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Role of Intellectual Property Rights on Economic Growth in China

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Abstract: Nowadays, Chinese government tries to gain more sustainable and high speed growth on the economic performance with more innovation brought by improving intellectual property rights (IPR) system. A view on protecting IP by previous studies is that the effect of strength IPR on economic growth is not clear. There is no doubt that the IPR construction could bring both benefit and cost to China. In this study, the role of IPRs on innovation activities are analyzed at first, and then I employ the cointegration theory to test the influence of IPR on China's economic growth (GDP). The final results show that there is a significant positive relationship between IPR and GDP.

Key Words: economic growth, intellectual property, innovation, China

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1. Introduction

1.1 Background

"Intellectual property (IP)" refers to inventions, devices, new varieties of designs and other properties that are produced through "mental or creative labour" by human beings, and the law regulating intellectual property is "highly politicized." [1] Considering the innovation is one of the most important dynamic for the economic growth, and the affects of intellectual property rights on innovation, the IPR plays a very important role on economic growth, especially in the long-run. In 1999, the Report from World Bank highlighted the role of knowledge and the contributions of intellectual property rights in social and economic progress[2].

The authorities in China try to gain more dynamics on economic growth through improving the intellectual property rights system. But previous studies find the effect of the IPR on economic growth is not very clear. The effect depend on several variables, like economic policy, income level, human capital, innovation ability etc. Maybe the strong IPR protection could not encourage the economic growth as most of us expected, especially when we consider the social cost for taking the strong IPR protection in China. In this study, I would like to overview the effect of IPR protection on the economics, and study the relationship between IPR and economic growth in China with the data of IPR protection and economic growth. With this study, I try to find out whether increasing IPR protection can make some positive contribution on economic growth in China.

1. Bently, L. and Sherman, B. (2001), *Intellectual Property Law* (1st ed.), New York: Oxford University Press, at 1-2.

2. World Bank (1999), *World Development Report – Knowledge for Development*, New York: Oxford University Press.

Intellectual property protection is a policy package that includes patent length and breadth, protection of trademarks, copyrights and trade secrets, and the degree of enforcement[3]. Considering the different effects of these aspects, in this study I will focus on patent protection, which has the most important and directly effects on innovation and economic growth compare with others.

1.2 Review the previous study

The IPR system literature by former scholars such as Grossman and Helpman, Maskus, and Ginarte etc will be used to develop this study. Literatures on the effect of IPR on economic growth in the developing economics have been particularly useful when study the relationship in China.

The theoretical model developed by Grossman and Helpman (1991) is about the innovation and economic growth[4]. Based on this study, Helpman (1993) analyzed the different IPR protection's effect in two regimes[5]. In his research, Helpman developed the dynamic general equilibrium models of two regions, North and South. He assumed the North invents new products and the South imitates technologies that have been invented in the North. With the strengthen IPR protection, the productions in the South have to be closed. In the short term, for more productions will be made in the North, the North gain more benefit. However, in the long-run, since more resources were shitted out of research sectors to production process, the innovation activities would be damaged. In Helpman's study, the South cannot gain any benefit with the strength IPR protection. However, in the real life, even the developing countries still have some innovation activities. Not all of the production in the developing countries imitates

3. Kwan, Y. K. and Lai, E.L.-C (2003), Intellectual Property Rights Protection and Endogenous Economic Growth, *Journal of Economic Dynamics and Control*, Vol 27, 853-873.

4. Grossman, G. M. and Helpman, E. (1991), *Innovation and Growth in the Global Economy*, Cambridge, MA, MIT Press.

5. Helpman, E. (1993), Innovation, imitation and intellectual property rights, *Econometrica* 61 (6), 1247–1280.

others. For instance, China is a developing country, and imitations are very common there. But we can still find some domestic innovations. The patent information in World Intellectual Property Organization (WIPO) can reflect the innovation ability in China. The number of PCT applications for 2007 indicated that Chinese companies filed 5,456 patents.

David M. Gould and William C. Gruben (1996) found the role of stronger intellectual property rights on economic growth is not very clear[6]. The effect is influenced by the level of development. In the open trade regimes, the expected competition forces to improve the innovation process and intellectual property system, to protect their innovation ability. But for the close trade regimes, the strong IPR protection has no ability to encourage the economic growth. The manufactories in these regimes prefer to develop their business with the low cost imitation instead of paying a lot on the innovation activities.

Park Walter G and Ginarte Juan Carlos (1997) studied the relationship for a cross-section of countries and found that the strong IPRs could not contribute on the economic growth directly[7]. Instead, the IPRs encourage the investment activities, for instance, the research and development activities. In the long-run, the strong IPR system would benefit the economic growth with more innovation.

Croix and Konan (2002) analyze the effect of the IPRs in China on the international trade between USA and China[8]. This research found that many developing countries prefer to set different IPR in different situation. The strong IPR protection is too early for some developing countries.

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6. Gould, D. M., and Gruben, W. C. (1996), The Role of Intellectual Property Rights in Economic Growth, *Journal of Development Economics*, Vol. 48, 323-350.

7. Park, W. G. and Ginarte, J. C. (1997), Intellectual Property Rights and Economic Growth, *Journal of Research Policy*, Vol. 26, 283-301.

8. Croix, S. J. L. and Konan, D. E. (2002), Intellectual Property Rights in China: The Changing Political Economy of Chinese-American Interests, *The World Economy*, 25(6): 759-788.

In this study, I would like to analysis the relationship between the IPR protection and economic growth in China. Try to find out whether strengthen IPR protection could incite the Chinese economic growth. These previous researches provide a good guide for the study in this field.

1.3 Aims and Research Questions

The principal aim of this study is to assess the effect of IPR protection on the economic growth in China.

Address the following question:

- For the industrial countries, the cost of strengthen IPR is less than countries who have weak innovation ability. As a developing country, the ability of innovation in China is not very strong with the limited both physical capital and knowledge accumulation. With the high cost of enforcing, whether the increasing IPR protection can make some contribution on the economic development is not very clear. Considering this, the first question is in China, a developing country with weak innovation ability, what the role of intellectual property protection is?

- The second question is what the effect of applying the strength intellectual property protection as the innovation strategy on China's economy growth is?

1.4 Method and Material

In order to assess the role of IPR on the economic growth in China, the correlation study will be developed based on the time-series analysis. The study use both primary and secondary data to conduct the empirical analysis.

The IPR system literature by former scholars such as Grossman and Helpman, Maskus, and Ginarte etc will be used to develop the study. Literature on the effect of IPR on economic growth in the developing economics have been particularly useful when study the relationship in China.

The data used in this study content both primary and secondary data. The authority records of the economic data in China's Statistical Yearbook published by the China's Statistical Bureau are very useful. The data about the IPR protection is calculated with the method developed by Park Walter G and Ginarte Juan Carlos. The Ginarte-Park index of IPR protection makes the analysis here possible. However, Ginarte-Park Index focuses more on the legislation in one country. In China, the enforcement is not as good as the law written on the paper. The stronger enforcement of the law in China after 2000 cannot be reflected by Ginarte-Park Index either, because the law on paper did not change any more. In the future study, the result could be more reliable, if a better index about the IPR protection could be developed.

2. The Economic Growth Theory

The study on the economic growth last for hundred years. Through these studies, economists try to find out the influence factors behind the economic growth. In the beginning of 20th century, the development of the Harrod-Domar model showed the economic growth was explained by the capital accumulation. The Neo-classical model adds the labor and technological change as other factors influence the economic growth comparing with the Harrod-Domar model. But the technology was treated as an exogenous factor. In 1980s, the development of the endogenous growth theory explains the technology development could increase the rate of return and the marginal productivity etc. With the emergence of the new growth theories, innovation has been treated as one of the dynamics for the long-run economic growth.

In the study of new growth theorists, such as Romer (1990), Grossman and Helpman (1991) recognize innovation as an engine to sustained growth. The process of

knowledge accumulation generates endogenously the productivity gain that sustains growth in the long run[9]. The new growth theories have shifted attention from capital to knowledge and learning within the field of economics and the study of economic growth.

In the old days, since the gap in technology was not very big, the organization could easily get more output and higher growth with more physical capital, compare with others. Nowadays, however, the physical capital is no longer the key element in the economic development. The former Soviet Union is one of the good examples to support this point. With a good job of accumulating the physical and human capital, the economic did not grow very well in that country.

Beside the physical and human capital accumulation, the technology is also one of the necessary driving forces especially for the long-run economic growth. We can easily find a lot of evidences support this saying even during the industry revolution period. The innovation happened in Great Britain in that period accelerated the economic development, made the economic growth there faster than any other parts of the world. With the advanced technology, the production process could be improved more. It means even with the same capital and labor input, the advanced technology could produce more output. This effect makes innovation holder has more competitive. All the organizations are trying to gain the sustainable development in the long term through the innovation. Douglass C. North (1981) notices that 'throughout man's past he has continually developed new techniques, but the pace has been slow and intermittent. The primary reason has been that the incentives for developing new techniques have occurred only sporadically.'[10]

9 . Grossman, G. M. and Helpman, E. (1991), *Innovation and Growth in the Global Economy*, Cambridge, MA, MIT Press.

10 . North, Douglass C. (1981), *Structure and Change in Economic History*, New York: W.W. Norton & Company, Inc., p. 164.

