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Patent Rights Protection, Multinational Companies Investment in China

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Master Thesis

April, 5th

Abstract

This paper evaluates the way that patents influence FDI in China. The theory suggests that a strong property right in terms of patents may benefit the inflows of FDI. An empirical study is conducted based on 31 provinces in China (not including Taiwan, Hong Kong and Macaw) during the period 1995-2007. The panel data method is chosen for the analysis in the study, with preliminary unit root test. The long run co-integration test and panel estimation show mixed results due to the different patent types. But overall, in China, the strengthening of IPRs in terms of increased absolute number of patents will surprisingly lead to less FDI.

Key Words: FDI, property rights, panel data, patent, China

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Abbreviations

FDI	Foreign Direct Investment
IPRs	Intellectual Property Rights
R&D	Research and Development
Utility	Patented Utilities
Design	Patented Designs
Invention	Patented Inventions
GDPPC	GDP Per Capita
TRIPs	Trade-Related Intellectual Properties
PRC	People's Republic of China
MNE	Multinational Enterprises

1. Introduction

Since the "open door" policy was adopted in 1978, China has undergone a tremendous inflow of foreign direct investment (hereafter referred to as FDI) in the past two decades. Especially in 2002, the absolute value of FDI inflow into China amounted to 53 billion dollars in total, an average of $144 million a day. China has surpassed the US as the world's second largest FDI recipient (after Luxembourg).

Even under the current financial crisis, with more than 1.3 billion population and a strong 10% growth rate, China is still attracting, and will attract, more foreign investment to look for opportunities in this booming market. However, the Chinese intellectual property rights (IPRs)-especially in terms of patenting-confuse or sometimes even crowd multinational companies out, due to the fact that many products in China, after their first appearances, will be easily imitated or copied. As a result, the massive productions of these pirated goods have damaged the multinational firm's branding and benefits. Consequently, in order to prevent the infringement, foreign firms tend to transfer old technologies, engage in less technical training, hide key aspects of know-how, without first-rated R&D facilities (Maskus, 2002).

Hence, actions should be taken immediately to solve this dilemma. Indeed, for the past few years, Chinese central government has made great progresses in establishing patenting legal system. Since 2000, Chinese patenting law has almost been modified in accordance with international standard; however, the effectiveness of the law enforcement is challenged in the face of counterfeiting or other infringing activities. As Maskus (2002) points out "China has implemented a very strong set of laws with IPRs, but there remain severe problems with enforcement". Therefore, the problem still exists in the patent protection, which is essential for FDI inflow. This paper is thus examining how the situation in domestic patenting protection influences inward foreign direct investment.

Thus, the objective of this paper is to investigate the impact of China's patenting on its ability to attract inward FDI. Foreign investment will be less likely to be present in a country that has less adequate patenting protection. On the grounds that foreign companies are

reluctant to venture given that local laws will not effectively deter or remedy a theft of their technology. It is commonly admitted that intellectual property rights is that stronger IPRs protection will give more motivations for FDI to invest in the local economy and make technological progress in the host countries (Arrow, 1962; Scherer, 1972). Therefore, it is expected that a positive relationship between FDI and the number of patents is observed. In addition to patenting protection, the PRC's success has been mainly because of manufacturing as a low-cost producer. This is attributed to a combination of cheap labor, good infrastructure, relatively high productivity, etc. Thus, the study also examines the above important economic determinants of FDI to work as control variables.

The paper begins by looking at the above objectives and then motivating it with an empirical study of a panel data analysis. This contributes to the current literatures in several ways. In the first place, this is an empirical research into the world's largest developing country − China. Global enterprises view China as one of the best choices for investment even though it does not have conducive environment for providing patenting protections; another perspective is that domestic markets are going through the transformation from heavy manufacturing industries into technological and environmental friendly productions; this renovation process will highly rely on foreign investment technology spillover. Hence, this study will hopefully shed some light on the importance of developing countries to build up a better business investment environment in terms of patenting protection. Secondly, instead of using cross-sectional data from a single year or pure time series, this study uses a panel data for 31 provinces in China with a year from 1995 to 2007. Also, a relatively large amount of sample observations will results in more powerful explanations in the discussion, seeing that the larger the sample size, the more confident we are of the estimates. Furthermore, in order to reveal more about the true heterogeneity in China, the whole country is divided into three regions - East, West and Middle. The segment allows for the examination of different levels of development stratified by geographic area. Fourthly, this paper also scrutinizes the three different patenting system protections which are invention, designs and utility. Unfortunately, the unit root tests and co-integration tests, in the interest of consistent estimations, abandon the invention and utility patenting variables, yet these variables are still under discussion in

this paper as indispensable backgrounds into patenting systems in China. Further research in the area is thus expected with a focus on examining the Chinese patenting structures.

The main finding from this study suggests that overall, the strengthening of IPRs in terms of increased absolute number of patents in China, will surprisingly lead to less FDI. This contradicts most of the theoretical economic literature. However, when looking at the regional levels of different economic and social development, it depends and varies a lot according to their acquired economic background. The regional econometric results show that the more developed area – Eastern China, is congruent with the assumption that more patents augment FDI inflow. While for the least developed areas, such as the West and Middle areas, suggest that patents response negatively to FDI. Thus, this study provides some empirical evidence to explain the impact of patenting protection on FDI inflow under the different regional levels of China.

The structure of the paper is organized as follows. Section 2 is a background of Chinese patenting protection including both patenting laws development and lack of property rights issues in China. Section 3 presents the relevant literature review, and section 4 builds up the theoretical background. It also briefly explains the reason to pick up patent as a proxy to capture the property rights. Section 5 is a description of the data, and section 6 presents the model, as well as the unit root and co integration test results. The last two sections contain a discussion of results and concluding remarks of the paper.

2. Background of the Patenting Protection in China

2.1 Chinese Patenting Law

For the past few years, Chinese central government has made great progresses in establishing patenting legal system. Table 1 presents an overview of chronological major events in the development of China's patent system.

Table 1 – Chronological overview of major event in china IPRs Development

Year	Event
1984	The Patent Law has been for the first time established as a legal protection for intellectual property rights, but with few provisions to the protection of pharmaceutical and chemical inventions.
1992	First Amendment to the Patent law, to expand the protection areas and extend the duration of patenting protection, including pharmaceutical and chemical inventions.
2000	The second Amendment of Patent Law, to take a further and significant step in support of the government's national strategy of rejuvenating country through science and education. China has ratified the agreement on Trade Related of Intellectual Property Rights (TRIPS).
2003	The number used in patent records has changed to 12 digits instead of 8, indicating that the patent number has improved a lot for the past years.
2004	The total number of patents' applicants has a breakthrough of 2 million.
2004	The online patent application system has been utilized as an improvement to offer a more convenient and modern service.

