

**Government-Led Performance Standard and High-Tech Innovation in China:
A Case Study of Zhongguancun High-Tech Development Zone**

By

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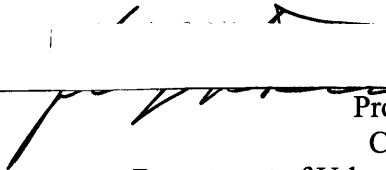
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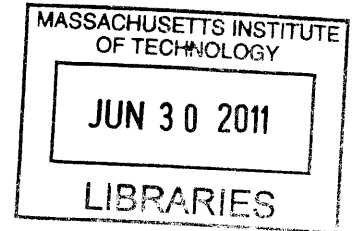
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Abstract

The object of the thesis is to gain an understanding of the role that Chinese government has played in promoting high-tech industries through performance standards and the output the policy generates.

As a latecomer in the high-tech industries, Chinese government has made great efforts to catch up, and the performance standards for High and New Technology Enterprises (HNTEs) are essential to understand the government's strategy. The government sets up concrete, measurable and monitorable performance standards in high-tech development zones, obliges those enterprises to meet these requirement, and grant qualified enterprises a special legal status "HNTEs". This legal status is closely linked to preferential policies such as tax concession, and import substitution to "get the price wrong" and directly allocate resources to the HNTEs. I will use the high-tech development zone (HTDZ) as a basis for my research for two reasons. First, the HNTEs exist in the form of residence in the HTDZ. Second, the central government has viewed the HTDZ as core carrier for the strategic development of high and new technology industry, and will keep encourage industrial cluster towards the HTDZ¹.

My research question is simple, expressed in one sentence: Does the Chinese government succeed in promoting high-tech innovation by imposing the performance standard? Or more specific, does different performance standards lead to significant change of innovation output in HTDZ?

Two methodologies- case study and regression analysis- are applied. I choose Zhongguancun (ZGC) HTDZ as my case study, review implemented laws on performance standard in ZGC and conduct a detailed comparison of two performance standards. Then regression model is used to test my hypothesis that the new performance standard has led to significant increase of the innovation output in ZGC. A brief summary

¹ Decision of the State Council on Cultivating and developing strategic high and new industry, Guofa [2010] no.32

of the regression analysis is that the performance standard is closely correlated with the intermediate innovation output, such as patent application and authorization, and its correlation with commercialized output is more complicated. Based on the result, I conduct two further hypothesis tests. First, I use the intermediate innovation output in Beijing excluding ZGC as a control group and it shows no evidence against the hypothesis that there is casual relationship between performance standard and significant growth of the intermediary innovation output. Second, I check the input level in ZGC, and it implies that the efficiency of high-tech innovation has been improved after the new performance standards.

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List of Abbreviations

DHNTE	Designation of High and New Technology Enterprises
DHNTEB	Designation of High and New Technology Enterprises in Beijing
GDHNTEZ	Guidance on the designation of High and New Technology Enterprises in ZGC
HNTEs	High and New Technology Enterprises
HNTPs	High and New Technology Products
HTIDZ	High-Tech Industrial Development Zone
IRBMCEADNI	Interim Regulation of the Beijing Municipality Concerning the Experimental Area for Developing New-technology Industries
MOST	Ministry of Science and Technology
NICs	Newly Industrialized Countries
OECD	Organization for Economic Co-operation and Development
ZGC	Zhongguancun

1. Introduction

The object of the thesis is to gain an understanding of the role that Chinese government has played in promoting high-tech industries through performance standards and the output the policy generates.

1.1 Research Question and Hypothesis

My original research question is very general: What's the role of government in promoting latecomers' high-tech industries?

Global ideology for economic development and industrialization has become one of open markets, increased foreign investment, and a greater role for the small-scale firm (Amsden and Chu, 2003). The paradigm of free trade, financial deregulation, and the privatization of state enterprises implies that the government should not intervene in the economy and let the self-regulating market do its job.

However, the reality in newly developing countries suggests otherwise. The follower status of high-tech industries of latecomers makes them vulnerable at the world technological frontier. As Richard Hill says, "The international competition, technology gap and barriers to saving for investment facing late developers are so daunting that without government intervention, little gets done"².

Developmentalism is an economic theory that advocates state managed markets in the national interest and it reflects the needs of the state in newly developing countries to attempt to catch up with a more advanced economy. The cases of East Asian NICs (newly industrialized countries) are essential to understand the role of developmental state. Behind the economic performance of the Asian tigers breathes the dragon of the developmental state (Castells, 1992), and the cooperative relations among government, business and labor under state leadership to speed the adoption of new technology, reduce production costs and expand global market share (Hatch and Yamamura 1996:220).

² Taipei Discussion Forum, 2007

Japan is the first nation-state in East Asia to assume a developmental function (Hill, 2007), and [the Japanese] they don't believe in the invisible hand³ (Dore, 2000). But, it turns out that Japan is the first to successfully catch up with the Western capitalist powers. The model is adopted by its neighbors- South Korea, Taiwan and Singapore.

Books by Alice Amsden and Robert Wade are among the most influential publications on East Asia Development. Amsden argues that the newly industrializing countries operate in a different paradigm from the earlier industrializing countries, and as she (1989:40) puts it, "The art is to get something done with intervention." Like Amsden, Wade focuses on the ways in which the state intervened positively in the market, shaping both economic actors and markets for economic growth. In "governing the market", Wade says, "Government resources and influence have promoted investment to be undertaken which would not have been undertaken under strictly free market conditions, thereby generating production and investment outcomes different from what would have happened if government had not intervened in this way."

There are many different policies of government intervention, such as the elective protection of domestic market from foreign import competition, control of the capital market, and industrial policies to upgrade manufacture. In this paper, I will focus on the performance standard that the Chinese government imposed on enterprises for high-tech promotion. The government sets up concrete, measurable, and monitorable performance standard, obliges enterprises to meet certain requirements, and grants qualified enterprises a special legal status, "High and New Technology Enterprise (HNTE)". At the same time, the government deliberately distorts the relative price by allocating direct and generous subsidies to the HNTEs, such as tax concession, import substitution, duty-free import for equipment. These two features- performance standards and subsidies- are only made possible by a strong state.

³ Flexible rigidities: industrial policy and structural adjustment in the Japanese economy, 1970-1980

My revised research question is simple, expressed in one sentence: Does the Chinese government succeed in promoting high-tech innovation by imposing the performance standard? Does different performance standards lead to significant change of innovation output?

1.2 Research Design

Although the performance standards are applied to the enterprises, I will use the high-tech development zone (HTDZ) as a basis for my research for two reasons. First, the HNTEs exist in the form of residence in the HTDZ otherwise they are not eligible to enjoy the preferential policies. Second, the central government has viewed the HTDZ as core carrier for the strategic development of high and new technology industry, and will keep encouraging industrial cluster towards the HTDZ⁴. The performance standard is the independent variable while the innovation output of the national high-tech development zones is the dependent variable.

I will discuss the background of the national performance standard and preferential policies and conduct a detailed descriptive analysis to show their basic structure. It reveals the goal that the central government tries to achieve on high-tech innovation, and the way that it pushes for the goal. I choose Zhongguancun (ZGC) HTDZ as my case study from the 83 national high-tech development zones (Appendix 1), review implemented laws on performance standard in ZGC and conduct a detailed comparison of two performance standards, one from 2000 to 2007 and another from 2008 till now. After the descriptive analysis of the independent variable, I will use regression model to test my hypothesis that the new performance standard has led to significant increase of the innovation output in ZGC.

⁴ Decision of the State Council on Cultivating and developing strategic high and new industry, Guofa [2010] no.32

1.3 Structure of the Thesis

Chapter 2 discusses the background of the performance standard and preferential policies. I will further illustrate the idea of government intervention by conducting a detailed analysis of national laws on performance standard and preferential policies in chronological order to show the basic structure. It reveals the goal that the central government tries to achieve on high-tech innovation, and the way that it pushes for the goal.

Chapter 3 introduces the Zhongguancun (ZGC) High-tech Industrial Development Zone for case study, provides brief information of its development history and location. Also, the advantages and disadvantages of the use of ZGC have been discussed.

Chapter 4 reviews all related laws on performance standard in ZGC, and separate the time into two categories: the “Conditions and Measures on the Designation of High and New Technology Enterprises in National High-Tech Industrial Development Zones (CMDHNTENHTIDZ)” was implemented from 2000 to 2007, and the “Designation of High and New Technology Enterprises (DHNTE)” was implemented from 2008 till now. I conduct a detailed comparison of the two performance standards, and significant change has been made in DHNTE: concrete and measurable requirements are implemented, new institutions have been built with the participation of experts, and output-side indicators have been added.

Chapter 5 uses regression model to test my hypothesis that the new performance standard has led to significant increase of the innovation output in ZGC. A brief summary of the regression analysis is that the performance standard is closely correlated with the intermediate innovation output, such as patent application and authorization, and its correlation with commercialized output is more complicated. Based on the result, I conduct two further hypothesis tests. First, I use the intermediate innovation output in Beijing excluding ZGC as a control group and it shows no evidence against the hypothesis that there is casual relationship between performance standard and significant growth of the intermediary innovation output. Second, I check the input level in ZGC,

and it implies that the efficiency of high-tech innovation has been improved after the new performance standards.