The failure to develop systematic property rights in innovation up until fairly modern times was a major source of the slow pace of technological change[11]. Offering the prize and protect the monopoly right to innovators are the most two common methods to encourage the innovation. Building the Intellectual Property Right system aim to encourage the innovation through offering right to use intellectual property to gain profit. North found that 'a systematic set of incentives to encourage technological change and raise the private rate of return on innovation closer to the social rate of return was established only with the patent system.'[12] Using Intellectual Property Right as a kind of right, make the knowledge to be one kind of property to gain the return of formerly innovation process and create profit in the following days.[13]

3. The role of intellectual property rights

Within every regime, building the IPR protection systems through laws mainly consider two reasons. One is to promote investments in knowledge creation and innovation by establishing exclusive rights to use and sell newly developed technologies, goods, and services.[14] For the knowledge is a kind of non-rival goods, it is easy to be gotten by the public. Without the laws protection, the imitators can easily reproduce the advanced technology without paying any cost on the research work. The imitators could easily offer a more competitive price and gain more profit than innovators with low cost. Hence, there would be less willing to invest on the research and innovation process in the under-protection situation. All producers would like to

11 . Ibid

12 . North, Douglass C. (1981), *Structure and Change in Economic History,* New York: W.W. Norton & Company, Inc., p. 164-165.

13. Granstrand O. (2005), Innovation and Intellectual Property Right, Fagerberg, J., Mowery, D.C. and Nelson, R.R. (eds), *The Oxford Handbook of Innovation* (266-290), New York: Oxford University Press.

14 . Maskus, K. E. (2000), Intellectual Property Rights and Economic Development, Prepared for the series "Beyond the Treaties: A Symposium on Compliance with International Intellectual Property Law".

share the free advanced knowledge developed by others rather than investing a lot of money, human capital and time on the high risk and expensive research work. With the protection from IPR system, the innovators and creators could gain additional profit thought the monopoly right of using and selling their knowledge. Under the good protection, there will be more willing to spend physical capital and human resources on innovation activities with the expectation of gaining more monopoly profit.

The other is to promote widespread dissemination of new knowledge.[15] Considering the non-rival character, knowledge is a kind of public-good, easy to be used and adopted by others. The innovators would like to gain the monopoly profit by keeping the knowledge privately rather than public to others. For instance, Coca-cola gains the monopoly profit through keeping the ingredient secret. The IPR laws provide innovators the legal right to gain monopoly price with their knowledge. But, at the same time, in order to gain the legal right, innovators have to publish all the information about the technology to others following the rules of IPR laws. Publishing the technology information will accelerate the technology developed process through disseminating the new knowledge. Based on the previous results, the next generation could be developed more efficient. Without repeating the research, a lot of energy, time and capital will be saved.

One of the most important function of IPR is efficient the knowledge transition. Based on the rules of IPR laws, the patent application must enclose all the technology information and public the information. The publication lower the access cost to latest knowledge and make the information transition more efficient. Great IPR system also speed the dissemination of knowledge with international cooperation, such as Foreign Direct Investment (FDI), international trade, technology license etc. Region with good IPR system has more attraction to international cooperation. Without worrying the free imitation, innovators would like to place their manufactures and product with advanced

15 . Maskus, K. E. (2000), Intellectual Property Rights and Economic Development, Prepared for the series "Beyond the Treaties: A Symposium on Compliance with International Intellectual Property Law".

technology in this market. With the inventions and ideas on the market, the region could get more advanced technology information and develop their own technology based on the existing knowledge. Good IPRs can benefit all social and protect the individual monopoly profit at the same time.

3.1 Development of IPR protection in China

China's intellectual property system has developed a lot during the past years. In the Maoist era, there was not any private property. A person who has private property was thought as selfish, exploiting. Everyone was shamed on this. All the properties belong to the masses in that period. In August 1950, Chinese central government promulgated a regulation on protection innovation and patent right. The inventor could get the patent right and rewards followed this regulation. This regulation was instead by a new regulation which was promulgated in 1963 by the central government. In the new regulation the innovator can only get the rewards for their contribution on the technology improvement, cannot gain the monopoly right to use the technology. China did not enact the patent law to protect the intellectual property until 1985. The patent law was amended twice in 1992 and 2000, respectively. But the enforcement in China was not paid much attention until 2001, when China got the admission to the World Trade Organization (WTO). In order to fulfill the requirements for becoming the member of WTO, Chinese government made a lot of efforts to improve IPR system to meet the strong minimum standards of IPR laws in TRIPS agreement. Today, the sophisticated laws and constant government encouragement has pushed China into the top three of PCT patent filing countries. The data from WIPO on the number of PCT applications for 2007 indicated that Chinese companies filed 5,456 patents, a 38% increase comparing with the figure in 2006.

3.2 The impact on investment in the technology innovation activities

In Sherwood (1990) study, a survey in Brazilian indicated that 80 percent of 377 firms would invest more in internal research and would improve training for their employees if better legal protection on IPR were available.[16]

In the weak protection system, the individual has limited interesting on investing innovative activities. In the case of under-protection, the advanced technology can be easily imitated by others without paying for using advanced technology and spending resources on R&D activities. Facing the competition from the imitators, the innovators are in a disadvantage position with high cost on previous research work. The imitators can offer a lower price and get more profit than the innovators with the low cost imitation. The cost for the innovation activities will be difficult to cover, facing these competitions. With under-protection, all producers want to enjoy the imitation profit instead of investing on the high cost and risk innovation activities.

With the protection from the IPR system, the innovators can gain monopoly profit with the right of applying and selling their advanced technology. We assume the resources is limited, the producers have to make a decision on how to distribute their limited resources. If they invest more resources in the production process, the research and development (R&D) activities input have to be reduced. On the opposite side, more R&D investment will shrink the investment on production. The decision of the producer depends on which activity can bring more profit. With good IPR protection, the new knowledge is protected as patent, copyright etc. The imitations become harder and high risk under the good IPR regime. At the same time, the innovation could bring more expected profit with the monopoly price during the protection period with the right to use and sell the innovation. Hence, with the expectation of more profit, the investment on innovation activities will be increased. At the whole social level, innovation rate will increase with more investment on innovation activities.

16. Sherwood, R. M. (1990), Intellectual Property and Economic Development, (Westview Press, Boulder, CO).

In Helpsman's study (1993), he analyzed the effect of strengthen IPR on the innovation within the endogenous growth theory context in North-South model[17]. In this model, there are only two regions, the North and the South. The North makes the innovation, and the South only imitates the technology developed in the North. With strength IPR protection, there is an inverted-U relationship between time and innovation rate in this model. The rate of innovation rises initially but declines subsequently.[18] At beginning, the tight IPRs lessen the imitation in the South. At this time, with the expectation of gaining more profit with the monopoly price, the North will put more resources in the research work to accelerate the innovation process. However, for the less imitation in the South, North have to spend more resources on the new product activities to satisfy the market demand and gain profit with the manufacture and selling in the following days. More resources have to be shifted from R&D sector to producing sectors. With less investment in R&D sector, the innovation rate will be diminished. In this model, Helpsman assumes it is a closed-economy, ignores the transition of the production activities between each other. Furthermore, the South was treated as without any innovation ability, cannot make any contribution on increasing innovation rate. Less and less investment will spend on the innovation activities in North with the strong IPR protection in the close economy, the rate of innovation will decrease with the less investment in the long-run.

However, if the international cooperation were considered in the model, like FDI, licensing of technology etc, as the later studies found, the investment on research and development work will not drop down any more, and rate of innovation will be higher with the tight IPRs protection. Lai (1998) finds that the rate of innovation increases with stronger IPR protection in both the North and the South as long as FDI is the major channel of international technology diffusion.[19] When the production activities

17. Helpman, E. (1993). Innovation, Imitation and Intellectual Property Rights, *Econometrica* 61 (6), 1247–1280.

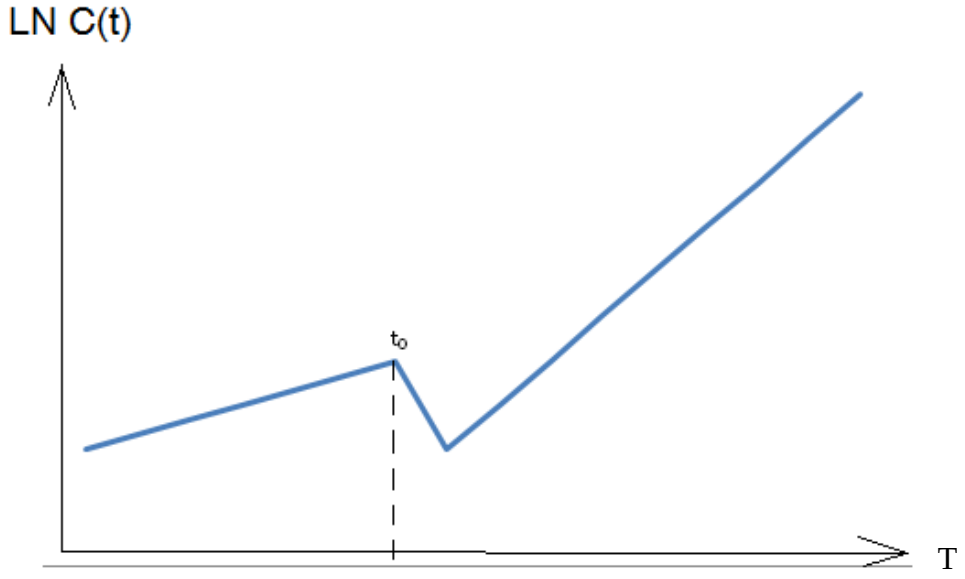
18 . Ibid

19. Lai, E.L.-C. (1998), International Intellectual Property Rights Protection and the Rate of Product Innovation, *Journal of Development Economics*, 55.115-130.

can take in other regions, there is no need to shift the resources out of R&D sector. On the global level, the rate of innovation will keep rising. In the study of Yun and Lai (2003), they found 'tightening IPR protection will induce an immediate loss of current consumption arising from the expansion of the R&D sector, but a gain in future consumption as a result of more investment in R&D, which induces faster innovation and faster growth' [20], as shown in Graph 3-1.