The first patenting law in China was established in 1984 and its main purpose according to Article one of the General provision of the Patent law, is" to protect patent rights for inventions-creations, to encourage invention-creation, to foster the spreading and application of inventions-creations, and to promote the development and innovation of science and technology, for meeting the needs of the construction of socialist modernization". Since its enactment, the patent law has experienced two revisions. In 1992, the effective

length of invention patents was prolonged from 15 to 20 years, and also the utility patents and design patents were extended to 10 instead of 5 years. The second amendment in 2000 was to meet the requirements of the WTO's Agreement on Trade-Related Intellectual Properties (TRIPs). Therefore, the patent law of China in line with the international standards, and is fairly similar to that of the United States.

2.2 Lack of Property Rights Enforcement in China

The stipulations of the patent law have almost been adjusted to the international norms since 2000. However, in China, the rule of law has been much more dominant than rules by law. Fang (2010) outlines three explications concerning the lack of property rights situation in China. Firstly, dated back to traditional China, the whole society treated intellectual property as a public benefit for everyone and should be shared for free. The old history had barely any records about the property rights protection for inventions and innovations. The awareness of intellectual rights' protection has not been embedded in people's mind. Up to now, some local companies still do not realize that their behavior of infringement could somehow violate other people's property rights. Secondly, the short period of property rights development will bring problems such as deficient in talents to handle property rights' suits. Thirdly, and most important, local governments do not have adequate motivations to enforce property rights thoroughly. In the absence of strengthening jurisdiction, local enterprises can steal technology from FDI to make profits easily. In contrast, the harsh punishment on such infringing behaviors will cause them to go bankrupt or at least lose lots of revenue. As we know, their business failures will negatively influence local governments' tax income and economic performances. Therefore, problems exist in the government administration and law enforcement on the local level. More precisely, Maskus (2002) lists several problems involving weak monetary and civil penalties, delaying in administrative and court procedure, as well as "local protectionism" taking place in regional jurisdictions. Given that decentralized regime was adopted, central government gives wider power to local governments in deciding what to do in their own territories. No matter how convincing the

central government laws and policies are, there are still inconsistencies between rules established by central government and enforcement executed by local governments.

Taking into account the previous discussions, the influences of patenting protection on FDI inflow are expected to diversify between the regions, and it is worth putting emphasis on the local level. As for the relevant policy recommendations, they will be different across the regions depending on their own characteristics.

3. Literature Review

3.1 Supporters of IPRs

A major argument in favor of strengthening IPRs (Intellectual Property Rights) is that they can encourage innovation and technology development. A conventional point of view holds that stronger intellectual property rights protection will give more motivations for FDI to invest in the local economy and make technological progress in the host countries (Arrow, 1962; Scherer, 1972). Maskus (2002) argues that in the absence of IPRs, rights holders cannot prevent infringement. What is more, if IPRs are not structured correctly and introduced in a good competition environment, the growth of economy will be diminished by limiting imitation and technology diffusion. Mansfield (1994) conducts a survey from 100 US firms, and finds that the strengths or weaknesses of a country's system of intellectual property protection have a substantial effect on FDI inflow into high technological investment. The survey indicates that officials of the firms are especially interested in whether there is adequate infrastructure in the host country, whether relevant government agencies provide effective law enforcement, as well as prompt and equitable treatment to foreign firms. However, bulk of the firms in many low-technology industries regard intellectual property rights protection as being relatively unimportant in the investment decisions. It all depends on the industries and sectors.

Furthermore, there are some empirical evidences about the relationship between patents and FDI. Rai (200) takes the Indian pharmaceutical industry as an example to show that strong patent protection together with India's inherent strengths-low cost manufacturing, strong re-engineering skills, and talented human resources at a low cost, make it a lucrative destination for FDI. Seyoum (2006) uses data from 70 countries and suggesting that the patent protection matrix and FDI matrix have a correlation of 0.443 (1990) and 0.491(1995) at $p<0.01$, suggesting a positive relationship between the dependent variables. Cheung and Lin (2004) uses provincial data from 1995 to 2000 to demonstrate that FDI has a positive effect

on the number of domestic patent applications in China. Since China has experienced notable changes in its IPRs systems in the past decade, Titus and Hong (2009) examine the contribution of IPRs' protection to the recent surge in China's inward flow of FDI. They use a panel data for 38 diverse countries from 1992 to 2005, and the results imply that IPR protection in China has a positive and significant effect in attracting FDI. Smauel (2010) also argues that if developing countries establish strong IPRs regimes aiming at improving the investment climate, human resources capacity, communications infrastructure, there will be higher possibility of economic growth induced by increasing of FDI. The seemingly unrelated regressions show that IPRs variable is significant and positively correlated with FDI.

3.2 Disagreements with strengthening property rights

This opinion argues that tighter intellectual property rights will encourage the monopoly power of large companies from developed countries, and negatively influence competition from small national companies from developing countries. Helpman (1993) develops a number of dynamic general equilibrium models to show that tighter IPRs bring about a reallocation of manufacturing towards higher priced developed products, which damage the benefits of the developing countries. Maskus (2002) is also concern that stronger IPRs create market power for monopolies in China under the weak immature competition market. Though the economic reforms have improved competition level, the economy "still remains far from a situation of free entry and vibrant competition in technology and product markets."

The empirical evidence in support of this opinion is very limited. For instance, in the paper by Etienne and Deffains (2005), the authors study the location choices of French firms in 17 developing countries and conclude that on average, patent rights exert only a negligible influence on the location choices of French firms. However, if the host countries are sufficiently large or if the expenditures on R&D are sufficiently small, patents would decrease the probability of location.

The way in which researchers have discussed this issue could be a very good reference point, but the related study, especially on Chinese regional level, is missing in the literature.

One of the reasons could be that China has a universal patenting law across the country, so there is not so much to do to distinguish between the regions in the analysis. However, once looking at this huge market, one can notice that China is diversified across the regions due to the decentralization reform. In other words, different regions have different levels of property rights protection in terms of law enforcement, policy and administration. Doing research with a focus on China can contribute to a better understanding of FDI development, with respect to the patenting protection and technological development level. Therefore, this paper attempts to fill this gap by investigating the patenting issue and FDI based on regional level of China.