2.National Performance Standards and Preferential Policies on the High and New Technology Enterprises

As a latecomer in the high-tech industries, China has made great efforts to catch up with the world-wide new technology revolution and the government views the next set of growth opportunities had to be created in high-tech industry to “shift China’s development focus in 21st century and achieve high-tech standards attained by developed countries”⁵.

Despite the open-up and liberalization, Chinese government has continued to play an important role in the industrialization, especially in the high-tech industries. The performance standard for HNTes is essential to understand the government’s strategy to promote technological innovation. The government sets up concrete, measurable and monitorable performance standards in high-tech development zones, obliges those enterprises to meet these requirement, and grant qualified enterprises a special legal status “High and New Technology Enterprise (HNTe)”. This legal status is closely linked to preferential policies such as tax concession, and import substitution to allocate resources to these HNTes. The performance standard is a criteria for firms to be eligible for the preferential polices and as a necessary condition to keep receiving the resources. Firms that performed poorly are removed from the list of HNTes and excluded from preferential treatment.

Wan Gang⁶, the Minister of Science and Technology, gave a speech on the performance standards for HNTes in 2010. He said, “the National Party's Congress made it clear that ‘Enhancing the independent innovation capability and building an innovative country is the core of national development strategy and the key to enhance the overall national strength. HNTes are definitely an important foundation for the high-tech development in China. They play a strategic position in adjusting the industrial structure, and enhancing the national competitiveness. We need to grant and guide innovative resources to the

⁵ http://www.qstheory.cn/tbzt/jkjjfzfszb/qwsy/201006/t20100610_32864.htm

⁶ Wan Gang is a Chinese expert on automobiles, former president of Tongji University (2002-2007) and the Minister of Science and Technology (2007-).

HNTes.’ So the Ministry of Science and Technology, the Ministry of Finance and State Administration of Taxation cooperate to achieve this goal. ”⁷ Gang’s speech and related laws on performance standards and preferential policies in a chronological order shows that the government intervention has been greater and more systematic in promoting high-tech innovation. The State Council decides the goal to achieve, point the direction and the Ministry of Science and Technology, Ministry of Finance, State Administration of Taxation and General Administration of Customs work together to enact the law.

I will illustrate the idea of government intervention in high-tech industries by conducting a detailed analysis of national laws on performance standard and preferential polices in chronological order to show their basic structure.

⁷ http://www.qsttheory.cn/tbzt/jkjjfzfszb/qwsy/201006/t20100610_32864.htm

2.1 Three National Performance Standards

2.1.1 National Law on the Performance standard for HNTEs

The Ministry of Science and Technology has enacted three policies on the national performance standard for HNTEs in the high-tech industrial development zones 1991, 2000 and 2008 separately (Table 2.1).

Table 2.1. National Laws on the performance standard for HNTEs

National Law	Released Date	Application Range
“Conditions and Measures on the Designation of High and New Technology Enterprises in National High-Tech Industrial Development Zones” [1991] no.12	3/6/1991	Companies located in National High-tech Industrial Development Zones
“Conditions and Measures on the Designation of High and New Technology Enterprises in National High-Tech Industrial Development Zones” [2000] no.324	7/23/2000	Companies located in National High-tech Industrial Development Zones
“Designation of High and New Technology Enterprises” [2008] no.172 & “Key high-tech areas supported by the state”	4/14/2008	Companies located in and out National High-tech Industrial Development Zones

(Source: Conditions and Measures on the Designation of High and New Technology Enterprises in National High-Tech Industrial Development Zones, [1991] no.12; Conditions and Measures on the Designation of High and New Technology Enterprises in National High-Tech Industrial Development Zones, [2000] no.324; Designation of High and New Technology Enterprises, [2008] no.172)

2.1.2 Structure of the Performance Standard

The national laws on the performance standard are well-organized, especially when we compare with the national laws on the preferential policies for HNTes. First, these three national laws are all enacted by the Ministry of Science and Technology, and the implementation is strict in the sense that no local government and national high-tech industrial development zones have the rights to change the performance standard during the implementation unless the State Council approved the specific adjustment. Second, although these three policies have different detailed requirement for high and new technology enterprises, they shared the same structure. It clearly tells the goal that the central government tries to achieve on high-tech innovation and the way it pushes for the goal. I will use the “Conditions and Measures on the Designation of High and New Technology Enterprises in National High-Tech Industrial Development Zones”[1991] no.12 to explain the structure from four aspects.

1) Key high-tech areas

Specific high-tech areas are listed “According to the international trend of high and new technology and the technological, economic and social development strategy in China”⁸. Only companies in these high-tech areas will be taken into consideration during the designation. These are eleven high-tech areas in the policy in 1991:

- 1. Microelectronics science and electronic information technology*
- 2. Space science and aerospace technology*
- 3. Photoelectron and optical, mechanical and electronic integration*
- 4. Life science and biology engineering technology*
- 5. Material science and new material technology*
- 6. Energy science, new energy and energy-efficient technology*
- 7. Ecology and environmental protection technology*
- 8. Geoscience and ocean engineering technology*
- 9. Science of fundamental matters and radiation technology*

⁸ Chapter 4, Conditions and Measures on the Designation of High and New Technology Enterprises in National High-Tech Industrial Development Zones”[1991] no.12

10. Pharmaceutical science and biomedical engineering

11. High-tech that has the ability to reconstruct traditional industries

2) Requirement on Location, Company Activity, and Operation Periods

The enterprises must be located in the national high and new technology industry development zones⁹.

The enterprise is engaging in the research, development, production, and sale of one or more high technologies in the key high-tech areas. However, pure commercial distribution of such technologies and their products are excepted.

Its operation shall be more than 10 years.

The duration of those classified as high and new technology products shall be within 5 years. For products that have longer technological cycles, the duration shall be extended to 7 years.

3) Requirement on Personnel

The person in charge of the enterprises shall be familiar with the research, development, production, and sale of the products in the enterprise, and shall be the full time personnel.

Personnel with college and university degree shall account for more than 30% of all the staffs in the enterprises. Personnel engage in the research and development of high and new technology products shall account for more than 10% of all the staffs in the enterprises.

For the labor-intensive high and new technology enterprises, personnel with college and university degree shall account of more than 20% of all the staffs in the enterprises.

4) Requirement on R&D

The enterprise has more than RMB 100,000 yuan as their own funds, as well as appropriated places and facilities corresponding to their respective scale of business activities.

⁹ Article 2, Conditions and Measures on the Designation of High and New Technology Enterprises in National High-Tech Industrial Development Zones"[1991] no.12

More than 3% of the gross revenue of the enterprises shall be spent on the research and development of high and new technology products.

The gross revenue of the enterprise shall be composed of technology income, output value of high and new technology productions, output value of ordinary technology products and technology-related trade. The aggregate of technological income¹⁰ and output value of high and new technology products shall account for more than 50% of the annual gross revenue of the enterprises.

2.2 Preferential Policies

It's more difficult to summarize the laws on preferential policies for HNTEs than the laws on performance standards. These preferential policies are scattered into different law system, and I have to read through a large amount of laws and regulations in order to get one or two articles on HNTEs. After intense reading and research, I find out that over 30 laws at the national level are related to the preferential policies on HNTEs. In order to convey a basic idea of the shared preferential policies at the national level, I have to omit related laws in the following four areas.

1) Geographic bias: According to the “Notification of the State Council on Providing Transitional Preferential Tax Treatments to High and new enterprises in Special Economic Zones and in Shanghai Pudong New District, State Council [2007] no.40”(Appendix 2), the high and new technology enterprises in Shenzhen, Zhuhai, Shantou, Xiamen, Hainan development zones and Shanghai Pudong New district could enjoy more generous benefits than high and new technology enterprises in other areas in China.

¹⁰ Technological income shall mean income derived from technical consultancy, technology transfer, technology contributed as equity investment, technical service, technical training, technical engineering design and contracts, technology export, adoption and acquisition of imported technology and trial productions.

2) Industrial bias: The central government is more generous to certain industries, especially the software industry. From 2000 to 2003, there are 6 laws enacted to grant additional benefits to the software industry and integrated circuit industry. (Appendix 3)

3) In order to encourage technological innovation, the central government grants benefits to the incubator enterprises (Appendix 4) that serve as technology support for the high and new technology enterprises, but it hasn't been listed as direct preferential policy.