Based on the globalization environment, the strength IPR protection will induce more investment on R&D activities, and gain more innovation and higher economic growth rate in the long-run. When the tight IPR protection is applied, the investment in R&D would increase immediately, with the consideration of higher interest rate and more saving in the future. The production falls down at the same time caused by the higher investment in R&D. On the other hand, the tight investment in R&D will lead to higher growth rate of production in future with the output of R&D on innovation.

Graph 3-1, The time path of consumption (C(t))



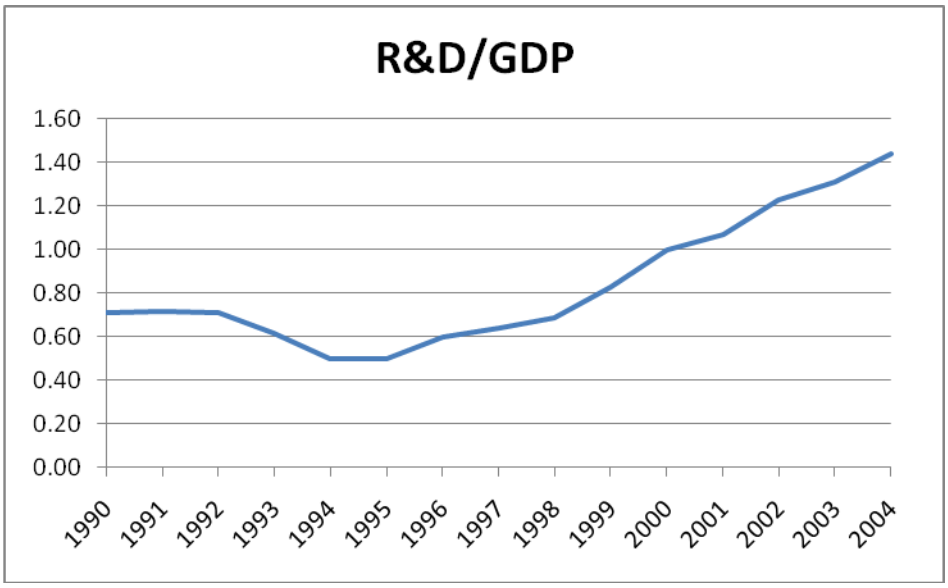
Note: The tight IPR protection is announced at t_0

20. Kwan, Y. K. and Lai, E.L.-C (2003), Intellectual Property Rights Protection and Endogenous Economic Growth, *Journal of Economic Dynamics and Control*, Vol 27, 853-873.

3.3 Investment on technology innovation activities in China

Realizing the important of the innovation on economic growth, China's government encourages innovation activities with many methods, for instance, investing more on education, offering special fund for high-tech research work. Taking stronger IPR institutions is one of these methods. With the strengthen IPR protection, China's R&D input as a percentage of GDP keeps increasing, which has been shown in Graph 3-2, from 0.5 per cent in 1994 grow to 1.48 per cent in 2007[21].

Graph 3-2, China's R&D input as a percentage of GDP, 1990-2004



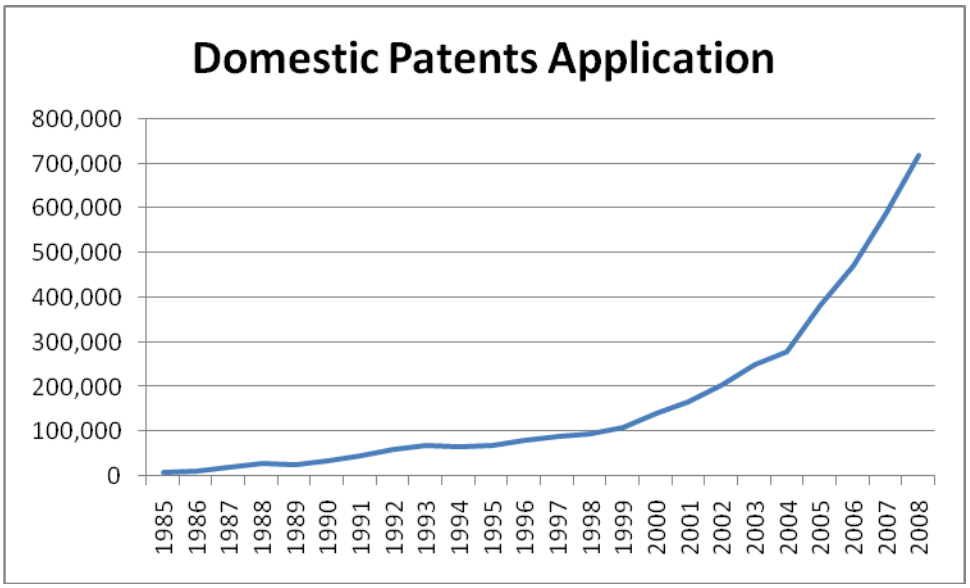
Source: China's Statistical Yearbook, Various years, National Bureau of Statistics, China Statistics Press

If we treat domestic patent application as the indicator of innovation output, we can easily found that the innovation in China, keep high growth rate, especially after 2000 when China became one of the members of WTO. China improved the IPR system a lot to fulfill TRIPS's requirement on IPR protection. Graph 3-3 has shown us the

21 . The figure came from China's Statistical Yearbook, National Bureau of Statistics, China Statistics Press.

domestic patent application trend. After 2000, the growth rate has a rapid increase. Tight IPRs encourages more investment on innovation activities and brings more innovation in China.

Graph 3-3, Domestic Patents Application in China, 1985-2008



Source: Annual Report, Various years, state intellectual property office of the people's republic of China

3.4 The impact on the technology transition

In addition to prompt the investment on innovation, the IPR system also tries to speed the information transition at the whole society level. The second purpose of Intellectual property rights system is stimulating acquisition and dissemination of information.

The regulation of IPR laws requires applicators public all technology information for getting patent right. These rules create more chances for public to gain the knowledge. Others beside innovators can gain the knowledge about the technology easily and use the information legally to develop further inventions by paying fee. Because the property right on knowledge can be protected by the IPRs, innovators can accept the requirement for public technology information. The publication cannot damage their

monopoly profit. It is difficult to image that innovators have any willing to public their technology information if others are free to reproduce them within weak protection situation. The good IPRs lower the access cost to knowledge for public, hence speed the acquisition and dissemination of information.

In addition to this, better IPR situation also induces knowledge spillover at the international level by attracting foreign firms to locate plants or selling products in this region. Studying the advanced technology developed in other countries is the important way to accumulate knowledge and improve the innovation ability for developing countries. Weak IPR protection will less the willing to invest or cooperate from others. It is difficult for technology holders to collect enough return with the competition from the imitation with lower cost. And the cost for maintain intellectual property in the weak protection system is much high, since technology holders have to pay more attention on protection their intellectual property. The free imitation retards the international cooperation and damage the information transition process. Under the good IPR system, it will be easier to translate the advanced information from abroad with international cooperation.

Knowledge formation is cumulative and as new inventions build on past practices the process of technical change could accelerate.[22] The efficient technology transition could accelerate the technology improvement process. As we all know a lot of innovations are made by recombination of existing technology. A lot of innovations are the improvement of the existing technology. The technologies which have been already used, give the innovators more ideas to invent advanced technology based on them. Easy access to the existing technology also prevents potential inventors from misspending their resource by reinvent. Technology dissemination reduces the cost for accessing the existing knowledge, especially for the knowledge developed outside the country. With the easy access to knowledge, the advanced technology can be learned

22. Scotchmer, S. (1991), Standing on the Shoulders of Giants: Cumulative Research and the Patent Law, *Journal of Economic Perspectives*, vol. 5, 29-42.

and practiced more, and result in the economic growth with the further advanced technology. This process for improving productivity by learning technology through patent information, takes place much shorter than through innovation activities. Without the patent system, time for learning existing technology will be much longer, since the information is difficult to access. We have to spend more time and energy on research work. The industry revolution in England is one of these examples. As the study by Joel Mokyr (2005) shown, the great improvement of productivity with the advanced technology in England during industry revolution period coursed by the easy access to knowledge.[23] Douglass C. North also found the Industrial Revolution was acceleration in the rate of innovation due to better specified property rights.[24]

From the WIPO's report, capital can be saved by 60% and time can be saved by 40%, if the research work based on the existed patent information. Good IPR protection afford firms greater certainty that they face limited threats of uncompensated appropriation. This certainty could induce them to trade and license their technologies and products more readily, enhancing their diffusion into the economy.

The technology transition at the international level is more efficient for accelerating the innovation process in developing countries. In the North-South model, South has limited innovation ability at beginning. The innovation activities will be very hard and high cost for South with limited intellectual accumulation. But, they can make improvement quickly with the existing technologies developed by North. During the middle of 20th century, a large part of the technology development in Japan was based on the technology transmitted from other industrial countries.