4. Theoretical Background

Intellectual property rights define the extent to which the owners of the technology or innovation protect themselves legally from others infringing or damaging' behaviors. For instance, if asymmetric information exists in the transactions, the buyers of know-how do not know the detailed characteristics, but the seller would not provide all the important information the buyer needs since they are afraid of revealing the insider details and buyers will "invent around". Intellectual property rights are working as a good method for protecting the seller's rights and ensuring the seller discloses the know-how to the buyer.

As defined in Casson (2009), knowledge internalization is the internalization of the flow of the knowledge which arises from R&D. Because of the market imperfections, buyers of the knowledge are afraid of buying the technology that is not worth the price. However, sellers could have been provided more detailed knowledge of the technology, but there is a risk of sharing the knowledge with the buyers before any further contract is written. Under these circumstances, the establishment of patenting system would solve the problem.

Intellectual property rights, especially patenting system, have been the driving factors for technological progress and protection. They enhance a firm's capacity and motivation for the innovation development. In the eclectic theory, it corresponds to the so-called "ownership advantage". Dunning (1988, 2002, 2008) explains that the ownership advantages are the intangible advantages including superior technology, trademark, trade secrets, patent, reputation, and innovation capacity that other firms do not have. These scale economies, other technological advantages, or management skills will keep the firms from compensating for the fixed cost of investing abroad.

In addition, "the product life cycle" by Vernon, also emphases on the relationships between innovative activities and FDI. Since it is too costly to coordinate the innovative activities by foreign companies due to the difficulties of collecting information across the borders, they will expand their R&D into the local markets with proper protection of their technology. Hence, patenting can ensure their exclusive use of the technology. As the

publishment of patent claims is also known to the competitors, they can also use the disclosed information to develop further innovations.

Seyoum (2006) states that in the absence of patent protection, (a) there is a risk of easy appropriation of information, which may decrease the prospect of a sufficiently lucrative return on investment for the potential inventor, and (b) when new knowledge is used in production, it will often be possible to reproduce the know-how than it original discovery, thus will make the inventor lack of incentives for more innovations . Besides, according to Granstrand (2009), a good innovation system with the certainty of contract, better monitoring and enforcement of IPRs, often results in positive feedback to the firms. Due to the fact that firms may have some constraint problems in their home countries, they engage in foreign operations in the new locations, while interacting with the home country, firms gradually become embedded in the host environment. A good innovation system, which can be explained to some extent by the patenting system, will result in a positive systemic lock in between the firms and patenting infrastructure.

In China, it is hard to capture property rights situation. The government will not disclose bad information on their own first of all. However, there is a relevant ranking about property rights called “International Property Rights Index” (See Appendix 2). It is obviously from the international level. But regarding on the regional level, there is lack of relevant study and ranking. The only source that related to my research was found in Fan, G., Wang, X., and Zhu, H.(2008). They are doing a survey based on the enterprises of their perceptions of the local governmental industrial organization (see further research section and appendix 3). The survey starts at 2005 and the data is available from 2005 to 2007. In consideration of the fact that a long time series analysis has more effective estimation, therefore, we cannot use it as a proxy to represent the situation with more lengths of time. Given the inconvenience of the data collection and as well as the patent is indispensable part of property rights, therefore the number of patents is chosen as an alternative for property rights. We have to realize that there might be a measurement error about this treatment. Thus, the results might be biased as well. Therefore, the interpretation of the conclusion in terms of the empirical results should be made with more care.

More precisely about patent notation, it is generally defined that one has a set of exclusive rights granted by a state (national government) to an inventor or his/her assignee for a limited period of time in exchange for a public disclosure of an invention. Therefore, to evaluate the number of patents also captures innovation systems, technological development , and as well as the property rights protection.

Thus, the paper investigates FDI location decisions based on regional level of patents to represent both innovation system and IPR protection.

5. Descriptive analysis and Data

5.1 Patent in China

It is predicted that in 2011 China will bypass the US in terms of the number of patent application filed. However, this is against traditional view of "made in China," which has more imitations and lack of innovations. Of course, this upwards sloping trend has something to do with the recent surge in government support for technology and innovation. From further research into the data on patents, one can notice that most of the patents have relatively low quality, and belong to the design and utility patenting categories(see below for the concepts of the categories in patents).

As stated in the Chinese Statistical Yearbook, "patent is an abbreviation for the patent right and refers to the exclusive right of ownership by the inventors or designers for the creation or inventions, given from the patent offices after due process of assessment and approval in accordance with the Patent Law". Patents are granted for inventions, utility models, and designs. Thus, three datasets are available to analyze patents in China. The differences between the data sets are explained in the statistical yearbook as follows. Patented inventions refer to "new technical proposals to the products or methods or their modifications". This indicator reflects the technologies with independent intellectual property. Patented Utility Models refer to "the practical and new technical proposals on the shape and structure of the product or the combination of both". This indicator reflects the condition of technological results with certain technical content. Designs refer to the "aesthetics and industrially applicable new designs for the shape, pattern, and color of the product, or their combinations". This implies the appearance of design achievements with independent intellectual property. According to the Patent law of the People's Republic of China, Chapter 5, Article 42, "the duration of patent rights for inventions shall be twenty years, the duration of patent right for utility models and patent right for designs shall be ten years, counted from the date of filing". Besides, Article 9 says that "where two or more applicants file applications

for patent for the identical invention-creation, the patent right shall be granted to be the applicant whose application was filed first".

As it can be seen from Figure 1, the number of patents granted by the government is increasing every year with an exponential shape. Among different types of patents, the utility and designs patents contribute a lot to the increasing number of total granted patents. In contrast, the number of invention patents does not change much during the period from 1995 to 2002, while it starts to increase after 2002, rising from 5187 pieces in 2002 to 28181 pieces in 2007. As aforementioned, invention patents are the ones that have most value-added for innovation and technology.