4) Transitional policies for high and new technology enterprises to go through authorization again under the updated performance standards. (Appendix 5)

2.2.1 National Law on the Preferential Policies for High and New Technology Enterprises

Table 2.2. National laws on the preferential policies for HNTes

Documents	Released Date	Issued Government	Benefits
Provisional Regulation on the development of national high-tech industrial development zones [1991] no.12	3/1991	Ministry of Science and Technology	1) Exemption from income tax in the first two profit-making years; 2) Reduced income tax after two years; 3) Low-interest Loan; 4) Import Substitute
Circular on the preferential policies on the enterprises income tax, Ministry of Finance, State Administration of Taxation [1994] no.1	1/1994	Ministry of Finance	Reduced income tax;
Circular of the Ministry of Finance and the State Administration of Taxation on Tax Issues Related to the Implementation of the Decision of the	11/1999	Ministry of Finance, State Administration of Taxation	1) Exemption from the sales tax for qualified technology transfer; 2) Exemption from

CPC Central Committee and State Council on Strengthening Technical Innovation, Development of High-tech and Realization of its Industrialization, Ministry of Finance, State Administration of Taxation [1999] no.273			custom duty and value-added tax for imported equipment
Law of the People's Republic of China on Enterprise Income Tax, Order of the President of the People's Republic of China, [2007] no.63	3/16/2007	President Hu Jintao	Exemption from income tax for technology transfer
Implementation Rules of Enterprise income Tax Law of the People's Republic of China, State Council [2007] no.512	11/28/2007	State Council	More specific requirement on the amount for exemption on enterprise income for technology transfer

(Source: Provisional Regulation on the development of national high-tech industrial development zones [1991] no.12; Circular on the preferential policies on the enterprises income tax, Ministry of Finance, State Administration of Taxation [1994] no.1; Circular of the Ministry of Finance and the State Administration of Taxation on Tax Issues Related to the Implementation of the Decision of the CPC Central Committee and State Council on Strengthening Technical Innovation, Development of High-tech and Realization of its Industrialization, Ministry of Finance, State Administration of Taxation [1999] no.273; Law of the People's Republic of China on Enterprise Income Tax, Order of the President of the People's Republic of China, [2007] no.63; Implementation Rules of Enterprise income Tax Law of the People's Republic of China, State Council [2007] no.512)

2.2.2 Structure of the Preferential Policies

From the five national laws on preferential policies, the central government could directly allocate resources to the HNTEs in four ways:

1) Import Substitute

Once the indicators of the high and new technology products developed by the domestic high and new technology enterprises reached the level of imported products and these domestic enterprises possess a certain production capacity, such import shall be controlled by existing import administration measures and these products shall be added into the “Prohibited Imported Products Catalogue”.¹¹

2) Enterprise Income Tax

A newly-established high and new technology enterprise may, upon approval by the taxation authorities of an application filed by the enterprise, be exempted from income tax in the first two operation years.¹²

While a newly-established enterprise in parks using Chinese and foreign investments scheduled to operate for a period of 10 years or more may, upon approval by the tax authorities of an application filed by the enterprise, be exempted from income tax in the first two profit-making years.¹³

High and new technology enterprises in key high-tech areas are subject to the applicable 15% enterprises income tax rate.¹⁴

¹¹ Article 9, Provisional Regulation on the development of national high-tech industrial development zones, 1991

¹² Article 6, Annex 3, Condition and Measures on the designation of high and new technology enterprises in national high-tech industrial development zones, [1991] no.12; Circular on the preferential policies on the enterprises income tax, Ministry of Finance, State Administration of Taxation [1994] no.1

¹³ Article 6, Annex 3, Condition and Measures on the designation of high and new technology enterprises in national high-tech industrial development zones, [1991] no.12

¹⁴ Article 1, Circular on the preferential policies on the enterprises income tax, Ministry of Finance, State Administration of Taxation [1994] no.1; Article 28, the law of the People's

When the export value of a high and new technology enterprise exceeds 70% of its total annual output, the enterprise income tax shall be levied at a reduced rate of 10% after being verified by the taxation authorities.¹⁵

On Technology Transfer

The income from qualified technology transfer shall be subject to exemption or reduced enterprise income.¹⁶

The amount of exemption on enterprise income for a technology transfer is up to 5 million. In the case of any excess over 5 million, there shall be allowed a 50% enterprise income tax credit.¹⁷

3) Sales Tax

The income derived from technology transfer¹⁸, technology development¹⁹, and their related technology consultation and technology service²⁰ offered by the units or individuals (including enterprises with foreign investment, the research and development centers invested and set up by foreign business, foreign enterprises, and foreign nationals)

Republic of China on Enterprise Income Tax, Order of the President of the People's Republic of China, [2007] no.63

¹⁵ Article 5, Annex 3, Condition and Measures on the designation of high and new technology enterprises in national high-the industrial development zones, [1991] no.12

¹⁶ Article 27(4), the law of the People's Republic of China on Enterprise Income Tax, Order of the President of the People's Republic of China [2007] no.63

¹⁷ Article 90, Implementation Rules of Enterprise income Tax Law of the People's Republic of China, State Council [2007] no.512

¹⁸ Technology transfer refers to the act of a transferor to transfer non- gratuitously the ownership or the right of use to its own patent or non- patented technology to another person.

¹⁹ Technology development refers to the act of a developer, upon entrustment of another person, to research into and develop new technology, new product, new technique or new material, as well as the system thereof.

²⁰ Technology consultation refers to the provision of reports concerning a specific technological project on such subjects as feasibility study, technical projection, special technological investigation, and analysis and evaluation. Technology consultation and technology services related to the technology transfer and technology development refer to the provision of technology consultation and technology services by the transferor (or the agent) to help the transferee (or the principal) master the transferred (or developed upon entrustment) technology according to the provisions of the technological transfer or development contact. In addition, the payment for the technology consultation and technology services is written on the same invoices with that for technology transfer (or development).

shall be exempt from the sales tax.²¹

If the transfer of technology by foreign enterprises and foreign individuals from outside our territory to the territory of China needs to be exempt from business tax, the technological transfer or development contract in writing, the written application of the taxpayer or its/his agent, and the certificate of examination and verification issued by the administrative department of science and technology at the provincial level in the place where the transferee is located shall, after examination and verification by the competent taxation authorities at the provincial level, be submitted to the State Taxation Administration for approval.²²

4) Import and Export

The equipment for self-use imported by enterprises to make products listed in the Catalogue of the State New & High-tech Products and the technology, accessories and the spare parts imported together with the equipment according to the contract shall be exempt from customs duty and the import-linked value-added tax with the exception of those commodities included in the Catalogue of Imports Not Exempt from Tax for Domestic Investment Projects provided by the Document GuoFa [1997] no. 37.²³

Where enterprises introduce the advanced technologies listed in the Catalogue of the State New & High-tech Products, the software charges²⁴ paid to a person outside our territory as provided by the contract shall be exempt from customs duty and the import-linked value-added tax.²⁵

²¹ Circular of the Ministry of Finance and the State Administration of Taxation on Tax Issues Related to the Implementation of the Decision of the CPC Central Committee and State Council on Strengthening Technical Innovation, Development of High-tech and Realization of its Industrialization, Ministry of Finance, State Administration of Taxation [1999] no.273

²² Ibid

²³ Ibid

²⁴ Software charges refer to the patent royalties, trademark fees, and the expenses for technical know-how, computer software, materials and etc. paid by the taxpayer of imports to the seller outside of our territory for the manufacturing, use, publication, distribution and broadcasting of the imports' technology and contents within our territory.

²⁵ Circular of the Ministry of Finance and the State Administration of Taxation on Tax Issues Related to the Implementation of the Decision of the CPC Central Committee and State Council

With respect to the products listed in the Catalogue for Export of China's New & High-tech Commodities issued by the Ministry of Science and Technology and the Ministry of Foreign Trade and Economic Cooperation, if the rate of tax refunded for its export is lower than that of tax levied, the tax levied may, subject to the examination and verification of the State Administration of Taxation, be refunded according to the rate of tax levied and the current provisions for administration of tax refund for export after the product is exported.²⁶

Three aspects of the preferential policies are worthy mentioning. First, these preferential policies indicate the central government has paid great attention on the HNTes. Most existing preferential tax policies have been canceled in the new law on enterprise income tax—"Law of the People's Republic of China on Enterprise Income Tax, Order of the President of the People's Republic of China, [2007] no.63", but all the preferential tax policies for HNTes have not only been kept, but expanded to be applied uniformly across the country. Famous enterprise tax lawyer Liu Tianyong said that these policies have encouraged enterprises to include HNTe qualification into the enterprise future plan²⁷.

Second, foreign high-tech enterprises, or joint enterprises with Chinese and foreign investments have to meet more stringent requirements, and the financial benefits they receive are relatively small. However, technology transfer from foreign enterprises to domestic enterprises is extremely encouraged.

Third, the central government has closely linked the development of HNTes and their products with import substitution. Once the domestic production of high and new products reach the import level and have the production capacity, then the imported products will be added into the "Prohibited Imported Products Catalogue".

on Strengthening Technical Innovation, Development of High-tech and Realization of its Industrialization, Ministry of Finance, State Administration of Taxation [1999] no.273

²⁶ Ibid

²⁷ <http://blog.ce.cn/html/63/112463-135880.html>

2.3 Choice of Independent Variable

Although the performance standard and preferential policies should be understood as a whole, I will only use the performance standard as the independent variable for innovation output for two reasons.

First, the national laws on performance standard are all enacted by the Ministry of Science and Technology and it's easy to track them down to the local level while the preferential policies are enacted by different Ministries and scattered into over 30 laws. Therefore, it's almost impossible to track down to the local level to confirm the implementation of each policy.

