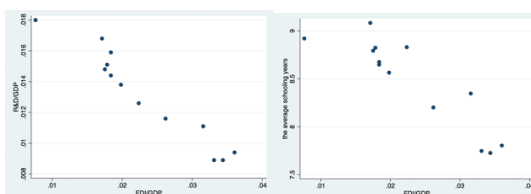
Figure 19 The correlation diagram of FDI/GDP, RD/GDP and human capital, Liaoning
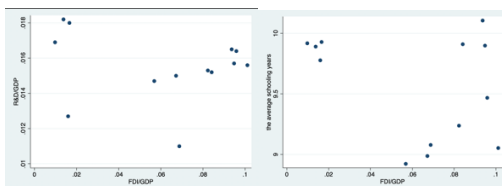
The first diagram is FDI/GDP and RD/GDP, the second one is FDI/GDP and human capital

Source: draw by the author

FDI/GDP and RD/GDP show no correlation in Liaoning, FDI/GDP and human capital show no correlation in Liaoning.
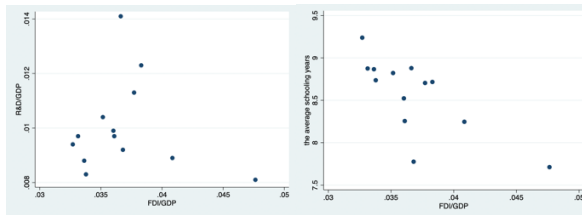
Figure 20 The correlation diagram of FDI/GDP, RD/GDP and human capital, Jilin
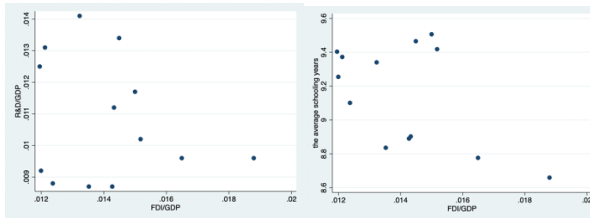
The first diagram is FDI/GDP and RD/GDP, the second one is FDI/GDP and human capital

Source: draw by the author

FDI/GDP and RD/GDP show no correlation in Jilin, FDI/GDP and human capital show weak negative correlation in Jilin.

Figure 21 The correlation diagram of FDI/GDP, RD/GDP and human capital,

Heilongjiang
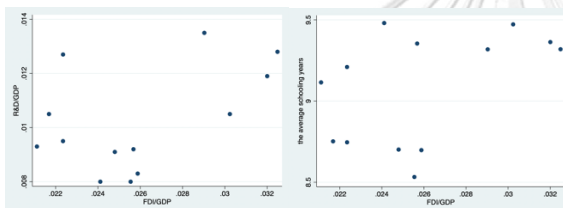
The first diagram is FDI/GDP and RD/GDP, the second one is FDI/GDP and human capital

Source: draw by the author

FDI/GDP and RD/GDP show weak positive correlation in Heilongjiang, FDI/GDP and human capital show weak positive correlation in Heilongjiang.

Figure 22 The correlation diagram of FDI/GDP, RD/GDP and human capital, Shanghai

The first diagram is FDI/GDP and RD/GDP, the second one is FDI/GDP and human capital

Source: draw by the author

FDI/GDP and RD/GDP show weak negative correlation in Shanghai, FDI/GDP and human capital show weak negative correlation in Shanghai.

Figure 23 The correlation diagram of FDI/GDP, RD/GDP and human capital, Jiangsu

The first diagram is FDI/GDP and RD/GDP, the second one is FDI/GDP and human capital

Source: draw by the author

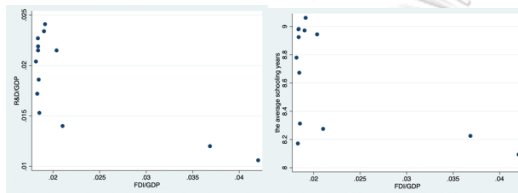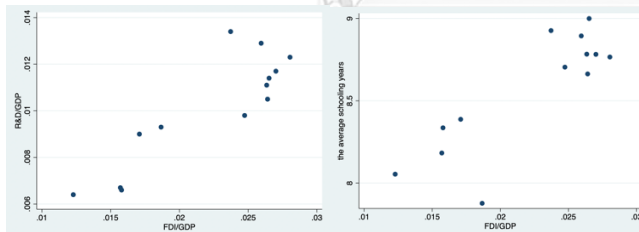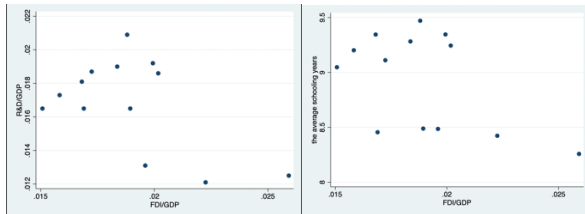FDI/GDP and RD/GDP show negative correlation in Jiangsu, FDI/GDP and human capital show negative correlation in Jiangsu.