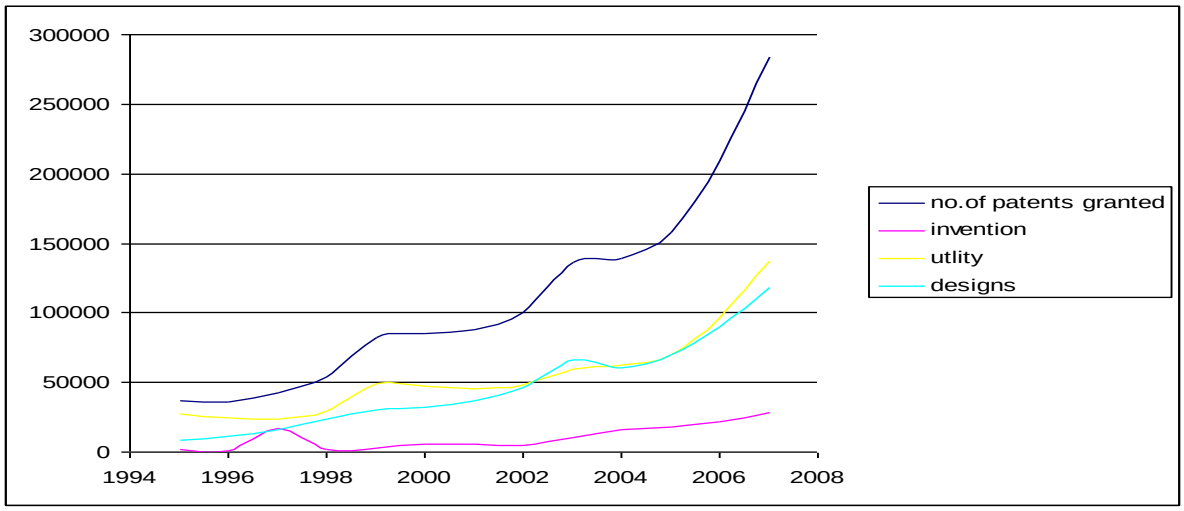

Figure 1 – Number of patents granted in China during 1995-2007 by the patent type (invention, utility, and designs)

5.2 FDI in China

FDI in China has great disparities across China. For example, in 2007 eastern parts of China (such as Shanghai and Guangdong Province) occupy almost half of the total FDI, while for the western part, there is just a small share of the whole FDI (see Figure 2).

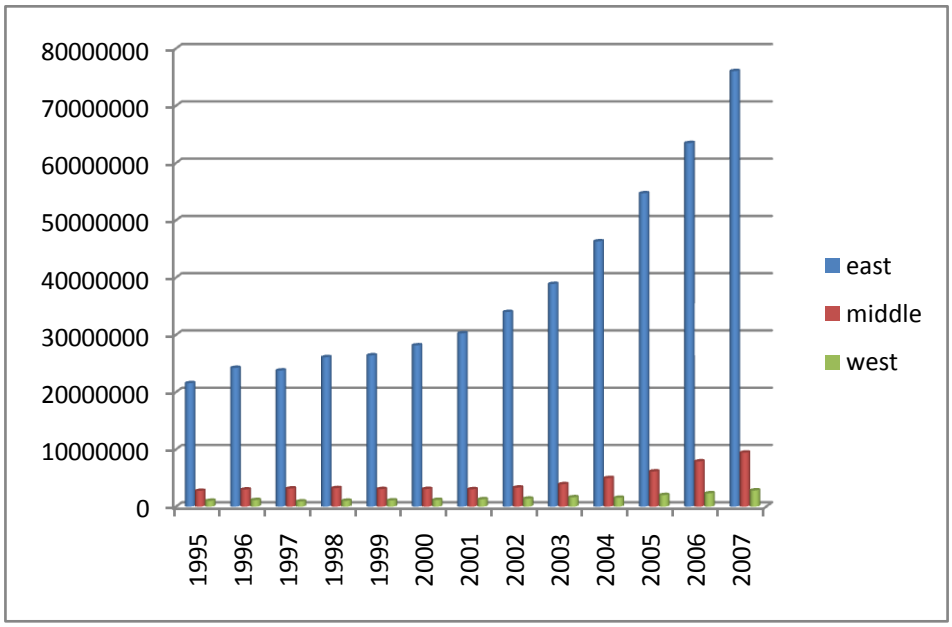

Figure 2 – Distribution of the FDI in China by regions during 1995-2007, thousand dollars

Source: *Chinese Statistical Yearbook from 1996 to 2008*

As can be seen from the Figure 2, the allocation of FDI across the provinces has been uneven with 89 percent of FDI in China going to the east part of China. In contrast, Middle and West occupy only very small proportion of it.

Overall, FDI mainly goes to eastern region. It increases every year as well. Compared to it, the middle part and west part of China rarely have FDI inflow.

6. Empirical Analysis

6.1 Model

The main empirical specification takes the form:

$$\log(FDI)_{it} = \beta_0 + \beta_1 \log(patent)_{it} + \beta_2 \log(design)_{it} + \beta_3 \log(utility)_{it} + \beta_4 \log(invention)_{it} + \beta_5 \log(infrastructure)_{it} + \beta_6 \log(trade)_{it} + \beta_7 \log(education)_{it} + \beta_8 \log(wage)_{it} + \beta_9 \log(gdppc)_{it} + \beta_{10} \log(poplation)_{it} + \varepsilon_{it}$$

where *i* and *t* denote province and time respectively. FDI is the regressand. Besides, the independent variables of interest are the total number of the patents, design patents, utility patents, and invention patents. In addition to, the control variables comprise infrastructure, trade, education, wage, GDP per capita and population.

A short description of the variables in the model is presented below:

- *FDI*: The actual FDI registered from foreign funded enterprise is being used as the regressand in the model;
- *PATENT*: relevant variables: patent includes the total number of the patents, the amount of utility patents, design patents and invention patents;
- *INFRASTRUCTURE*: FDI often picks up the investment location that has good infrastructure such as bridges, ports, highways, etc. For convenience of the data collection and along with in view of infrastructural situation of China, which is highly relying on transport of railways. The distance of railways is chosen to evaluate each province's infrastructure;
- *TRADE*: The total imports and exports from yearly basis. Open society with more trade will offer multinational enterprises more opportunities to the local market;
- *EDUCATION*: Education level is a proxy for labor force level. The human capital determines the competency of the companies and an easy way to assess talents is to evaluate their educational background. Higher education means higher management and good skills in most of the cases. In China, there is a compulsory policy of ensuring nine years education for all people and furthermore a practical demand for high-level educated people is considered so

important for foreign investment. Hence, to make the estimation the amount of higher education-college graduates every year is added as an index for education;

- *WAGE*: China is reputed as a manufacturing country. "Made in China" has a comparative advantage in terms of low labor cost. But one has to keep in mind that the wage is different from GDP per capita. Wage is more related to labor cost in China than GDP.
- *GDPPC*: In order to capture the degree of regional economy development, GDP per capita is used here;
- *POPULATION*: FDI is aiming at a big market that offers great demand from the consumers as a motivation for the suppliers.