Second, the implementation of the performance standards is strict so no local government and national high-tech industrial development zones have the right to change the performance standards unless the State Council approves the specific adjustment, but the preferential policies vary at the local level. The local governments have participated in intense competition to attract business and have enacted local laws for more preferential policies²⁸, such as government-led venture capital, loans with interest rate lower than normal commercial loans and cheap land. In another word, the national preferential policies only capture little of the true benefits that HNTEs enjoy, and it's difficult to build a clear timeline if we use the preferential policies as the independent variable.

²⁸ Tong Dahuan, <http://www.ftchinese.com/story/001036562>

3. Case Study- Zhongguancun High-Tech Industrial Development Zone

3.1 Background on ZGC

I investigate a specific example of high-tech industrial development zone in China, the Zhongguancun (ZGC) High-Tech Development Zone. ZGC, the so-called “China’s Silicon Valley” is legendary pilot in China’s science and technology history and it has been the largest cluster of semiconductor, computer, and telecommunication firms in China.

History

One scientist in the Chinese Academy of Science (CAS), Chen Chunxian, was the father of ZGC. As a result of Richard Nixon and Mao’s agreement, the United States and China engaged in exchange friendship program and Chen was invited to visit the United States in 1979. During this trip, Chen was inspired by the Silicon Valley and Route 128 in Massachusetts and upon return he started his own technology consulting firm- Beijing Plasm Association Advanced Technology Service Office on October 23, 1980. It’s the first time Beijing had an entrepreneurial initiative in the market and the idea of commercializing research. In an interview in 2004, Chen said, “I don’t think this (setting up a private consulting company in 1980s) is anything special. Chinese scientists have gone through a very difficult time in the 1960s. In the 1970s, we went to America and then we asked ourselves ‘Why can’t we do things in a better way? Why can’t we do the same as Silicon Valley and route 128 in China?’”²⁹ More professionals from CAS and nearby Universities followed Chen, acted as risk-takers and devoted themselves to this experiment. Technological researches were gradually transformed into marketable products and an “Electronics Streets” was formed.

In 1986, the central government conducted a systematic survey in the “Electronics Streets” and the State Science and Technology Commission, the predecessor of the Ministry of Science and Technology, began research on high-tech parks in other countries in order to

²⁹ <http://gaige.rednet.cn/c/2008/02/26/1447537.htm>

replicate their successful experience in China. Also, the increasing enterprises propelled the government to launch the National Torch Program to support the formation of high-tech development zone. In 1988, the State Council approved setting up the Beijing Experimental Zones for New Technology and Industrial Development and “Electronics Streets” became the first national high-tech development zone in China. ZGC marks the starting point of the high-tech development in China.

Location

ZGC has 10 sub-parks (Figure 3.1) all across the city with the centerpiece- Haidian Park in the northwestern Beijing. The total area is 232 square kilometers. In 2010, ZGC contributes 19.2%³⁰ of the total GDP in Beijing.

Figure 3.1. Layout of ZGC



³⁰ http://www.zgc.gov.cn/pflzn/mtbd_sfqlzn/69854.htm

3.2 Advantage and Disadvantage of Using ZGC as Case Study

I have to admit that ZGC is a special case. First, ZGC is home to top universities such as Qinghua University, Beijing University, 60 institutions of higher education and more than 200 research institutes. No other high-tech development zone enjoys the strong research capacity. Second, statistic has approved the significance of ZGC among the 83 national high-tech development zones. From different indicators, I choose the number of HNTes, the number of employees and export to illustrate the point (Table 3.1). It shoes that ZGC might not be representative of other high-tech development zones in China (Figure 3.2, 3.3, 3.4).

Table 3.1. Comparison of numbers of HNTes, number of employees and export between ZGC and the all national high-tech development zones in China

Year	Total Number of HNTes		Total Number of employees (10,000 Persons)		Export (Billion, Dollar)	
	All national high-tech development zones	ZGC	All national high-tech development zones	ZGC	All national high-tech development zones	ZGC
1988	-	527	-	1	-	0.1
1989	-	850	-	-	-	0.3
1990	-	974	-	-	-	0.4
1991	2587	1343	14	-	1.8	0.5
1992	5569	2442	34	6.9	4.1	0.7
1993	9687	3769	55	10.8	5.4	1.1
1994	11,748	4229	80	11.26	12.7	1.3
1995	12,937	4438	99	12	28.8	2.3
1996	13,722	4506	129	12.5	43	2.5
1997	13,681	4525	148	15.9	64.8	3.1
1998	15,935	4931	180	17.3	78.5	6.5

1999	17,497	5576	221	24.3	119.1	9.6
2000	20,796	6186	251	29.3	186	18.2
2001	24,293	8019	294	36.1	226	30.5
2002	28,338	9673	349	40.6	329	28.8
2003	32,857	12030	395.4	48.9	570	32.9
2004	39,000	13957	448.4	55.7	824	53.6
2005	41990	16452	521.2	69.1	1116.5	94.9
2006	45000	18149	540	79.2	1355.1	137.3
2007	48472	21025	-	89.9	1728.1	197.1
2008	52,632	18437	716.5	94.1	2015.2	207.4
2009	53,692	17940	815.3	106.2	2007.2	208.2
2010	-	15754	-	-	-	223.1

(Source: Annual review of economic development in ZGC from 2000-2010; The almanac of ZGC from 2008-2010; Development review on the twentieth anniversary in ZGC)

Figure 3.2. Ratio of HNTEs in ZGC to the HNTEs in all 83 national high-tech development zones

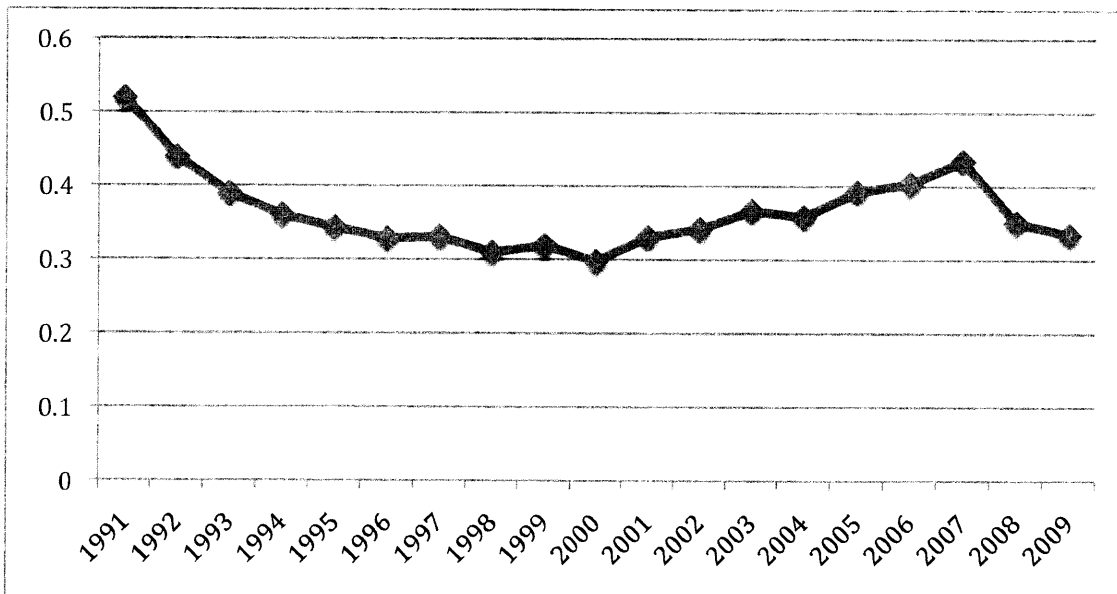


Figure 3.3. Ratio of employees in ZGC to the employees in all 83 national high-tech development zones