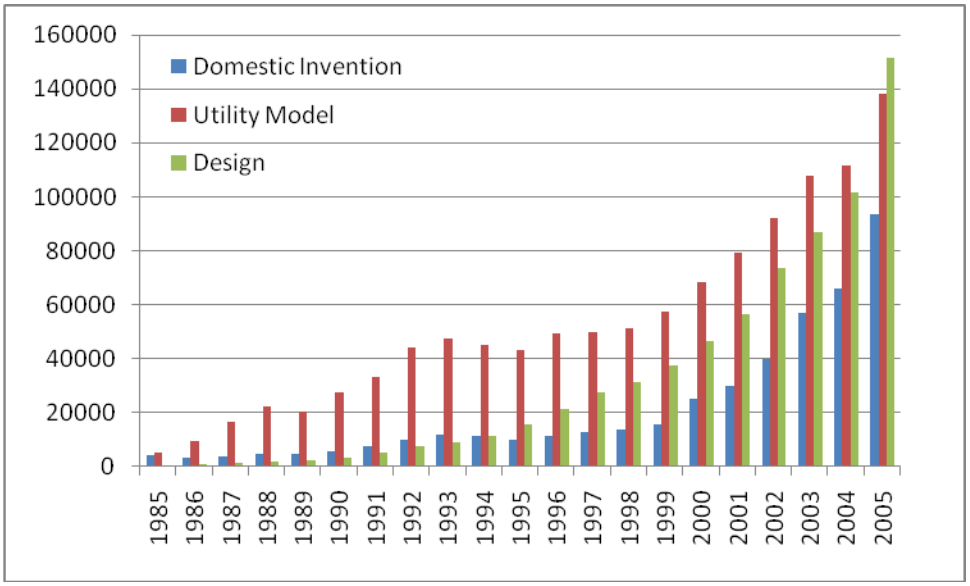
Nowadays, China has developed a lot with more knowledge accumulation in past years. But the innovation ability compare with developed countries is still very weak. Graph

23. Joel, M. (2005), The Intellectual Origins of Modern Economic Growth, *The Journal of Economic History*, 65, 285-351

24. North, Douglass C. (1981), *Structure and Change in Economic History*, New York: W.W. Norton & Company, Inc., p. 159.

3-4 shows that most of the domestic patent applications in China are Utility Model, based on the small improvement of previous invention. For the most knowledge intensive patent, invention is the least in the three kind of patent application. Learning from others with more advanced technology is valued for improving the innovation ability in China. Increasing IPRs can absorb more technology knowledge from abroad. There are three main ways to transit the technology knowledge at the international level, FDI, international trade and licenses.

Graph 3-4, patent application in three different kinds in China, 1985-2005



Source: Annual Report, Various years, state intellectual property office of the people's republic of China

3.4.1 IPR and FDI

With FDI, the host-country can employ capital, equipment, and technology, which enhances the productivity of its own resources, from abroad. The knowledge spillover from FDI help the host-country enjoy the knowledge accumulated in other countries, both the advanced technology and management skills. Regarding protecting the technology, managing against infringement in under-protection situation will cost the technology holder a lot, not only lost physical capital but also knowledge property.

They have to spend more on protecting their technology and stopping others' infringement activities. Worrying about the free rider of the technology and the high cost of management, the under-protection situation will be less attracting for investment with advanced technology compare with the stronger IPR protection situation. Countries moving up the FDI cycle find a growing economic interest on adopting stronger IPRs, an interest congruent with their own expanding abilities to produce new products and technologies.[25]

The IPR also has different effects on different industries. Certain industries are more sensitive to the IPRs than others. For instance, the chemical and pharmaceutical industry is dependent on IP protection, since the technology in this field is easy to copy. U.S. firms, limit foreign direct investment in the countries with weak intellectual property rights protection, particularly in the chemical and pharmaceutical industries[26].

In addition to the volume of FDI, the quality of FDI is another important factor affected by the IPRs. For the R&D facilities and the final productions are significantly depends on the IPR protection[27]. With the weak IPR protection, FDI always happened with the low-tech product which has limited knowledge or high-tech which is difficult to be learned. It is difficult to learn more valued knowledge within this kind FDI.

Under-protection IPR even hinders the transition of knowledge. The stronger IPR protection make sure the technology will be protected by the law, hence the technology holders do not need to worry their technology be copied by rivals with free. Technology can be transmitted more with FDI under the protection of IPRs. The FDI, let engineers, managers or suppliers and consumers learn the advanced technology

25 . Maskus, K. E. (2000), Intellectual Property Rights and Foreign Direct Investment, (Working Paper No. 22), World Bank, Centre for International Economic Studies.

26. Mansfield, E. (1994), 'Intellectual property protection, foreign direct investment, and technology transfer' (IFC discussion paper 19), The World Bank and International Finance Corporation, Washington, DC.

27. Ibid.

through working or using process. Spillover knowledge will contribute on the further domestic innovation activities.

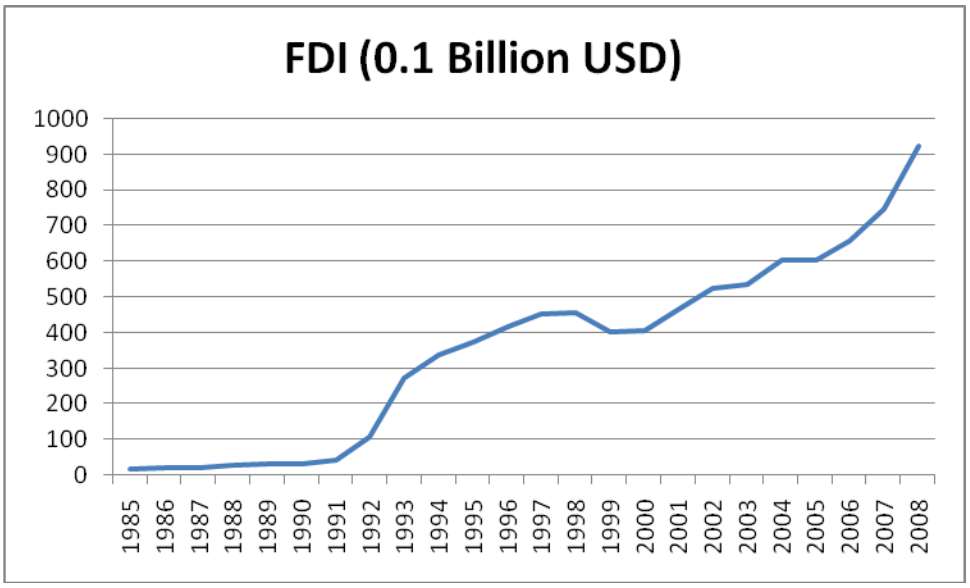
However, the FDIs are influenced by a lot of factors, not only the IPRs, like the size of the country, the economic policy, labor cost etc. Some previous studies have found that the effects from IPRs on FDI are not very clear, especially in less developed countries. These developed countries with low skilled, education and productivity levels, fail to attract any FDI. In these countries, the level of IPR protection makes little or no difference on attracting FDI, since the FDI will not be developed there. Beside the capacity of one industry to be copied, the ability to imitate of one country also influenced the relation between an increase in FDI and stronger IPRs.

For China, the big size market with low-cost labours and open economy policy has much attraction to FDI. Since 1990, China attracted 230 billion US dollars in foreign investment, which accounts for 45% of foreign direct investment entering Asia.[28] Of course, the exchange rate, low-cost labor, and an increasing domestic market in China are parts the factors entice the international cooperation into China. However, when we consider the development of China's economic today, the competition on exchange rate and labor cost is lower than before. We need to find a sustainable way to attract FDI and get more knowledge transition to develop economic. In the early years, under the weak IPR protection, the private and imitation in China forced investors with advanced technology to hind their technology to avoid the free riders. The knowledge spillover in this case is limited. In the long-run, it is difficult to rely on these kinds of FDI, and international cooperation to get technology accumulation for improving innovation ability. China tries to attract more high quality FDI through better IPR protection situation.

28. Sie, A. K. Y., and Fryxell, G. E. (2004), Anti-counterfeiting strategies and managerial confidence in the IPR regime: An empirical examination of foreign brands in Chinese markets. Paper presented at the meeting of the Academy of Management, New Orleans, LA.

With amending patent law in 1992, IPR protection in China improved a lot. The growth rate of FDI accompanied to strength IPR protection also experienced a rapid growth, as Graph 3-5 shown. In 2000, China had received 40.7 million US Dollar in FDI. As one of the members in WTO, China promised complying with at least the minimum standards of IPR protection. This promise makes China attract more FDI in the following years after 2000.

Graph 3-5, Volume of FDI in China, 1985-2008



Source: China's Statistical Yearbook, Various years, National Bureau of Statistics, China Statistics Press

3.4.2 IPR and International Trade

International trade provides channels of communication that stimulate cross-border learning of production methods, product design, organizational methods and market conditions. Each of these helps either to employ domestic resources more efficiently or enable a country to adjust foreign technologies to domestic use. Helpman, and Hoffmaister (1997) found that a one-percent increase in imports of machinery and

equipment from OECD countries tended to raise total factor productivity in developing countries by around 0.3 percentage points on average.[29]

The intellectual property system is one of the key considerations when the firm has willing to develop the international market in other regions. The estimated value of intellectual property can rang to billions of dollars, so IPR protection is always been considered seriously. Fink and Braga (1999) find that a foreign firm may give up the sale of their produces in a market where IPR protection is weak, since it will be difficult for them to reap benefits with the competition from free pirate[30]. The weak IPR could incentive foreign firms make the decision not to export the products with advanced technology to this market. In 1990s, international seed producers had to restrict the export of some seed varieties to Chinese farmers due to poorly specified IPRs for new plant varieties in China. The weak IPRs harder the information transition for China through the international trade.