In order to test how the patents influence FDI, four panel regressions are performed respectively: the whole China dataset, western part, eastern part and middle part, respectively. As the datasets are quite large and have an unstable trend, the logged values of the variables are computed to avoid fluctuation problems. The application of logarithm transformation makes the variables more stable with less standard deviation, so it becomes easier to make relevant estimations.

Conventional regressions without testing for the data stationary often suffer from unacceptably low power of consistent estimates. As the time series covers more than ten years, there is a concern about the reliability of the results (if the variables are non-stationary). I intend to address this issue by making available co-integration test to reduce the possibility of spurious regression. Thus, panel co-integration techniques are performed to allow us to selectively pool information about long-run relationships.

6.2 Testing for a Unit Root and Cointegration

If simply regress FDI on the set of variable vectors, we risk incorrect inferences due to a spurious regression. This treatment of estimation can result in a rather high R square, significant parameters estimation, and very small Durbin-Waston statistics, notwithstanding the actual variables are unrelated with each other. To avoid this so-called spurious regression, it is essential to first identify the order of integration of each variable. For instance, if all the

variables are integrated of order one, then they might have the equilibrium relationships in the long run. The estimation procedures are arranged in the following ways:

1. Remove cross-section dependence.

In order to get orthogonal procedure, it is necessary to remove the cross section dependence. The procedure is to first calculate the mean of the variables and then subtracted it from each respective value. As an example, FDI hat is calculated as follows:

$$\widehat{FDI}_{it} = FDI_{it} - \overline{FDI_t}$$

The same process is repeated for all the other variables defined in the equations for both models. (Please note that hereafter all the variables are excluding the cross section dependences. For convenience, the hat is omitted from the writing).

2. Unit root test.

Eviews provides several ways of testing stationary called unit root tests in general. When it comes to panel data, these would include Levin, Lin & Chu with common unit root process, while regarding on the individual unit root process, there are Im, Pesaran and Shin W-stat, with ADF-Fisher Chi-square, PP-Fisher Chi-square as the references. Furthermore, there are several selections when it comes to unit roots. Those contain unit root tests with intercept and trend, with either of them or neither is included. For simplicity, the condition with individual intercept is being reported in the Table 2. According to the rejection area of probability distribution, if the reported p-value is smaller than a certain amount, at least 10 percent in my study, then we reject the null hypothesis of unit root assumption. Otherwise, they are stationary in their level. For instance, take panel log (*FDI*) as an example. In view of the levels statistic, they cannot reject the unit root possibility, however, moving to the next step of 1st differences, the series have more than two significant rejection statistics. Thus, we make the conclusion that we cannot reject that log (*FDI*) has a unit root. In another word, log(*FDI*) has one order of integration which denotes as *I(1).*

Table 2 – Results from panel unit root tests

Variable	Test	# of lags	Statistic			The order of integration
			Levels	1st differences	2nd differences	
log(FDI)	*Levin, Lin & Chu*	1	0.38480	-11.9290***	-	
	Im, Pesaran & Shin	1	69.2787	154.372**	-	I(1)
	ADF-Fisher	1	56.8316	219.888	-	
log(edu)	*Levin, Lin & Chu*	1	-1.27034	-10.8889***	-	
	Im, Pesaran & Shin	1	45.3627	164.563***	-	I(1)
	ADF-Fisher	1	42.5223	269.444***	-	
log(Infr)	*Levin, Lin & Chu*	1	-0.61623	-7.74329***	-	
	Im, Pesaran & Shin	1	46.9489	131.065***	-	I(1)
	ADF-Fisher	1	107.493*	-	-	
log(trade)	*Levin, Lin & Chu*	1	7.40122	-8.49400***	-	
	Im, Pesaran & Shin	1	30.4868	137.178***	-	I(1)
	ADF-Fisher	1	31.1621	292.587	-	
log(patent)	*Levin, Lin & Chu*	1	1.91009	-8.84492***	-	
	Im, Pesaran & Shin	1	53.0872	171.712***	-	I(1)
	ADF-Fisher	1	33.9227	202.179***	-	
log(wage)	*Levin, Lin & Chu*	1	11.2559	-40.8355***	-	
	Im, Pesaran & Shin	1	20.7525	143.486***	-	I(1)
	ADF-Fisher	1	19.4443	183.120***	-	
log(popu)	*Levin, Lin & Chu*	1	11.2559	-40.8355***	-	
	Im, Pesaran & Shin	1	20.7525	143.486***	-	I(1)
	ADF-Fisher	1	19.4443	183.120***	-	
log(invent)	*Levin, Lin & Chu*	1	-2.05516	-	-	
	Im, Pesaran & Shin	1	97.9243	-	-	I(0)
	ADF-Fisher	1	106.126	-	-	
log(utility)	*Levin, Lin & Chu*	1	2.43686	-10.4541***	-	
	Im, Pesaran & Shin	1	45.9365	199.822***	-	I(0)
	ADF-Fisher	1	34.5579	246.271***	-	
log(design)	*Levin, Lin & Chu*	1	0.38480	-	-	
	Im, Pesaran & Shin	1	69.2787	-	-	I(1)
	ADF-Fisher	1	56.8316	-	-	
log(gdppc)	*Levin, Lin & Chu*	1	16.4473	-9.58578***	-	
	Im, Pesaran & Shin	1	25.7868	71.2382	-	I(1)
	ADF-Fisher	1	11.7571	153.269***	-	

H_0: Unit root

***denotes rejection of the null hypothesis at the 1% significance level, **5%

significance level, *10% significance level.

Table 2 suggests that except for that utility patents and invention patents which are stationary, all the other variables are integrated of order one, they can continue to tested for cointegration relationship between them. The imperfect quality of the data forces me to discontinue the two important variables-utility patents and invention patents, but all the other variables can still be evaluated under co integrating test.

2. Testing for cointegration.

Kao(1999) derives the asymptotic distributions of the least-squares dummy variables estimator. Furthermore, he conducts Monte Carlo experiments to evaluate finite sample properties of the tests, concluding that his method is substantially robust and the results have better size and power properties. Thus, the choice of Kao residual tests is employed for the cointegration tests.