Figure 24 The correlation diagram of FDI/GDP, RD/GDP and human capital, Zhejiang

The first diagram is FDI/GDP and RD/GDP, the second one is FDI/GDP and human capital

Source: draw by the author

FDI/GDP and RD/GDP show negative correlation in Zhejiang, FDI/GDP and human capital show negative correlation in Zhejiang.

Figure 25 The correlation diagram of FDI/GDP, RD/GDP and human capital, Anhui

The first diagram is FDI/GDP and RD/GDP, the second one is FDI/GDP and human capital

Source: draw by the author

FDI/GDP and RD/GDP show positive correlation in Anhui, FDI/GDP and human capital show positive correlation in Anhui.

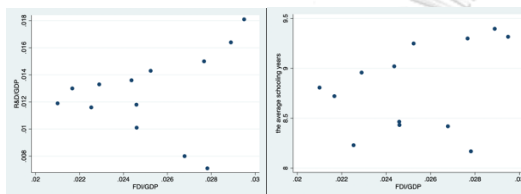*Figure 26 The correlation diagram of FDI/GDP, RD/GDP and human capital, Fujian*

The first diagram is FDI/GDP and RD/GDP, the second one is FDI/GDP and human capital

Source: draw by the author

FDI/GDP and RD/GDP show negative correlation in Fujian, FDI/GDP and human capital show negative correlation in Fujian.

Figure 27 The correlation diagram of FDI/GDP, RD/GDP and human capital, Jiangxi
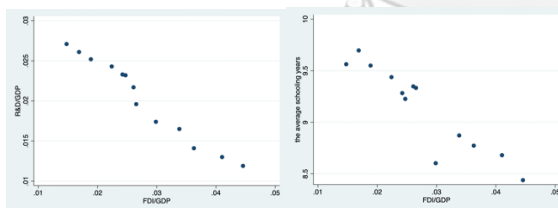

The first diagram is FDI/GDP and RD/GDP, the second one is FDI/GDP and human capital

Source: draw by the author

FDI/GDP and RD/GDP show no correlation in Jiangxi, FDI/GDP and human capital show weak negative correlation in Jiangxi.

Figure 28 The correlation diagram of FDI/GDP, RD/GDP and human capital, Shandong

The first diagram is FDI/GDP and RD/GDP, the second one is FDI/GDP and human capital

Source: draw by the author

FDI/GDP and RD/GDP show weak negative correlation in Shandong, FDI/GDP and human capital show weak negative correlation in Shandong.

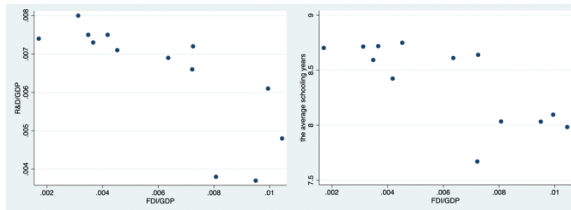*Figure 29 The correlation diagram of FDI/GDP, RD/GDP and human capital, Henan*

The first diagram is FDI/GDP and RD/GDP, the second one is FDI/GDP and human capital

Source: draw by the author

FDI/GDP and RD/GDP show positive correlation in Henan, FDI/GDP and human capital show positive correlation in Henan.
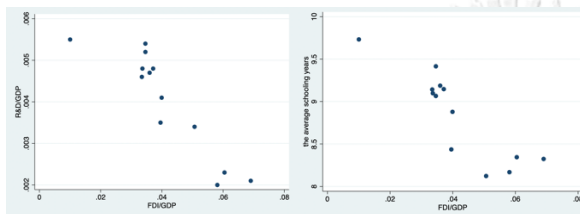
Figure 30 The correlation diagram of FDI/GDP, RD/GDP and human capital, Hubei

The first diagram is FDI/GDP and RD/GDP, the second one is FDI/GDP and human capital

Source: draw by the author

FDI/GDP and RD/GDP show weak negative correlation in Hubei, FDI/GDP and human capital show weak negative correlation in Hubei.