The effects of IPR protection on the international trade are also influenced by the countries' imitate ability. Smith (1999) analyzes the relationship between IPRs, and exports from the USA, in 96 countries [31]. For those countries which have high ability to imitate, as she found, there is a positive relationship between trade and IPRs. IPR in the countries with weak imitation ability has no different or limited effects on the international trade. Smith concludes that IPR protections in importing countries are influenced the decision for US export, but only in countries that pose a threat of imitation.

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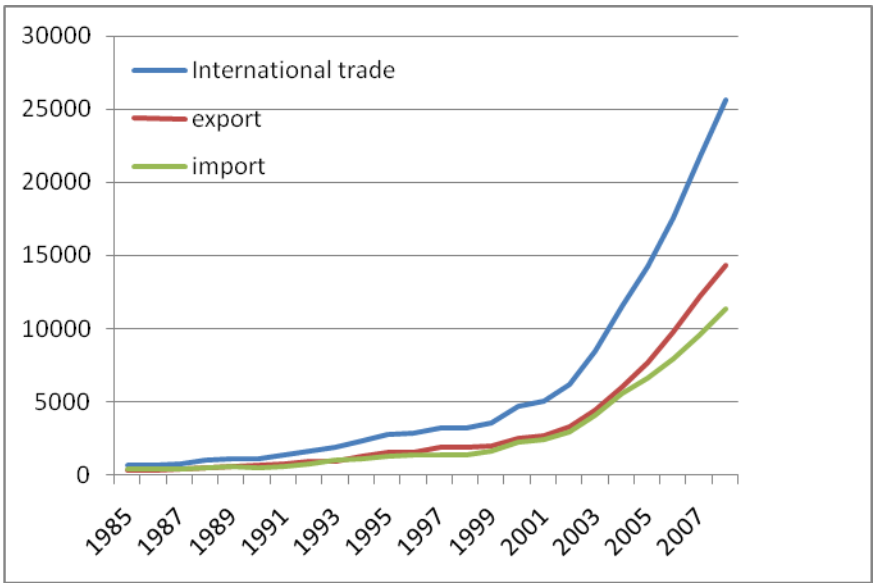
29. Coe, D. T, Helpman, E. and Hoffmaister, A. W. (1997), North-south R&D Spillovers, *The Economic Journal*, 107 (440), 134-149.

30. Fink, C. and Braga, C. A. P. (1999), How Stronger Protection of Intellectual Property Rights Affects International Trade Flows, from http://citeseerx.ist.psu.edu/viewdoc/summary?doi=10.1.1.27.3802.

31. Smith, P. J. (1999), Are Weak Patents a Barrier to U.S. Exports?, *Journal of International Economics*, vol. 48, 151-177.

One of the main driving forces for building the strong IPR system in China is the international trade. In order to trade goods with United States, China signed the 1979 Agreement on Trade Relations between United State and China. Following this agreement, China must adopt international IPR standards to protect intellectual property. After 2000, as one of the members in WTO, the special position brings a lot of benefits to the international trade between China and other members. At the same time, of course China as the member in WTO enforces the protection law regarding the IPR under the TRIPS agreement.

Graph 3-6, international trade in China, 1985-2008, (0.1 Billion US Dollar)



Source: China's Statistical Yearbook, Various years, National Bureau of Statistics, China Statistics Press.

After joining WTO, the international trade in China boosts a lot, from 509.77 billion US dollar in 2001, persistently grow to 2561.6 billion US dollar in 2008. Growth rate has been shown on Graph 3-6. The percentage of international trade on GDP in these years also had a same trend. In 2001, the share was only 38.47%. In 2008, the share has increased to 63.86%.[32]

32 . The figure calculated with the information published by NSC. Detail information was given in the Appendix 2.

A developing country's total factor productivity will be larger, when larger foreign R&D capital stock, more open to machinery and equipment imports from the industrial countries[33]. With better IPR situation, the big Chinese market will attract larger flow of international trade. At the same time, advanced technology accompanies the products will import to China. The export also has the ability to translate knowledge and information. When the goods are sold and used abroad, feedback and requirements come from the market will give producers more ideas about how to improve the product and technology. Based on transiting products with advanced knowledge with international trade, the innovation in China will be more efficient.

3.4.3 IPR and License

Concluding with the licensor, a written license contract gives the licensee a right for the exploitation of the patent with paying licensor fee. The license is the most directly way to transit the technology between the parties of the contract. The technology can be learned and used with the permission of license.

Since, the buyers will know all the information about what the buying technology is with the license, the seller have to make sure the buyer will not take off information and imitate the technology without paying for it. The weak IPR protection will raise the risk losing the technology with the license activities for sellers. Hence, the holder of the technology might be more willing to give up the cooperation under the weak IPRs, or just transfer the old technology, or without release enough information for protecting their knowledge property. The technology transition will be very hard with this method under the weak IPR protection.

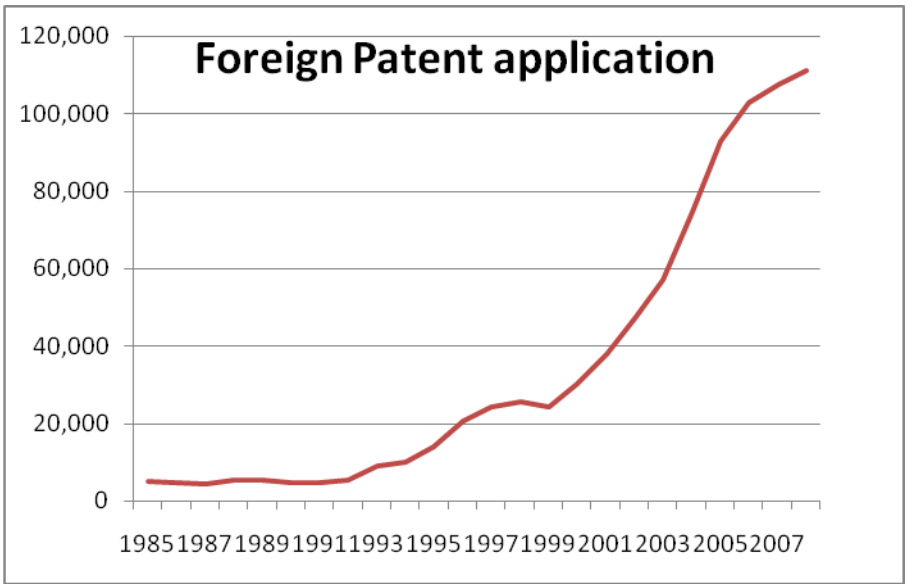
3.5 The technology transition in China

33. Coe, D. T., Helpman, E. and Hoffmaister, A. W. (1997), North-south R&D spillovers, *The Economic Journal*, 107 (440), 134-149.

In the early years, international cooperation did not transit much valued technology to China. The advanced technology within FDI, import goods are protected by other ways not by IPR form, since the IPR system was not good enough for protecting the legal right. The quality of FDI, or import goods are limited by the under-protection IPRs. Most of the FDI only produce some low-tech product. The core technology productions were made in other regions. The low quality FDI decreased the effect of technology transition in China. Within the weak IPRs in China in the early years, for imitators, patent system like a library of technological information that allowed them to undertake a complete reconstruction of the technology. This situation force inventors try to protect their technology by keeping it privately, instead of publishing the technology information with patent system. If the FDI or import products have any advanced technology, investors would hind the technology information to protect the profit brings by the technology. With these protection methods, it is hard for others to access the advanced technology information. The international cooperation made little contribution on learning and accumulating knowledge in that period, since the technology cannot be easily accessed.

With the stronger IPR protection in recent years, more efficient technology transition appears in China. I use the foreign patent application as the indicator to reflect the trace of the technology transition. As we can see from Graph 3-7, the figure of foreign patent in China, there are two turning points with increasing growth rate of patent application. One is 1992, when China introduced a stronger patent law. Another is 2000, when China became the member of WTO and was enforced to following TRIPS requirement taking minimum IPR standards in China. The foreign patent application has a more rapid increase after 2000. The promises given by China convince investors from abroad that their knowledge asset can be protected by the IPRs. With legal method to protect knowledge, the management is easy and low cost. The IPR laws also lower cost for others to access the technology information.

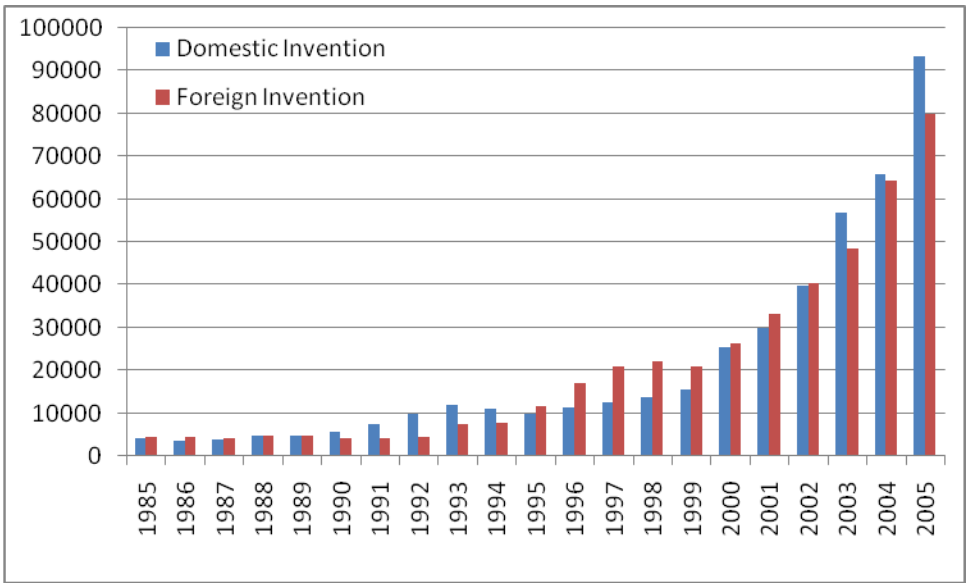
Graph 3-7, foreign patent application in China, 1985-2008



Source: Annual Report, Various years, state intellectual property office of the people's republic of China

Through the international cooperation activities, the advanced knowledge is transited from abroad. In China, there is half of the invention application which is the most knowledge intensive innovation come from abroad. We can found this information from Graph 3-8. Chinese innovation ability is not as powerful as in developed countries. Through technology transition, we can learn more advanced technology, and improve our technology with the knowledge accumulation.