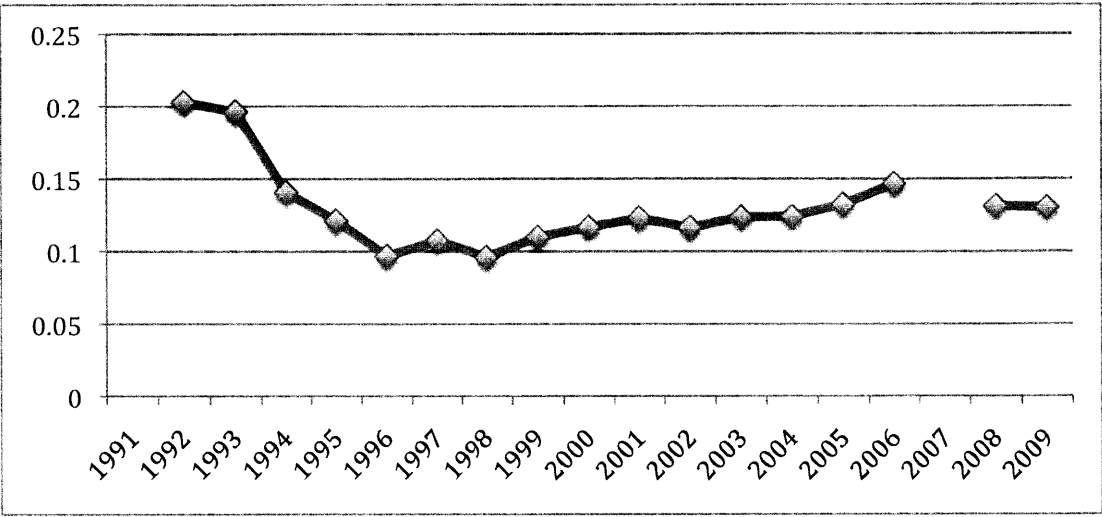
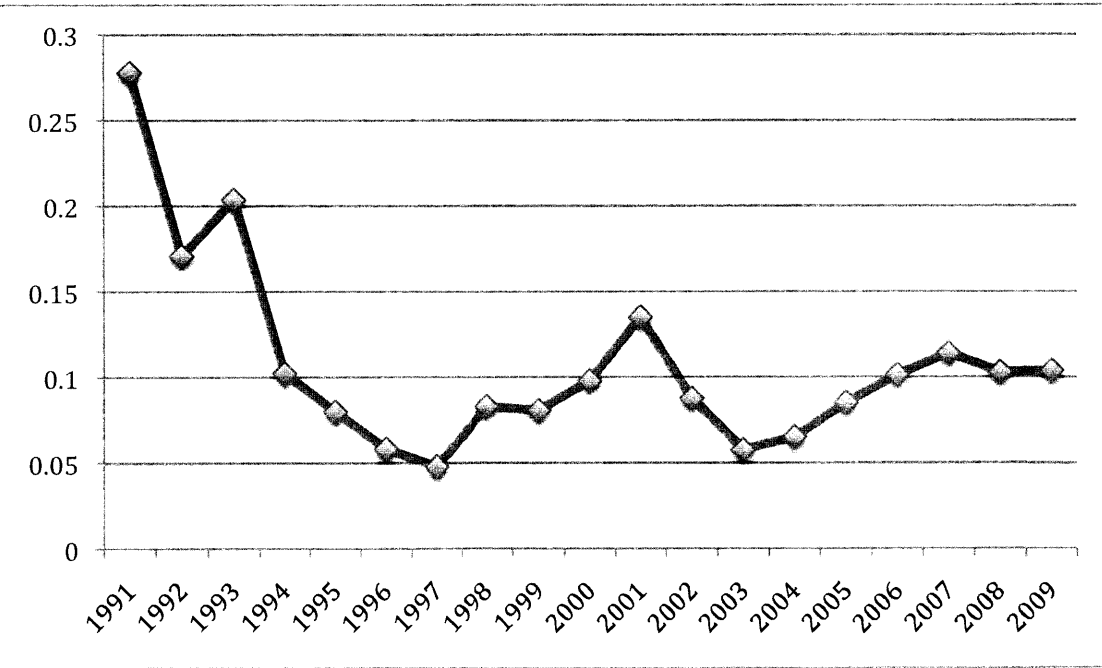


Figure 3.4. Ratio of export in ZGC to the export in all 83 national high-tech development zones



But I choose ZGC because I am more interested in a development zone that the central government pays a lot of attention rather than a development zone that is representative of the national level. Since ZGC is located in Beijing, it's easier for the central government to monitor its behavior and the implementation of the performance standards and shape the high-tech development zone to its expectation. So ZGC definitely gives more information about how the central government thinks in terms of hi-tech promotion.

Another advantage to choose ZGC is the relatively availability of data (Appendix 6). Few national high-tech development zones publish detailed polices on their performance standard, but due to the importance of ZGC in China and its closeness to the central government, the related local laws and regulation are clearly documented. The database in ZGC is relatively well-maintained compared to the other 82 national high-tech development zones. I will conduct a detailed descriptive analysis on the laws and regulation in chapter 4 and statistical analysis on the innovation outcome in chapter 5.

4. Performance Standard in ZGC

4.1 Implemented Performance Standard in ZGC

I review all the related laws on performance standards since 1978 at the national and the city level since 1978, and then confirm their implementation in ZGC through its official website³¹. Four related laws have been enacted in Beijing, and I list them in a chronological order in Table 4.1.

Table 4.1. Implemented and non-implemented laws of performance standard in ZGC

Document	Released date	National Policy as Guidance	Issued Government	Implementation in ZGC
Interim Regulation of the Beijing Municipality Concerning the Experimental Area for Developing New-technology Industries (IRBMCEADNI)	5/20/1988	No	Beijing Municipal People's Government	No
Designation of High and New Technology Enterprises in Beijing Jingkegaofa [2001] no.364 (DHNTEB [2001] no.364)	7/2/2001	Yes (Conditions and Measures on the Designation of High and New Technology Enterprises in National High-Tech Industrial Development Zones [2000] no.324)	Beijing Municipal Science & Technology Commission	Yes
Guidance on the	3/2009	Yes	Management	Yes

³¹ <http://www.zgc.gov.cn/zcfg10/>

designation of High and New Technology Enterprises in ZGC (GDHNTEZ)		(Designation of High and New Technology Enterprises” [2008] no.172 & “Key high-tech areas supported by the state)	Committee of ZGC	
Outline of the development planning of the ZGC from 2011 to 2020 ³²	1/2011	No	Management Committee of ZGC	No

(Source: Interim Regulation of the Beijing Municipality Concerning the Experimental Area for Developing New-technology Industries; Designation of High and New Technology Enterprises in Beijing, Jingkegaofa [2001] no.364; Guidance on the designation of High and New Technology Enterprises in ZGC; Outline of the development planning of the ZGC from 2011 to 2020)

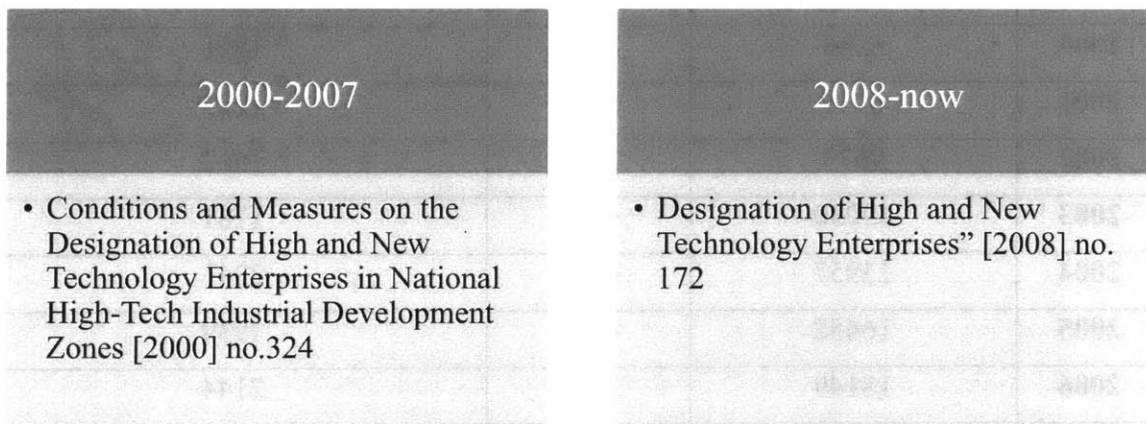
The first regulation- “Interim Regulation of the Beijing Municipality Concerning the Experimental Area for Developing New-technology Industries” was enacted in 1988. Although regulation hasn’t been implemented in ZGC, it shows a prototype of the performance standards. The second and third laws on performance standard all have national policy have guidance, and are released one year after the national policies. They’re largely in accordance with the national policy, but with slight local modifications. The fourth related regulation is the “Outline of the development planning of the ZGC from 2011 to 2020”, and it is enacted by the management committee of ZGC to make small adjustment from the 2009 regulation. Since the “Interim Regulation of the Beijing Municipality Concerning the Experimental Area for Developing New-technology Industries” has never been implemented and the “Outline of the development planning of the ZGC from 2011 to 2020”, has only been implemented for 4 months, I will omit these two regulations and only focus on the second and third regulation.³³

³² State Council Approval, Guohan [2011] no.12

³³ <http://www.zgc.gov.cn/fzbg/yjkt/index2.htm>

Both the “Designation of High and New Technology Enterprises in Beijing” in 2001 and the “Guidance on the designation of High and New Technology Enterprises in ZGC” have national policies as guidance. The implementation of the performance standards actually started right after the national policy in 2000 and 2008, while the local policies were enacted one year later³⁴. So I separate the time into two categories: from 2000 to 2007 and from 2008 till now (Figure 4.1).

Figure 4.1. Two time categories and related performance standards



The government is serious about the performance standard, and their implementation is stringent. I collect the numbers of HNTes, new HNTes and evicted HNTes that failed to meet the performance standard from 1988 to 2010 (Table 4.2).

Table 4.2. The number of total HNTes, new HNTes, evicted HNTes that fail to meet the performance standard from 1988-2010 in ZGC

Year	Total Number of HNTes	New HNTes	Evicted HNTes that fail to meet the performance standards
1988	527	-	-
1989	850	-	-
1990	974	-	-

³⁴ <http://www.zgc.gov.cn/zcfg10/>

1991	1343	-	-
1992	2442	-	-
1993	3769	-	-
1994	4229	-	-
1995	4438	-	-
1996	4506	-	-
1997	4525	-	-
1998	4931	-	-
1999	5576	1227	582
2000	6186	2461	1851
2001	8019	3060	1227
2002	9673	3321	1667
2003	12030	4138	1781
2004	13957	4268	2341
2005	16452	4434	1939
2006	18149	3841	2144
2007	21025	3772	896
2008	18437	966	3544
2009	17940	2114	3196
2010	15754	-	-

(Source: Annual review of economic development in ZGC from 2000-2010; The almanac of ZGC from 2008-2010; Development review on the twentieth anniversary in ZGC)

Figure 4.2 shows that the total number of HNTes in ZGC have been grown from 1988 to 2007 but encountered sharp decline from 2008 (Figure 4.2). We also observe turning points for the number of new HNTes and evicted HNTes in 2008 in Figure 4.3. It's closely related to the change of performance standard, and I will conduct detailed comparison of the two performance standards in chapter 4.2.