Figure 31 The correlation diagram of FDI/GDP, RD/GDP and human capital, Hunan

The first diagram is FDI/GDP and RD/GDP, the second one is FDI/GDP and human capital

Source: draw by the author

FDI/GDP and RD/GDP show no correlation in Hunan, FDI/GDP and human capital show no correlation in Hunan.

Figure 32 The correlation diagram of FDI/GDP, RD/GDP and human capital, Guangdong

The first diagram is FDI/GDP and RD/GDP, the second one is FDI/GDP and human capital

Source: draw by the author

FDI/GDP and RD/GDP show negative correlation in Guangdong, FDI/GDP and human capital show negative correlation in Guangdong.

Figure 33 The correlation diagram of FDI/GDP, RD/GDP and human capital, Guangxi

The first diagram is FDI/GDP and RD/GDP, the second one is FDI/GDP and human capital

Source: draw by the author

FDI/GDP and RD/GDP show weak negative correlation in Guangxi, FDI/GDP and human capital show weak negative correlation in Guangxi.
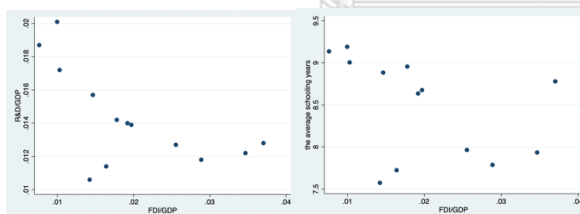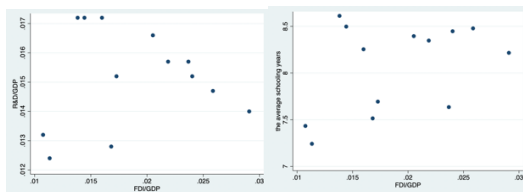
Figure 34 The correlation diagram of FDI/GDP, RD/GDP and human capital, Hainan

The first diagram is FDI/GDP and RD/GDP, the second one is FDI/GDP and human capital

Source: draw by the author

FDI/GDP and RD/GDP show negative correlation in Hainan, FDI/GDP and human capital show negative correlation in Hainan.

Figure 35 The correlation diagram of FDI/GDP, RD/GDP and human capital, Chongqing

The first diagram is FDI/GDP and RD/GDP, the second one is FDI/GDP and human capital

Source: draw by the author

FDI/GDP and RD/GDP show weak negative correlation in Chongqing, FDI/GDP and human capital show weak negative correlation in Chongqing.
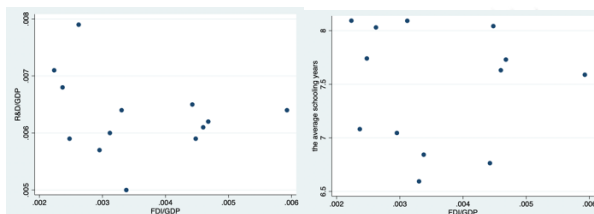
Figure 36 The correlation diagram of FDI/GDP, RD/GDP and human capital, Sichuan

The first diagram is FDI/GDP and RD/GDP, the second one is FDI/GDP and human capital

Source: draw by the author

FDI/GDP and RD/GDP show no correlation in Sichuan, FDI/GDP and human capital show weak positive correlation in Sichuan.
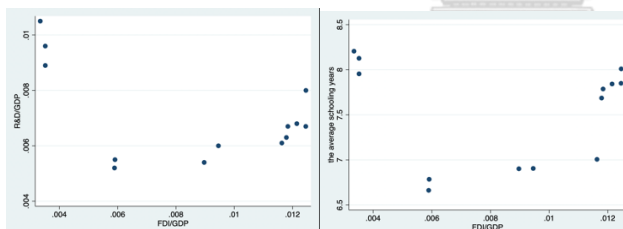
Figure 37 The correlation diagram of FDI/GDP, RD/GDP and human capital, Guizhou

The first diagram is FDI/GDP and RD/GDP, the second one is FDI/GDP and human capital