Table 3 – Cointegration tests results

	Total		East		Middle		West	
Within Dimension	Statistics	Prob	Statistics	Prob	Statistics	Prob	Statistics	Prob
Panel ADF-Statistic	4.666***	0.0000	-3.865***	0.0001	-1.563*	0.0589	-2.808***	0.0025
Between Dimension	Statistics	Prob	Statistics	Prob	Statistics	Prob	Statistics	Prob
Group ADF-Statistic	-3.441***	0.0003	-4.065***	0.0000	-1.214987	0.1122	-2.715**	0.0033

***Significant at the 1%level; **at the 5% level; *at the 10% level.

.

Thus, all the variables are almost cointegrated with each other in all the categories of the regions, and we can continue with the further panel analysis. Then the model is modified as the following equation:

$$\log(FDI)_{it} = \beta_0 + \beta_1 \log(patent)_{it} + \beta_2 \log(design)_{it} + \beta_3 \log(infrastructure)_{it} + \beta_4 \log(trade)_{it} + \beta_5 \log(education)_{it} + \beta_6 \log(wage)_{it} + \beta_7 \log(gdppc)_{it} + \beta_8 \log(poplation)_{it} + \varepsilon_{it}$$

7. Empirical Results

The estimation results are presented in Table 4.

Table 4 – Effects of patents on FDI inflows in 1995-2007 (Panel Least Squares Estimation)

Region		**1995-2007**	
Whole China(31 provinces)			
	Independent Variables	**Coefficients**	**t-value**
	PATENT	-0.358651	-1.093293
	DESIGNS	0.086162	0.603978
	INFRAS	0.136947	1.048020
	TRADE	0.576520**	2.028007
	EDUCATION	0.271723	0.775978
	WAGE	0.429376	0.219195
	GDPPC	-0.005514	-0.020185
	POPULATION	0.057300	0.018562
	Constant	4.09E-15	1.97E-13
East Region(12 provinces)			
	Independent Variables	**Coefficients**	**t-value**
	PATENT	0.599337	0.536771
	DESIGNS	0.139716	0.176130
	INFRAS	-0.107539	-0.316699
	TRADE	0.332979	0.801269
	EDUCATION	-0.034721	-0.083473
	WAGE	-1.002038	-0.492389
	GDPPC	2.619076	1.403585
	POPULATION	-5.135322	-1.467578
	Constant	-0.021388	-0.055282
Middle Region (9 provinces)			
	Independent Variables	**Coefficients**	**t-value**
	PATENT	-0.391887	-1.268417
	DESIGNS	0.174416	1.455997

	INFRAS	-0.55419**	-1.980891
	TRADE	-0.266284**	-1.773752
	EDUCATION	-0.088339	-1.085997
	WAGE	-0.113873	-0.668482
	GDPPC	1.133986***	4.446698
	POPULATION	4.081580	2.523250
	Constant	-0.544772	-1.700073
West Region(10 provinces)			
	Independent Variables	**Coefficients**	**t-value**
	PATENT	-1.073392*	-2.726388
	DESIGNS	0.105148	0.595170
	INFRAS	0.301571*	1.909258
	TRADE	0.451045	1.204531
	EDUCATION	1.543512	1.585577
	WAGE	0.111077	0.085228
	GDPPC	-0.064525	-0.221285
	POPULATION	-0.577612	-0.384263
	Constant	-0.408019	-1.107956

Notes: a. all variables are log of their actually values.

*indicates coefficients are rejected at 1% significant level; ** indicates coefficients are rejected at 5% significant level; *** coefficients are rejected at 10% significant level.

The control variables that cover education, population, wage, trade, and infrastructure are shown to be highly correlated with FDI, which makes them important determinants of FDI inflow. As the data is non-stationary, all the t-statistic and r squares, p-values are not taken into consideration.

However, patents, which capture both the property rights of the government and the innovation ability of the regions show quite mixed results. The total number of patents has significant relationship with FDI. A one percent increase in patents decreases FDI by 36% percent, which seems to go against my theory proposition. However, when considering the regional level, one can notice that for highly developed areas such as Eastern China, FDI responses positively to the patent applications while in the other two least developed regions

more patent applications leads to less FDI inflow. An especially explicit indicator is FDI in western areas: a one percent patent increase will lead to almost more than 100 percent FDI decrease.

Compared to the patent coefficient, the parameter for design patents with respect to FDI suggests that FDI responses positively to the number of design patents all over China. This is in accordance with the theoretical background. However, this also implicitly indicates that invention patents or utility patents negatively relate to FDI inflow. Recall on the technical cointegretion tests, which unfortunately drop out the data without integrating of order one, we cannot make clear statements about each individual effect. But as it is know to us, design patents are very easy to get, this cannot really indicate the innovation ability or the property rights protection issues' influences on FDI.

The main sustainable benefit of FDI lies in its ability to bring in technical know-how for a developing country, but in China as a whole does not really follow the property theory, especially for those least developed regions. This raises the question: Whether innovation is an important issue for the foreign companies, or may be that the property rights have to give way to the cheap labor and big markets in the poorly developed areas.

8. Conclusion and Policy Suggestions

China, a rising dragon – deriving from Chinese traditional culture as a symbol of power and prosperity, is attracting the worldwide attention. My research study is only a snap shot of the topic of foreign investment. Stronger patent protections, larger market size, low labor costs, better infrastructure, and education influence FDI inflow into developing countries.

The less developed regions in China indicate that more patents are surprisingly crowding out FDI according to the data analysis. However, this can be explained as well that western and middle region do not have that much FDI compared to the eastern regions, in another word, the FDI data statistics from the two developing regions do not have enough information such as trends or fluctuations to make the estimations. Therefore, there is a risk of misleading the results for these two small data pools. However, eastern costal regions, which are so much relying on FDI, respond significantly positively to FDI inflow. This implies that in order to attract FDI, IPRs reform must be accompanied by relevant improvements in education, infrastructure, and good business investment environment.

Another explanation of the seemingly unreasonable relationship between FDI and patenting protections is that China is still a manufacturing country. The title of China as a leading manufacturing economy would not require as many patents for production as they do for their consumption market. Thus, foreign investment is paying small attention to the number of patents - rather, they are aiming at lowering production costs than innovating in the host market. However, since China is in urgent need of transformation into a more technologically oriented and higher added-value production, the technology spillover from FDI will fill in the gap. In order to absorb the benefits of FDI to utilize advanced technology, China should therefore have more investment in education and training to lead to better human resources. In the long run, with the transfer of R&D to China and large potential for high consumption in the local market, the demand for better protection in terms of patents will increase significantly. I am confident that there will be a better institution for property rights in order to attract more and more foreign direct investment.