Figure 4.2. The total number of HNTes in ZGC from 1988-2009

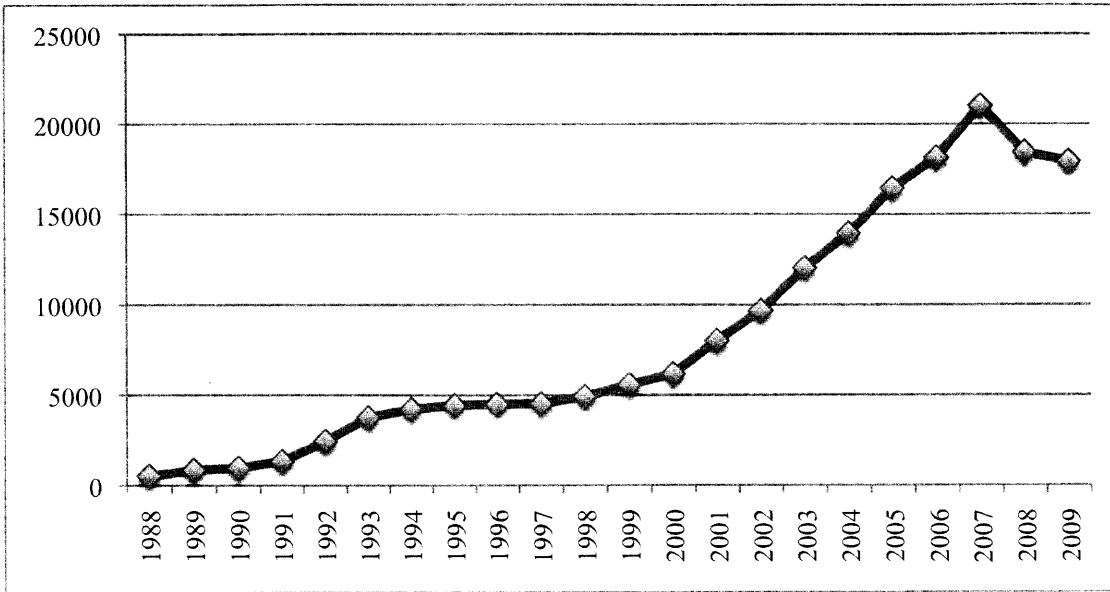
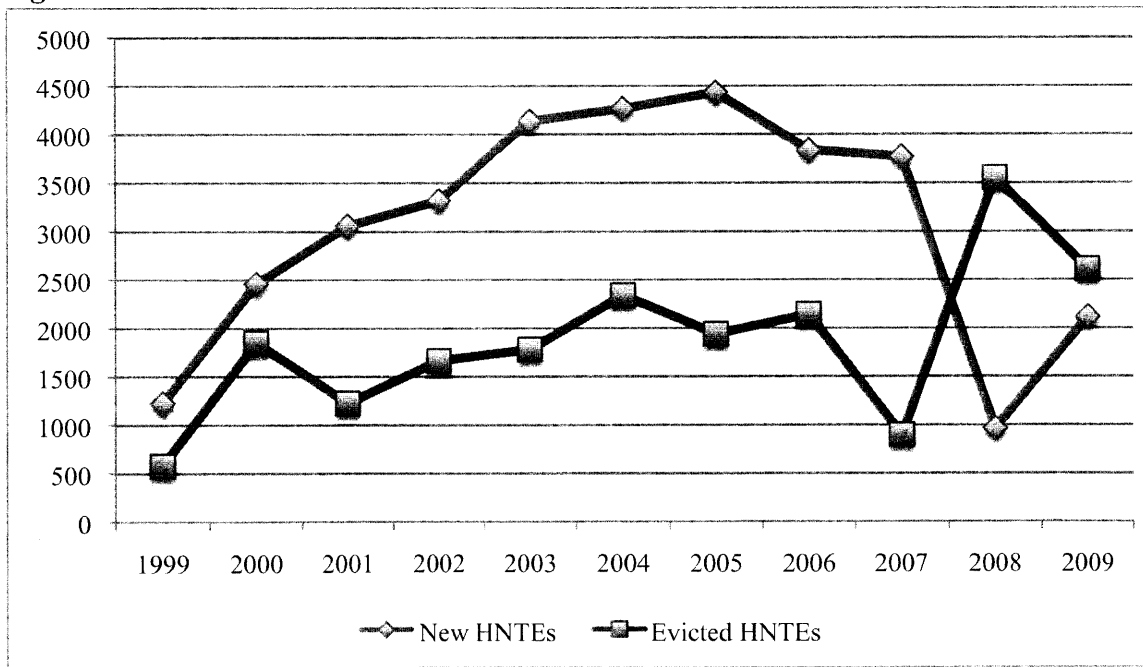


Figure 4.3. The number of new HNTes and evicted HNTes from 1999-2009



4.2 Detailed Comparison of the Performance Standards between “Conditions and Measures on the Designation of High and New Technology Enterprises in National High-Tech Industrial Development Zones (CMDHNTENHTIDZ) [2000] no.324” and Designation of High and New Technology Enterprises (DHNTE) [2008] no.172”

The government frankly acknowledges that the Organization for Economic Co-operation and Development (OECD), the United States and Korea are the role model for the performance standard in 2008- DHNTE, and intense research has been conducted to draw on international experience in the high-tech areas. In comparison to the CMDHNTENHTIDZ in 2000, DHNTE has been more systematic with uniform, concrete and measurable requirement, institutions-building for top-down mechanism. Also, it's more result-oriented and the first time the innovation output has been included in the requirement. I will conduct a detailed comparison of the two performance standards from the six aspects listed below.

4.2.1 Definition of high-tech areas

Specific high-tech areas are listed “according to the international trend of high and new technology and the technological, economic, and social development strategy in China”³⁵. The choices were based on the careful study of technological development and trends by the committee of government, business, and university experts. Only companies in these high-tech areas will be taken into consideration during the qualification. Table 4.3 shows the change of high-tech areas between CMHNTENHTIDZ [2000] no.324 and DHNTE [2008] no.172.

³⁵ Chapter 4, Conditions and Measures on the Designation of High and New Technology Enterprises in National High-Tech Industrial Development Zones”[1991] no.12

Table 4.3. Comparison of high-tech areas in CMHNTENHTIDZ [2000] no.324 and DHNTE [2008] no.172

Documents	Conditions and Measures on the Designation of High and New Technology Enterprises in National High-Tech Industrial Development Zones (HNTENHTIDZ) [2000] no.324	Designation of High and New Technology Enterprises (DHNTE) [2008] no.172
Definition of high-tech areas	1.Electronic information technology	1.Electronic information technology
	2.Bioengineering and New medical technology	2.Bioengineering and New medical technology
	6.Modern agricultural science and technology	
	5.Aerospace technology	3.Aerospace technology
	3.New material technology	4.New material technology
	-	5.High-technology service (New)
	7.New energy and energy-efficient technology	6.New energy and energy-efficient technology
	10.Nuclear application technology	
	8.Environmental protection technology	Resource and environment technology
	4.Advanced manufacture technology	High-tech that has the ability to reconstruct traditional industries
9.Ocean engineering technology		

(Source: Conditions and Measures on the Designation of High and New Technology Enterprises in National High-Tech Industrial Development Zones (HNTENHTIDZ) [2000] no.324” and Designation of High and New Technology Enterprises (DHNTE) [2008] no.172)

4.2.2 Core intellectual property

DHNTE [2008] no.172 highlights the independent and exclusive core intellectual property, without which no legal status “HNTE” can be granted. Also, the main products of the enterprises must use the core intellectual property. It’s result-oriented policy, and an ambitious move for the central government to push HNTEs for high-tech innovation.

Intellectual property rights include: invention, utility models as well as non-simple-pattern-change product designs (it mainly refers to the product designs through scientific research and development), software copyrights, integrated circuit layout design and new plant varieties³⁶.

Enterprises who register in China (excluding Hong Kong, Macao and Taiwan) must get the intellectual property either by independent research and development, tech transfer, tech recipient and mergers and acquisitions in the past three years, or has obtained it for more than 5 years³⁷.

The intellectual property shall be registered in China, or the enterprise has more than five-year worldwide license rights. Also, the intellectual property should be in effective protection of laws in China³⁸.

The authenticity of the intellectual property must be able to verified through the Intellectual Property Office of the PRC by patent tag and patent number. The software

³⁶ Guidelines for the management of HNTEs, 2008

³⁷ Ibid

³⁸ Ibid

*copyright for the software companies must be able to verify through the website of Chinese Copyright Protection Center under the National Copyright Administration*³⁹.