Graph 3-8, domestic invention and foreign invention patent application in China, 1985-2005



Source: Annual Report, Various years, state intellectual property office of the people's republic of China

4. Assess the Role of IPR on Economic Growth in China

Maskus applies the method from Coe, Helpman, and Hoffmaister (1997), and finds that the stronger patents required by TRIPS could raise Chinese TFP by perhaps 0.6 percentage points per year[34]. With the stronger IPR protection, more investment was spent on R&D activities, and more technologies were transited to China. Both of them can increase the rate of innovation. In the long-run these innovation will bring high growth on economic in China. In this sector, I try to test the hypothesis that a strengthen IPR is associated with a positive effect on GDP.

34. Maskus, K. E. (2000), Intellectual Property Rights and Economic Development, prepared for the Series "Beyond the Treaties: A Symposium on Compliance with International Intellectual Property Law"

4.1 Methods

In order to assess the role of IPR on the economic growth in China, the correlation study will be developed based on the econometric method. A relation between the economic variables, say $Y_t = a + b*X_t + u_t$, often produces empirical results in which the R^2 is quite high, but the Durbin-Watson statistic is quite low. This happens because economic time series are dominated by smooth, long term trends. The economic time serious' variables behave individually are most nonstationary random walks. Considering this, I use cointegration theory to analyze the correlation. Cointegration is the link between integrated processes and steady state equilibrium. The study based on both primary and secondary data to conduct the analysis. I assume there is no relation between IPR protection and economic growth, and use econometric method to test the hypothesis.

To detect cointegration I use the following procedure.

1. Determine whether or not GDP_t and IPR_t contain unit roots. If the two series are both I(d), then we can reject the hypothesis of no relationship between them. This is equivalent to say there will be a relationship between GDP and IPR protection in long run, they can be cointegrated.

   In this study, I use the Augmented Dicky Fuller (ADF) test in Eviews 5.1, to check the stationary of time series and detect the existence of unit roots.

2. If they are both I(d), we can estimate the parameters of the cointegrating relation with *Engle-Granger* Technique. At first, I estimate the long-run equilibrium as following one. In order to diminish the autocorrelation within variables, I add the lag length of GDP in the general model. Using the traditional ordinary least square regression method, the final equilibrium can be gain.

   LNGDPt = a + b* LNIPRt + c* LNGDP(t-1) + d* LNGDP(t-2) + e* LNGDP(t-3)+ f* LNGDP(t-4)+ g* LNGDP(t-5)

3. Test to see whether or not error correction mechanism (Ecm_t) in the least squares appears to be stationary at beginning ($Ecm_t \sim I(0)$).

   $Ecm_t = Y_t - Y_{t-1}$
   $= LNGDP_t - LNGDP_{t-1}$

   In a model which includes two such variables, if it is possible to choose coefficients which make error correction mechanism ($Ecm_t = Y_t - Y_{t-1}$) in the least squares appears to be stationary ($Ecm_t \sim I(0)$), we can say that GDP and IPR are cointegrated. There is a stable long-run relationship between GDP and IPR protection.

4. But such an empirical result does not tell us about the short run relationship between GDPt and IPRt. I use the error correction mechanism, Ecm_t, to tie the short-run behavior of GDP to its long-run value. The model for short run is,

   $DLNGDP_t = \alpha * DLNIPR_t + \beta * DLNGDP_{t-1} + \gamma * ecm_{t-1} + \varepsilon_t$

   where 'D' denotes the first difference operator.

5. Finally, using Vector Autoregression (VAR) model to do Granger causality test, for finding out whether changes of IPR is the course for changes of GDP.

4.2 The Data used

The data used in this study content both primary and secondary data. The authority records of the economic data in China's Statistical Yearbook published by the China's Statistical Bureau are very useful. In this study, the GDP figure is used as economic indicator. All the GDP data come from the administration record. The index of IPR

protection computes here with the method developed by Park Walter G and Ginarte Juan Carlos, and based on the fact in China. The Ginarte-Park Index assess the IPR level, makes the analysis possible. However, Ginarte-Park Index also has some limitation though it is the most popular index to assess the IPR protection. It only focuses on the legislation in one country, without calculating on enforcement. In China, the enforcement is not as good as the law written on the paper. And the improving of enforcement cannot be indicated by the index. In the future study, the result could be more reliable, if a better index about the IPR protection could be developed.

Table 4-1: the IPR protection (Ginarte-Park index) in China, 1985-2004

YEAR	Ginarte-Park Index	YEAR	Ginarte-Park Index
1985	1.512	1995	3.190
1986	1.512	1996	3.190
1987	1.512	1997	3.190
1988	1.512	1998	3.190
1989	1.512	1999	3.524
1990	1.512	2000	3.524
1991	1.512	2001	4.190
1992	1.512	2002	4.190
1993	2.857	2003	4.190
1994	3.190	2004	4.190

Note: the content of calculating can be found in the Appendix 3.

Park Walter G and Ginarte Juan Carlos (1997) calculated the IPR protection index in 110 countries for the period 1960-1990[35]. The index consists of five categories of the patent laws[36]: (1) extent of coverage, (2) membership in international patent agreements, (3) provisions for loss of protection, (4) enforcement mechanisms, and (5)

35. Park, W. G. and Ginarte, J. C. (1997), Intellectual Property Rights and Economic Growth, Journal of Research Policy, Volume 26, 283-301.

36. The content of these categories have been indicated in the Appendix 1.

duration of protection. Each of these categories was scored a value ranging from 0 to 1. The sum of these five values gives the overall value of the IPR protection in a country. The value between zero to five, the higher number reflect stronger levels of IPR protection. Before analysis the relation between the IPR and economic growth in China, I calculated the Ginarte-Park Index during the period of 1985-2004[37] with the evaluation method developed by Ginarte and Park and the fact of China. The final results have been indicated in Table 4-1.

The figure of GDP and GDP growth rates come from China's yearbook, published by National Bureau of Statistics of China. For the GDP was calculated by the current price, and the GDP growth rate was calculated by the comparable price, the real GDP here is calculated with the GDP growth rate and the figure of 1984 (GDP: 720.81 Billian Yuan).

Table 4-2: Economic Growth in China, 1985-2004

year	GDP(0.1 Billian Yuan)	GDP growth rate	Real GDP(0.1 Billian Yuan)	LN Real GDP
1985	9016	13.50%	8181.194	9.009593
1986	10275.2	8.90%	8909.32	9.094853
1987	12058.6	11.60%	9942.801	9.204604
1988	15042.8	11.30%	11066.34	9.311663
1989	16992.3	4.10%	11520.06	9.351845
1990	18667.8	3.80%	11957.82	9.389141
1991	21781.5	9.20%	13057.94	9.477152
1992	26923.5	14.20%	14912.17	9.609933
1993	35333.9	14.00%	16999.87	9.740961
1994	48197.9	13.10%	19226.85	9.864063
1995	60793.7	10.90%	21322.58	9.967522
1996	71176.6	10.00%	23454.84	10.06283
1997	78973	9.30%	25636.14	10.15176
1998	84402.3	7.80%	27635.76	10.22687
1999	89677.1	7.60%	29736.07	10.30012
2000	99214.6	8.40%	32233.9	10.38077
2001	109655.2	8.30%	34909.32	10.46051
2002	120332.7	9.10%	38086.06	10.5476
2003	135822.8	10.00%	41894.67	10.64291

37. The content of the calculating have been indicated in the Appendix 3.

2004	159878.3	10.10%	46126.03	10.73913

Source: Real GDP calculated based on the GDP in 1984 (720.81 Billian Yuan) and GDP growth rate which came from China's Statistical Yearbook, Various years, National Bureau of Statistics, China Statistics Press.

4.3 Results

From the data for the period 1985 to 2004 for China, the following results were obtained with the traditional ordinary least square regression method.

$$\text{Ln}(GDP_t) = 8.789 + 1.182 * \text{Ln}(IPR_t)$$
$$t = (89.828) \quad (12.252)$$
$$R^2 = 0.89 \qquad D.W. = 0.87$$

The positive coefficient of *independent variable is* Ln (IPR_t) *which* is highly significant in statistical. And the R-squared in this model is also very high, 89 percent of GDP growth depending on variation of IPR which is an independent factor. However, the extremely low Durbin–Watson *d* value, which suggests the autocorrelation between variables, is only 0.87, suggested there is something wrong in the preceding regression. Therefore, the result above is meaningless with the autocorrelation within variables. In order to against the spurious regression, the model will be estimated by a correction of the nonstationary of the series.