Source: draw by the author

FDI/GDP and RD/GDP show no correlation in Guizhou, FDI/GDP and human capital show no correlation in Guizhou.
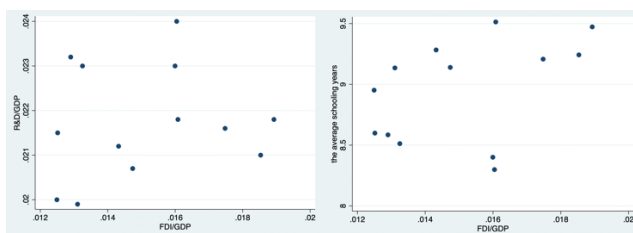
Figure 38 The correlation diagram of FDI/GDP, RD/GDP and human capital, Yunnan

The first diagram is FDI/GDP and RD/GDP, the second one is FDI/GDP and human capital

Source: draw by the author

FDI/GDP and RD/GDP show weak negative correlation in Yunnan, FDI/GDP and human capital show no correlation in Yunnan.
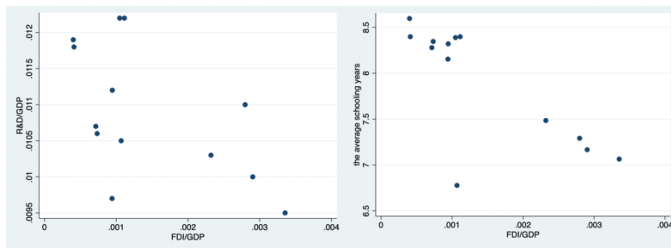
Figure 39 The correlation diagram of FDI/GDP, RD/GDP and human capital, Shan'xi

The first diagram is FDI/GDP and RD/GDP, the second one is FDI/GDP and human capital

Source: draw by the author

FDI/GDP and RD/GDP show no correlation in Shan'xi, FDI/GDP and human capital show weak positive correlation in Shan'xi.

Figure 40 The correlation diagram of FDI/GDP, RD/GDP and human capital, Gansu
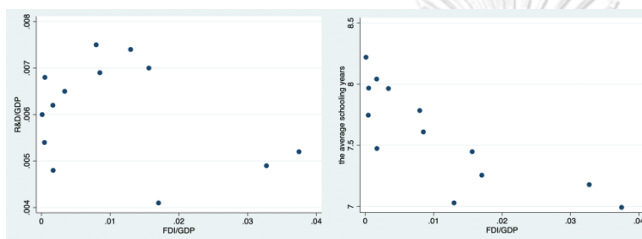

The first diagram is FDI/GDP and RD/GDP, the second one is FDI/GDP and human capital

Source: draw by the author

FDI/GDP and RD/GDP show weak negative correlation in Gansu, FDI/GDP and human capital show weak negative correlation in Gansu.

Figure 41 The correlation diagram of FDI/GDP, RD/GDP and human capital, Qinghai
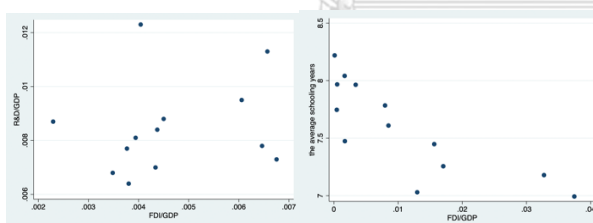

The first diagram is FDI/GDP and RD/GDP, the second one is FDI/GDP and human capital

Source: draw by the author

FDI/GDP and RD/GDP show no correlation in Qinghai, FDI/GDP and human capital show negative correlation in Qinghai.

Figure 42 The correlation diagram of FDI/GDP, RD/GDP and human capital, Ningxia

The first diagram is FDI/GDP and RD/GDP, the second one is FDI/GDP and human capital

Source: draw by the author

FDI/GDP and RD/GDP show no correlation in Ningxia, FDI/GDP and human capital show no correlation in Ningxia.

Figure 43 The correlation diagram of FDI/GDP, RD/GDP and human capital, Xinjiang
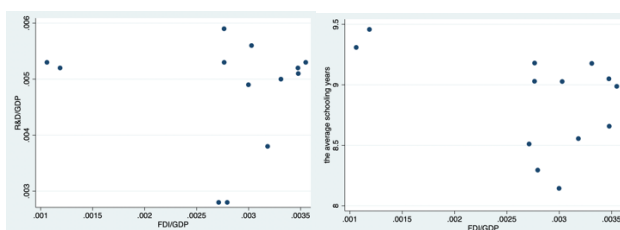

The first diagram is FDI/GDP and RD/GDP, the second one is FDI/GDP and human capital

Source: draw by the author

FDI/GDP and RD/GDP show no correlation in Xinjiang, FDI/GDP and human capital show weak negative correlation in Xinjiang.

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