4.2.3 Relate R&D expense with the enterprise size

Based on the development stage of the HNTes in China, DHNTE [2008] no.172 made adjustment to the ratio of R&D expense in the total sale income according to the size of the HNTes.

Liang Gui⁴⁰, the director general Torch High Technology Industry Development Center under the Ministry of Science and Technology addressed this issue in a 2009 interview. He said, “In the late 1990s, most Chinese HNTes just started and were at a development stage. They mainly engaged in the R&D activities and high-tech products development, and the sale scale is minimal. That’s the major reason that the central government uses 5% as the ratio of R&D expense as a percentage of the sale income, but it doesn’t fit the situation in the 21st century.”⁴¹ According to Liang, HNTes have made great progress, and their economies of scale have gone through rapid growth. One pattern shows up: the ratio of R&D expense in the total sale income decrease when the size of the enterprise grows larger. When the enterprises go through the start-up period, they invest more on market development and expansion of the production capacity, so the ratio will decrease. After taking the development of HNTes in China into account and statistic analysis of the national R&D level of the HNTes, the DHNTE relate the ratio of R&D expense in the sale income with the size of the HNTes.

³⁹ Ibid

⁴⁰ Liang Gui obtained PHD in mathematics from Fudan University and completed post doctoral research in real estate investment and urban economy. He used to be the director general of Shanghai Pudong Science and Technology Department, Pudong Economic and Trade Bureau, and he also worked as senior managers in several high-tech companies. He has published paper and books on Venture Capital and Entrepreneurship in China and western countries.

⁴¹ http://www.gov.cn/zwhd/2009-01/23/content_1213827.htm

For HNTEs with annual sales revenue lower than 50 million, the ratio of R&D expense in the total sale income=6%⁴²;

For HNTEs with annual sales revenue between 50 million to 2 billion, the ratio of R&D expense in the total sale income=4%⁴³;

For HNTEs with annual sales revenue lower than 50 million, the ratio of R&D expense in the total sale income=3%⁴⁴;

4.2.4 Uniform, concrete, and measurable requirement

Before 2008, the performance standard didn't provide the detailed measures on the key indicator, such as specific criteria on R&D expenditures and the national high-tech development zones lack uniform standards. DHNTE gave specific, clear measures to define each input to avoid the arbitrariness in the qualification. I will give some examples to illustrate the point

***Scientific Staff:** employees engage in R&D activities and other technical activities with the cumulative actual working time over 183 days. It includes direct scientific and technological personnel and technology support staff⁴⁵.*

***R&D Staff:** includes researchers (mainly professionals engage in research and development projects), technical staff (employees with technical knowledge and experience in one or more areas including engineering, natural science and life science and work under the guidance of the researchers) and support staff (skilled workers participating in R&D activities)⁴⁶.*

⁴² Article 10, Chapter 3, Guidance on the designation of High and New Technology Enterprises in ZGC

⁴³ Ibid

⁴⁴ Ibid

⁴⁵ Guidelines for the management of HNTEs, 2008

⁴⁶ Ibid

Statistics of the R&D Staff: full-time staff can be identified by the employment contract. Part-time or temporary staff must work through the year for more than 183 days⁴⁷.

4.2.5 Top-down mechanism

A set of institutions has been build to impose the performance standard in a top-down mechanism.

Before 2008, the approvals of HNTEs were implemented by the Science and Technology Department, Finance Department, and Tax Department at the provincial level without the cooperation from the central government. Since 2008, the DHNTE [2008] has established a cooperative mechanism among different levels of government, and given clear responsibilities to each level. At national level, the Ministry of Science and Technology, Ministry of Finance, and State Administration of Taxation have created a joint national leading team to guide, manage, and supervise the qualification and management of HNTEs. There is a specific office under the leading team as an intermediate between the national government and local certificate authorities. At local level, the certificate authorities consist of the Science and Technology Department, Finance Department, and Tax Department, and it works close with the HNTEs. It makes possible for the national government to know the overall HNTEs situation, supervise the local authorities, and determine the direction to move forward. A detailed structure and responsibilities for the national and local institutions are listed below.

National Level

The leading team consists of the Ministry of Science and Technology, Ministry of Finance and State Administration of Taxation, and its responsibilities include:

- 1) to determine the direction of HNTEs and examine HNTEs' reports*
- 2) to coordinate and solve common issues in the implementation*
- 3) to resolve dispute and supervise the approvals during the implementation*
- 4) to propose rectification plan for areas where major problems appear.⁴⁸*

⁴⁷ Ibid

⁴⁸ Guidelines for the management of HNTEs, 2008

There is a specific office under the leading team to handle the daily work. The office is geographically located in the Torch High Technology Industry Development Center. Its responsibilities include:

- 1) to submit reports on the HNTEs across the country*
- 2) to supervise the implementation of the management of HNTEs*
- 3) to manage the record of all the HNTEs across the country*
- 4) to establish and manage “HNTEs management network”*
- 5) other duties assigned by the leading team.⁴⁹*

Local level

The Science and Technology Department, Finance Department, and Tax Department in the provinces, autonomous regions, and municipalities form HNTEs certificate authorities. Their responsibilities include:

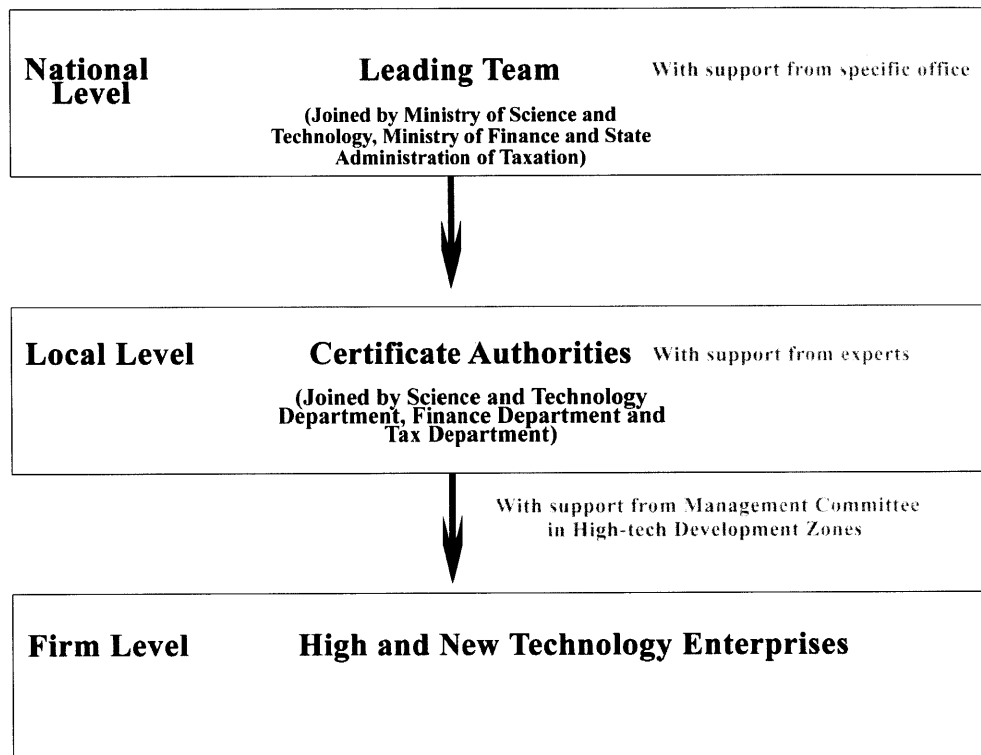
- 1) to manage the approvals of the HNTEs in their administrative area*
- 2) to accept the application form of existing HNTEs, reexamine their status and grant continuing status to qualified enterprises*
- 3) to supervise and inspect HNTEs, and receive, verify and process reports*
- 4) to choose experts to participate in the qualification process and submit report to the Leading Team Office at national level.⁵⁰*

The management committee in the high-tech development zone facilitates both the certificate authorities and the HNTEs to handle affairs such as licensing, taxation, finance and investment, employment and intellectual property for new technology firms. The top-down mechanism is showed in Figure 4.4.

⁴⁹ Ibid

⁵⁰ Ibid

Figure 4.4. Structure of the top-down mechanism



(Source: Guidelines for the management of HNTes, 2008)

4.2.6 Participation of hired experts

The government has realized that politicians alone know little about the high-tech development. High-tech sectors differentiate from each other quite a lot. For example, how to separate R&D activities with non-R&D activities in different high-tech sectors are beyond the knowledge of most politicians. So the participation of experts from different high-tech areas is essential during the qualification process.

The 2008 performance standards requires certificate authorities to hire qualified experts to participate in the qualification, and experts have to meet following requirement to be eligible:

- 1) live and work in mainland China and have the citizenship of the People's Republic of China;*
- 2) have senior technical titles, and relevant professional backgrounds, and working experience in the key high-tech areas, and have a comprehensive understanding of the high-tech development in certain sector and the market condition;*
- 3) are familiar with the national technology condition, macro-economy, and industrial polices and have deep understanding or the performance standard in relevant documents*
- 4) have a good professional ethics, stick to the rules, and be fair to every enterprise.⁵¹*

Qualified experts will use their expertise and experience in their field to make an assessment of the reported projects, high-tech products (and services) and the core intellectual rights, to make an assessment and submit reports as a basis for the certification authorities to make final decisions.