Recall from the models, it is true that low wage cost and large economic scale and good infrastructure are still the most important determinants of FDI inflow. These factors are more of acquired economic conditions, in another word; those are hard to change in the short run for the western and middle part to catch up. But as to the local enforcement environment and efficiency of administration, these have more room to make improvement. However, the evolving system of changing presents both opportunities and challenges at the same time. The opportunities come from the innovation, more spillover effects from FDI and the whole technology development. While the challenges (Maskus, 2002) arise from moving resources out of infringing or counterfeiting activities with lower cost into legitimate with higher costs of imitating products and technologies, and absorbing the costs of administering a stronger system. Obviously, least developed regions are not ready for these higher costs changes. There are several other things to do at the same time with patenting protection improvement. As Maskus (2002) suggests for the whole China, local government can also use their own power to adopt enterprise localized reform, develop financial system and innovation system such as patenting system especially when it comes to law enforcement of property rights, expand educational opportunities, and sustain good competition on the regional markets.

For Further Research

There are three other extensive and interesting fieldwork studies of patent protection with FDI deriving from my paper. One is to concern about the different types of patents to see the innovation system in China. Another is to take into account the law enforcement environment in Chinese regional level. A third study is to discuss sector categories of property rights and their impacts on corresponding sector of FDI.

In spite of a universal law of patent protection in China, the enforcement differs a lot across the country. Since 1978, China has gone through the decentralized reform from centralized government which gave little autonomy for local governments. The decentralization gave local government more power financially and administratively. Consequently, local governments became a major controller of enterprises investment and supervisor. They are more into enlarge their resource possession, investment and spending in the short run. Local companies are their income resources. In order to raise more revenue,

they would protect them even though they are infringing other foreign companies' interest. In this context, local government definitely varies a lot in terms of law enforcement of property rights protection.

A survey (Fan, Wang, Zhu, 2008) has been done based on the enterprises about their satisfactions of the local Industrial Associations and lawyer's service. In China, Industrial Associations are more manipulated by the government and therefore they are more of governmental organizations. Thus, it is more or less an index proxy for the law enforcement of the regional market. Unfortunately, the data is only available from 2005 to 2007.

Appendix 3 shows us the differences across the regions with respect to laws enforcement. The subjective evaluation of local law environment indicates that East gains the best satisfaction from enterprises during 2005 to 2007. While the middle part of China is doing well in 2005, however, in 2006 and 2007 they have worse situation than the West. In terms of patenting protection issues, this also can indicate the trend of FDI into highly developed regions because of better enforcement environment.

Regarding on the sector study, a rough pie graph of the foreign direct investment flow within sector distributions was shown in the appendix 4. It indicates that sectoral pattern has been shifted from low-valued to high-valued sector from 2002 to 2007. The share of manufacturing has decreased significantly from 78% to 63%, while the proportion of investment in Real Estate and wholesale and retail trades has been increasing. The fact that less proportional FDI flows into manufacturing sector is consistent with China's current upgrading and modernization economy. This also indicates that the whole situation of property rights has improve in that high-added value sectors require more confidence and trust in host countries' property rights protection. However, FDI still spends at least 60 percent into low technology manufacturing sector with fewer requirements of property rights. As Mansfield (1994) mentions, bulk of the firms in many low-technology industries regard intellectual property rights protection as being relatively unimportant in the investment decisions. This can somehow explain that, the overall data generalized from country level, will not show strong positive relationship between FDI and patents.

The lack of data makes me fail to present these results to the readers despite the important role they are playing in my research. For instance, if we could have more data about the enforcement survey and integrate them in the regressions as control variables. The coefficient of patents may be changing in accordance with my theoretical part. Therefore, further explorations are welcome into these fields.

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Appendix:

Appendix 1: Patent applications by provinces

	2002				2007			
	All type	**Invention**	**Utility**	**Design**	**All type**	**invention**	**Utility**	**Design**
Eastern area								
Beijing	6345	1061	3721	1563	14954	4824	7364	2766
Tianjin	1827	102	1163	562	5584	1164	3063	1357
Hebei	3353	190	2018	1145	5358	462	3570	1326
Liaoning	4554	385	3260	906	9615	1220	7035	1360
Shanghai	6695	341	2805	3549	24481	3259	9718	11504
Jiangsu	7595	334	4304	2957	31770	2220	12944	16606
Zhejiang	10479	188	3860	6431	42069	2213	16108	23748
Fujian	4001	63	1306	2632	7761	336	3323	4102
Shandong	7293	322	4700	2271	22821	1435	15356	6030
Guangdong	22761	352	6395	16014	56451	3714	21636	31101
Guangxi	1054	46	675	333	1907	188	1219	500
Hainan	199	6	46	147	296	51	143	102
Subtotal	76156	3390	34253	38510	223067	21086	101479	100502
Central area								
Shaanxi	1524	146	1053	325	3451	755	2034	662
Inner Mongolia	679	53	428	198	1313	120	788	405
Jilin	1507	157	902	448	2855	454	1943	458
Heilongjiang	2083	138	1541	404	4303	668	3079	556
Anhui	1419	99	813	507	3413	317	2003	1093
Jiangxi	1044	63	525	456	2069	176	1316	577
Henan	2590	149	1869	572	6998	563	4517	1918
Hubei	2209	192	475	542	6616	886	4400	1330
Hunan	2347	158	1600	589	5687	735	3438	1514
Subtotal	15402	1155	9206	4041	36705	4674	23518	8513

West Region								
Chongqing	1761	51	743	967	4994	354	2500	2140
Sichuan	3403	231	1520	1652	9935	825	4023	5087
Guizhou	615	47	334	234	1727	233	1120	374
Yunnan	1128	83	522	523	2139	368	1017	754
Tibet	7	1	3	3	68	4	22	42
Shaanxi	1524	146	1053	325	3451	755	2034	662
Gansu	397	71	251	75	1025	180	656	189
Qinghai	85	14	48	23	222	28	84	110
Ningxia	126	22	114	80	296	32	200	64
Xinjiang	627	61	407	159	1534	90	1035	409
subtatoal	9673	727	4995	4041	25391	2869	12691	9831