I assume that there exists some long-run equilibrium (cointegration) relationship among the nonstationary variables. The first step is to use the Augmented Dicky Fuller (ADF) test for checking the stationary of time series and detect the existence of unit roots in the series. From the result of the test, indicated in the Table 4-3, we can easily found that where $LNGDP_t$ is nonstationary, its first difference ($DLNGDP_t$) is stationary. Regarding the independent variable $LNIPR_t$, the stationary test found it integrated as the same order as $LNGDP_t$, its first difference ($DLNIPR_t$) is stationary while the $LNIPR_t$ is nonstationary.

Table 4-3, result of the unit root test of GDP and IPR index,

	(C,T,K)	t-Statistic	Test critical values (5% level)	stationary
LNGDPt	(C,T,2)	0.195797	-3.052169	Nonstationary
DLNGDPt	(C,T,1)	-4.033097	-3.052169	stationary
LNIPRt	(C,T,0)	-2.094668	-3.673616	Nonstationary
DLNIPRt	(C,T,0)	-3.747886	-3.690814	stationary

Note: Augmented Dicky Fuller (ADF) test, C as intercept; T as trend; K as Lag Length, which is automatically selected based on SIC.

Time series $LNGDP_t$ and $LNIPR_t$, both are *I* (1). Then we can use the *Engle-Granger* Technique for testing cointegration with long-run equilibrium relationship among non-stationary series. The lag length of GDP is considered within the long-run equilibrium to diminish the autocorrelation. After omitting the insignificant variables LNGDP(t-2), LNGDP(t-3), LNGDP(t-4), LNGDP(t-5), the final equilibrium has been gotten as below.

$$\mathbf{LNGDP_t = 0.559 + 0.067\ LNIPR_t + 0.946\ LNGDP_{(t-1)}}$$

$$t = (1.963) \quad (1.705) \quad (29.165)$$

With the result of t-statistics, we know IPR protection has significant positive effect on GDP in the long run. Then, I check the stationary of error correction mechanism (Ecm_t) with the ADF test to determine whether the hypothesis of no cointegration can be rejected.

$$\mathbf{Ecm_t = LNGDP_t - (0.559 + 0.067\ LNIPR_t + 0.946\ LNGDP_{(t-1)})}$$

With Eviews 5.1, the result of ADF test for the error correction mechanism has been shown in the Table 4-4.

Table 4-4, result for unit root test of error correction mechanism (Ecm_t)

	(C,T,K)	t-Statistic	Test critical values (1% level)	stationary
Ecm_t	(C, T, 1)	-4.083312	-3.886751	stationary

Note: Augmented Dicky Fuller (ADF) test, C as intercept; T as trend; K as Lag Length, which is automatically selected based on SIC.

The stationary error correction mechanism indicates that GDP and IPR are cointegrated. There is a stable long-run relationship between GDP and IPR protection. The positive significant coefficient of $LNIPR_t$ is 0.067, which interprets in the long-run every percent improvement of the IPR protection will make the GDP grow 6.7 percentage.

Considering there may be disequilibrium in short-run, I use the error correction mechanism, Ecm_t, to tie the short-run behavior of GDP to its long-run value. The result of equilibrium adjustment is,

$$\mathbf{DLNGDP_t=0.05273*DLNIPR_t+ 0.9636*\ DLNGDP_{t-1}\ -0.594382*\ ecm_{t-1}}$$

t = (1.150720) （14.71938） （-2.039312）

where 'D' denotes the first difference operator, 'ecm_{t-1}' denotes the one-period lagged value of the error from the cointegrating regression. It shows that, short-run changes in IPR protection have a significant positive impact on short-run changes in GDP. The coefficient 0.05273 is the short-run marginal propensity to economic (GDP) growth. The negative coefficient of ecm_{t-1} adjusts the disequilibrium.

Now we know the two variables, $LNIPR_t$ and $LNGDP_t$ are cointegrated and each is individually first difference. However, we have no idea either IPR must Granger-cause GDP or GDP must Granger-cause IPR until now. I use Vector Autoregression (VAR) model to do Granger causality test. With Eviews 5.1, I got the result of Granger causality test which has been shown in Table 4-5.

Table 4-5, the result of Granger causality test

Dependent variable: GDP			
Excluded	Chi-sq	df	Prob.
IPR	10.43750	4	0.0337
All	10.43750	4	0.0337

Dependent variable: IPR			
Excluded	Chi-sq	df	Prob.
GDP	15.24603	4	0.0042
All	15.24603	4	0.0042

With these results, which explain current GDP in terms of lagged 1 period, 2 periods, 3 periods, 4 periods IPR protection and current IPR protection in terms of lagged 1 period, 2 periods, 3 periods, 4 periods GDP, we essentially treat GDP and IPR protection as a pair of endogenous variables. There are no exogenous variables in this system. Stronger IPR protection could contribute on the GDP growth, at the same time government will not strengthen the IPR protection until their economic become better.

4.4 Discussion

China increase IPR protection in recent years based on the need to improve innovation ability for sustainable economic growth and the requirement of TRIPS agreement. As I have mentioned in section 3, increasing IPR protection will stimulate investment on innovation activities and promote widespread dissemination of new knowledge. These functions can create a lot of contribution on improving innovation ability. Based on the endogenous growth theory, more innovations will encourage on economic growth. With this study, we can find the valid positive relation between changes of IPRs and changes of GDP in China.

Since 1980, China has made extensive process in joining international IPR convention. In this process, the improving IPR system enhance innovation ability in China with higher investment in innovation activities and more technology transition both interregional and international and create more domestic innovations. As the debate on the function of IPR protection has mentioned nowadays, tight IPR protection also cost a lot, especially for developing countries.

Looking at the development in different countries, we can easily found several examples about the positive impact of strong IPR protection on economic development,

for instance, America, Japan. However, the IPRs also bring some blocks on the development road. Sometimes because the high cost of using the existing knowledge, the innovation would be damaged, and the knowledge spillover became low efficient. Considering the weak innovation ability in China, strength IPR protection will reduce imitation and increase social cost at the same time.

The IPR protection in China in the early years was very weak. 'Western firms are always complaining about the theft of intellectual property in China. From knock-off designs to copycat brand names, pirated music and fake drugs, China has a well-earned reputation as a free-for-all when it comes to patents and copyrights'[38]. Most of the protection built on the imitated activities in China. Limited literature accumulation and physical capital make the innovation ability in China is very weak. Imitation is widespread and it has played a major role in the growth of high performing economies in the early years such as the development of Japan. Increasing IPR protection will increase the imitated cost and transmit the profit from the imitators to the innovators which will make a negative effect on economic growth. The final effect of strength IPR protection on economic growth depends on whether the cost can be overwhelmed by the benefit.

The cost for strengthen IPR protection includes:

1. There will be more cost for using the previous innovation. With the IPR protection, others have to pay technology holders fee for legally using patented technology. At the national level, the weak IPR protection could help the domestic manufactories adopt the advanced technologies which have been developed in the foreign market with low cost imitation. There are several countries developed their domestic technology with the low cost imitation at the begin stage of development. For instance, in the post-war period, the patent right could not be granted to pharmaceuticals in Japan. Japanese developed

38 . *Economist* (April 10th, 2008), Chinese firms warm to intellectual property, http://www.economist.com/business/displaystory.cfm?story_id=11023270#activate.

their technology in pharmaceuticals industry with imitation in those years a lot. In addition to this, the IP law encouraged Japanese to apply the utility model patent right based on the improvement of the foreign innovation. These weak IPR protection treatments in Japan in that period help them to develop their own innovation based on the advanced technology transmitted from abroad.

When the IPR protection was increased, others who use technology have to pay patent holders fee. The production cost will raise much with the strengthen IPR protection. China is a net import technology country, increasing IPR protection will shift the profit from domestic to abroad.

Strength protection would also have negative effects on the innovation actions at the same time. The strong protection could make sure all the social value been obtained by the first generation innovators. For the later generations, however, it would be easily infringing the early ones if the protection is much wide. By paying, knowledge can be used by later generations. The high cost for using knowledge will make innovation activities not easy to gain enough profit from the market. The next generation will difficult to be encouraged with the strong IPR protection. With the high rate of profit, first generations have less willing to do more innovation. They will prefer to enjoy the exiting monopoly profit with the IPR protection.

2. Strength IPR protection cost customers more. For all participants in the market pursue max profit, Intellectual property holders would like to fix a high price to gain more monopoly profit, without worrying the competition from others. With strength IPR protection, customers have to shift consumption from low price imitation products to legitimate ones. For the legitimate goods always have a higher price than imitated goods, customers have to pay more on the consumption. Watal (1996) computed that static price impacts of patent coverage in India could raise average patentable drug prices by perhaps 50% from a 1994 base.

3. Cost for IPR management is another negative effect of strength IPR protection. Beside the payment to patent holders, IPR management also increases social cost a lot with strength IPR protection. Building the organization and training stuff to enforce the law, government need to invest some capital and human resource on IPR protection. In Chile, additional fixed costs from this upgrade were estimated at $718,000 and annual recurrent costs at $837,000 on administration[39]. Training professional administrators and judges, promoting the law to public all increase the social cost.

The effect of IPR system on economic growth depends on whether social benefits which are created by it can cover the social cost. No doubt, the IPR system creates social cost with monopoly and complex legal system. In the long-run, these costs may be counterbalanced by greater incentives for innovation as discussed earlier. Higher productivity and product quality created by the innovation will benefit the economic growth. The data analysis in this study has clearly tell us the positive impact of strengthen IPR protection on economic growth in China.

5. Conclusion

The aim of this thesis is to assess the effect of IPR protection on the economic growth in China. This has been done by analyzing the role of IPR system on innovation and assessing the relation between IPR and GDP in China with time serious data and cointegration theory.