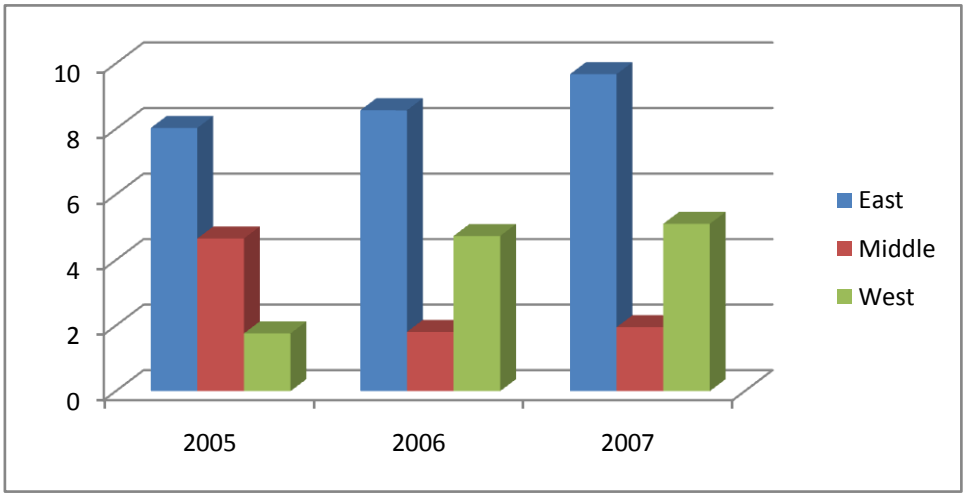
Source: *Chinese Statistic Yearbook from 1998 to 2008.*

Appendix 2: 2011 IPRs Statistics

Category	Score	World Rank
Intellectual Property Rights	5.2	53 of 129
Protection of Intellectual Property Rights	5.7	46 of 129
Patent Protection	8.2	34 of 129
Copyright Piracy	1.6	93 of 129

Source: *http://internationalpropertyrightsindex.org/china-c26*

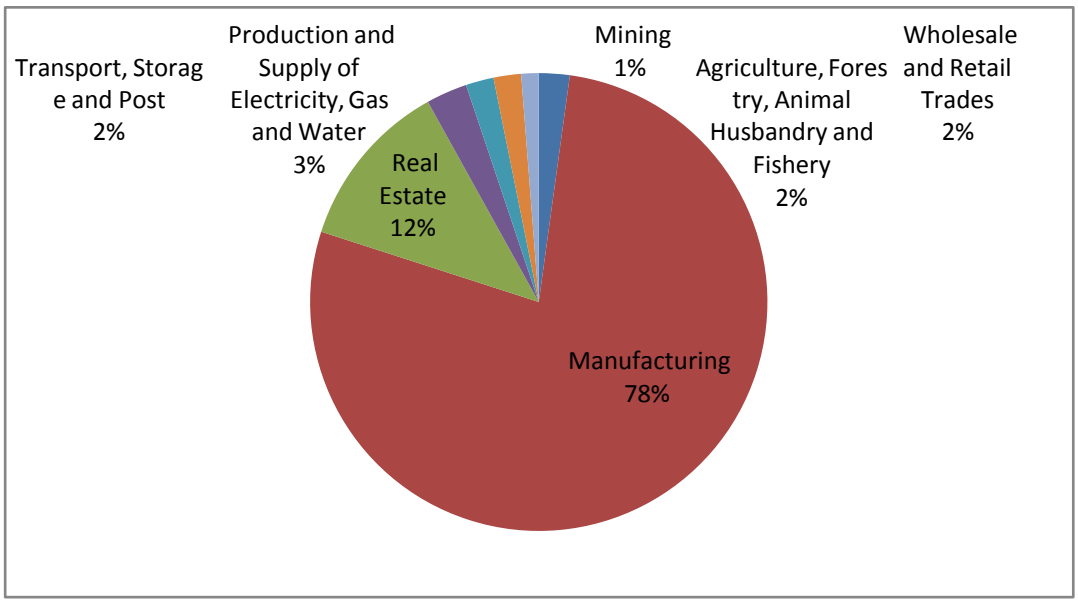
Appendix 3: The mean of the index from 2005 to 2007



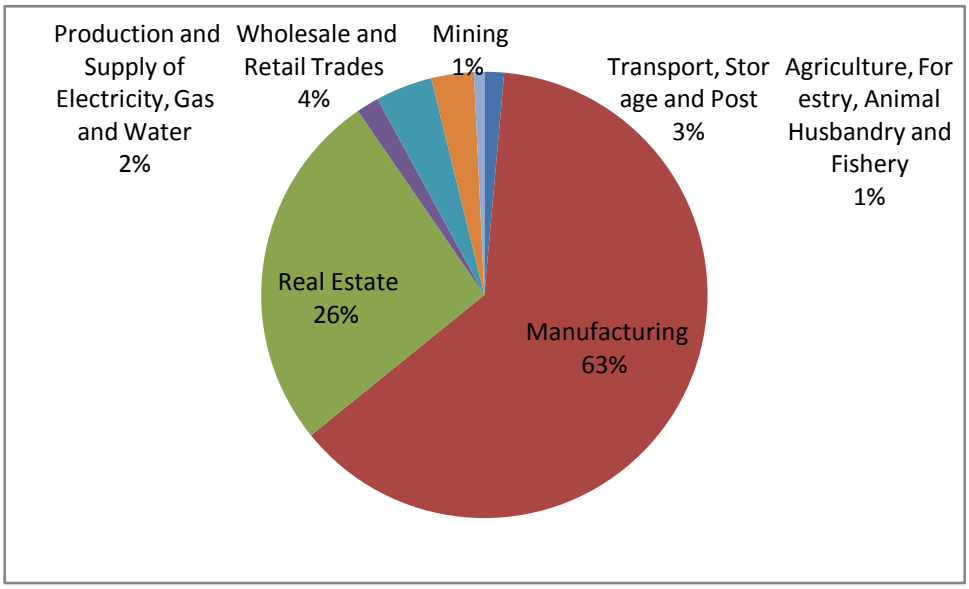
Source: *National Economic Research Institute Index of Marketization of China's Provinces 2008 Report,*

Appendix 4: China's sectoral FDI

China's FDI by sector in 2002



China's FDI by sector in 2007



Source*: Chinese Statistical Yearbook*