Today, there is a heated debate on whether strengthen IPR can benefit the economic growth. With different characters in various countries, the IPR system has different effects. In this study, I discuss the role of IPR protection on innovation at first, based

39. United Nations Conference on Trade and Development, 1996, *The TRIPS Agreement and Developing Countries*, (Geneva: UNCTAD).

on the previous research. Through endogenous growth theory, we know innovation has positive effects on economic growth. Considering this theory and the effects of IPR system on innovation, I study the relation between IPR protection and economic growth in China.

This study finds strengthen IPR protection can create more innovation through encouraging investment on innovation activities and stimulating technology transition and dissemination. The IPR protect the knowledge capital, which is the typically non-rival production. With the weak protection from the law, it will be difficult to get the rewards for covering the cost during the innovation process, when the innovators face the competition from others' free imitation. The IPR system is built to encourage investing on innovation activities through giving the innovators monopoly benefit with their innovation work. Strong IPR protection makes sure the innovators can be benefited with the monopoly profit and then incents innovation activities. In China, more investment has been put into R&D activities with increasing IPR protection.

In addition to this, more technology will be transited and disseminated with the strength IPR protection both at interregional and international level. Publish patent technology information is one part of the requirements for getting patent right. These rules lower the access cost to technology information for public. The international cooperation which is attracted more by strengthen IPR protection, will also transit more advanced information from abroad. China benefits the technology accumulation with FDI, international trade and license. If we adopt the foreign patent application as the indicator for technology transition, we can found with the IPR protection become stronger, more technology was translated to China. More investment on innovation activities and technology information dissemination created more innovation in China.

On one hand, strength IPR protection incents more innovation. These activities higher the product's quality and increase the productivity. On the other hand, imitators have to stop their free imitation activities, consumers have to face higher monopoly price, government need to spend more resources on administration. The strength IPR

protection brings more social cost. Whether strengthen IPR protection can make a positive effect on economic growth depends on which part is higher. If the benefit of more innovation can overtake the social cost, strengthen IPR protection will make positive contribution on economic growth.

For China, we enjoy both the benefits and limitation of strength IPRs. With the limited evidence available, 20 years time series data of economic growth and IPR protection in China, the result of correlation study based on correlation theory suggests that the relationship between IPR and economic growth is significantly positive in the long-run. In the short-term, the relation between the two variables is also a valid positive relation. Strength IPR protection in China has a significant positive effect on economic growth. In brief, increasing IPR protection could be effective, for the benefit can overcome of potential limitations that exist in markets for costs and anticompetitive abuse. The result also tells us, the IPR protection will be strengthened with wealthier income. Higher GDP will strengthen IPR protection.

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Appendix1: the categories of the GP index

	yes	no
1. Coverage		
1.1 patentability of pharmaceuticals	1	0
1.2 Patentability of chemicals	1	0
1.3 Patentability of food	1	0
1.4 Patentability of plant and animal varieties	1	0
1.5 Patentability of surgical products	1	0
1.6 Patentability of microorganisms	1	0
1.7 Patentability of utility models	1	0
2. Membership in international treaties		
2.1 Paris convention and revisions	1	0
2.2 Patent cooperation treaty	1	0
2.3 Protection of new varieties (UPOV)	1	0
3. Loss of protection measures against losses		
3.1 Working requirements	1	0
3.2 Compulsory licensing	1	0
3.3 Revocation of patents	1	0
4. Enforcement		
4.1 Preliminary injunctions	1	0
4.2 Contributory infringement	1	0
4.3 Burden-of-proof reversal	1	0
5. Duration		
Application-based standard		
$x \geq 20$ years	1	
$0 \leq x < 20$	x/20	
Grant-based standard		
$x \geq 17$ years	1	
$0 \leq x < 17$	x/17	

Appendix2: Volume of International Trade in China 1989-2005 (0.1 Billion Yuan)

	International trade	GDP	International trade / GDP
1989	4156.0	16992.3	24.46%
1990	5560.1	18667.8	29.78%
1991	7225.8	21781.5	33.17%
1992	9119.6	26923.5	33.87%
1993	11271.0	35333.9	31.90%
1994	20381.9	48197.9	42.29%
1995	23499.9	60793.7	38.66%
1996	24133.8	71176.6	33.91%
1997	26967.2	78973	34.15%
1998	26849.7	84402.3	31.81%
1999	29896.2	89677.1	33.34%
2000	39273.2	99214.6	39.58%
2001	42183.6	109655.2	38.47%
2002	51378.2	120332.7	42.70%
2003	70483.5	135822.8	51.89%
2004	95539.1	159878.3	59.76%
2005	116921.8	183084.8	63.86%

Source: 1985-2005 from China's Statistical Yearbook, Various years, National Bureau of Statistics, China Statistics Press

Appendix3: the GP index of China, 1985-2004

Year	1.1	1.2	1.3	1.4	1.5	1.6	1.7	Sub-total	2.1	2.2	2.3	Sub-total	3.1	3.2	3.3	Sub-total	4.1	4.2	4.3	Sub-total	5	total
1985	0	0	0	0	1	1	1	0.429	1	0	0	0.333	0	0	0	0.000	0	0	0	0.000	0.75	1.512
1986	0	0	0	0	1	1	1	0.429	1	0	0	0.333	0	0	0	0.000	0	0	0	0.000	0.75	1.512
1987	0	0	0	0	1	1	1	0.429	1	0	0	0.333	0	0	0	0.000	0	0	0	0.000	0.75	1.512
1988	0	0	0	0	1	1	1	0.429	1	0	0	0.333	0	0	0	0.000	0	0	0	0.000	0.75	1.512
1989	0	0	0	0	1	1	1	0.429	1	0	0	0.333	0	0	0	0.000	0	0	0	0.000	0.75	1.512
1990	0	0	0	0	1	1	1	0.429	1	0	0	0.333	0	0	0	0.000	0	0	0	0.000	0.75	1.512
1991	0	0	0	0	1	1	1	0.429	1	0	0	0.333	0	0	0	0.000	0	0	0	0.000	0.75	1.512
1992	0	0	0	0	1	1	1	0.429	1	0	0	0.333	0	0	0	0.000	0	0	0	0.000	0.75	1.512
1993	1	1	1	0	1	1	1	0.857	1	0	0	0.333	0	1	0	0.333	0	1	0	0.333	1	2.857
1994	1	1	1	0	1	1	1	0.857	1	1	0	0.667	0	1	0	0.333	0	1	0	0.333	1	3.190
1995	1	1	1	0	1	1	1	0.857	1	1	0	0.667	0	1	0	0.333	0	1	0	0.333	1	3.190
1996	1	1	1	0	1	1	1	0.857	1	1	0	0.667	0	1	0	0.333	0	1	0	0.333	1	3.190
1997	1	1	1	0	1	1	1	0.857	1	1	0	0.667	0	1	0	0.333	0	1	0	0.333	1	3.190
1998	1	1	1	0	1	1	1	0.857	1	1	0	0.667	0	1	0	0.333	0	1	0	0.333	1	3.190
1999	1	1	1	0	1	1	1	0.857	1	1	0	0.667	0	1	0	0.333	0	1	0	0.333	1	3.190
2000	1	1	1	0	1	1	1	0.857	1	1	0	0.667	0	1	0	0.333	0	1	0	0.333	1	3.190
2001	1	1	1	0	1	1	1	0.857	1	1	1	1.000	0	1	0	0.333	1	1	1	1.000	1	4.190
2002	1	1	1	0	1	1	1	0.857	1	1	1	1.000	0	1	0	0.333	1	1	1	1.000	1	4.190
2003	1	1	1	0	1	1	1	0.857	1	1	1	1.000	0	1	0	0.333	1	1	1	1.000	1	4.190
2004	1	1	1	0	1	1	1	0.857	1	1	1	1.000	0	1	0	0.333	1	1	1	1.000	1	4.190

Source: Based on the Patent Laws & Regulations and the fact in China from 1985-2004

Appendix 4: Patent application in China, 1985-2005

	Domestic					Foreign			
	Total	Invention	Utility Model	Design		Total	Invention	Utility Model	Design
1985	9411	4065	5077	269		4961	4493	97	371
1986	13680	3494	9580	606		4829	4515	93	221
1987	21663	3975	16605	1083		4414	4084	101	229
1988	28582	4780	22190	1612		5429	4872	210	347
1989	27367	4749	20553	2065		5538	4910	174	454
1990	36585	5832	27488	3265		4884	4305	127	452
1991	45395	7372	33157	4866		4645	4051	125	469
1992	61788	10022	44198	7568		5347	4387	171	789
1993	68153	12084	47252	8817		9123	7534	247	1342
1994	67807	11191	45188	11428		9928	7876	323	1729
1995	68880	10018	43429	15433		14165	11618	312	2235
1996	82207	11471	49341	21395		20528	17046	263	3219
1997	90076	12710	49904	27462		24132	20953	225	2954
1998	96248	13726	51226	31296		25741	22234	171	3336
1999	109970	15598	57215	37157		24269	21096	277	2896
2000	140339	25346	68461	46532		30343	26401	354	3588
2001	165773	30038	79275	56460		37800	33166	447	4187
2002	205544	39806	92166	73572		47087	40426	973	5688
2003	251238	56769	107842	86627		57249	48549	1273	7427
2004	278943	65786	111578	101579		74864	64347	1247	9270
2005	383157	93485	138085	151587		93107	79842	1481	11784

Source: 1985-2005 from annual reports of State Intellectual Property Office of China