In all, the DHNTE in 2008 has made significant change of performance standards from the DHNTENHTIDZ in 2000. Concrete and measurable requirements are implemented, new institutions have been built with the participation of experts, and output-side indicators have been added. But does the new performance standard have any actual influence on the innovation output? I will test my hypothesis that the new performance standard has led to significant change on the innovation output with a regression model in chapter 5.

⁵¹ Guidelines for the management of HNTEs, 2008

5. Regression: Does the new performance standard lead to significant change of innovation output in ZGC?

5.1 Indicator for innovation output and Regression Model

Indicator for innovation output

There have been a lot of debates on the indicators for innovation output. Patent is widely used in the study of innovation (Patel and Pavitt, 1992), but the actual economic value of a patent is difficult to assess, and cross-industry comparison carried out with the indicator rely upon the unrealistic assumption that the homogeneous technological content and economic significance of patents in different industries (Santerelli, Piergiovanni, 1995). Schumpeter argued that patents are only technological measures of new knowledge because they fail to show the commercialization of new knowledge and he suggests innovation should be based on the direct and systematic monitoring of the new output events defined by the initial entry into commercial use. It's quite different from the counting of the patents, which is an intermediate indicator of knowledge activity.

In chapter 5.2, I will use both the intermediary indicator- patent application and patent authorization, and the commercialized indicator- new product income and the technology income for regression.

Regression Model

Annual figure on innovation output Y_t can be plotted over an extended number of years. The research issue is whether the Y_t has been affected by the new performance standard. Informally, to assess the effect of the new performance standard, we can simply look at the shift in Y_t before and after 2008. But formally, we need to confirm whether the observed change is statistically significant.

I will use patent application as an example of Y_t to illustrate the model. The regression

equation is that:

$$Y_t = b_0 + b_1 X_{1t} + b_2 X_{2t} + e_t$$

Where Y_t = annual number of patent application in ZGC, X_{1t} = a counter for years, from 0-9, X_{2t} = a dummy variable scored 0 for observation from 2000 to 2007, and 1 for 2008 and after.

If the estimate for b_2 is not significant different from b_1 , then we infer that the new performance standard had no effect on the level of innovation.

My concern about the regression model is that there are only data for two years after the implementation of the new performance standard and it's insufficient. First, it might take years for the policies to show actual effect on innovation output, so even if b_2 is not significant different from b_1 we can't simply deny the effect of the new performance standard. Second, if b_2 is significant different from b_1 we still need to be careful in drawing the conclusion. It's possible that the effect is not sustainable and the innovation output will drop to the starting level in the third year. Third, we can't draw casual relationship simply from the regression, and further test is necessary for that purpose.

5.2 Results

5.2.1 Intermediate output- Patent

The number of patents generated by the HNTEs in a high-tech development zone is a general indication of the creation of new idea. I list the number of patent application and patent authorization in ZGC from 2000-2009 in Table 5.1. Since the base of HNTEs in ZGC change every year with new HNTEs coming, and unqualified HNTEs driven out, I will also use the patent application per HNTE, patent application per employee, patent authorization per HNTE and patent authorization per employee as indicators for the intermediate output (Table 5.2).

Table 5.1. The patent application and patent authorization in ZGC from 2000-2009

Year	Patent Application	Patent Authorization
2000	871	550
2001	1273	706
2002	2370	890
2003	2660	1279
2004	2525	1398
2005	4607	1409
2006	5570	2022
2007	6967	3046
2008	16547	12842
2009	17225	10554

(Source: Annual review of economic development in ZGC from 2000-2010; The almanac of ZGC from 2008-2010)

Table 5.2. The patent application and patent authorization per HNTE and per employee in ZGC from 2000-2009

Year	Patent Application per HNTE	Patent Authorization per HNTE	Patent Application per employee	Patent Authorization per employee
2000	0.141	0.089	29.727	18.771
2001	0.159	0.088	35.263	19.557
2002	0.245	0.092	58.374	21.921
2003	0.221	0.106	54.397	26.155
2004	0.181	0.100	45.332	25.099
2005	0.280	0.086	66.671	20.391
2006	0.307	0.111	70.328	25.530

2007	0.331	0.145	77.497	33.882
2008	0.897	0.697	175.845	136.472
2009	0.993	0.608	162.194	99.379

(Source: Annual review of economic development in ZGC from 2000-2010; The almanac of ZGC from 2008-2010)

Judging from Figure 5.1, 5.2 and 5.3, year 2008 is a turning point, but I will use regression to check their significance.

Figure 5.1. The patent application and patent authorization in ZGC from 2000-2009

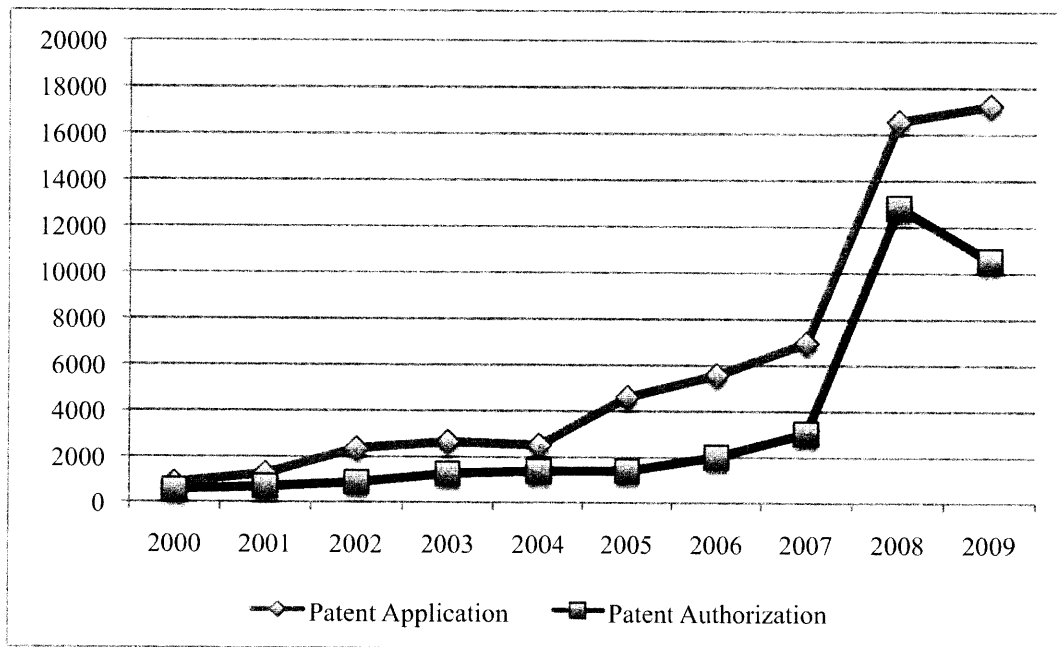


Figure 5.2. The patent application and patent authorization per HNTe from 2000-2009

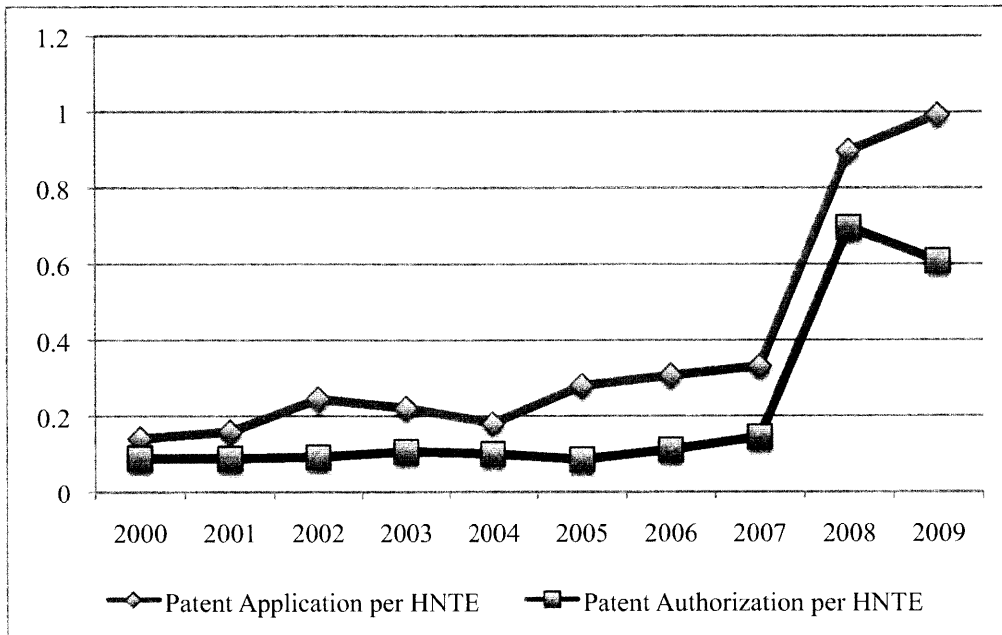


Figure 5.3. The patent application and patent authorization per employee from 2000-2009

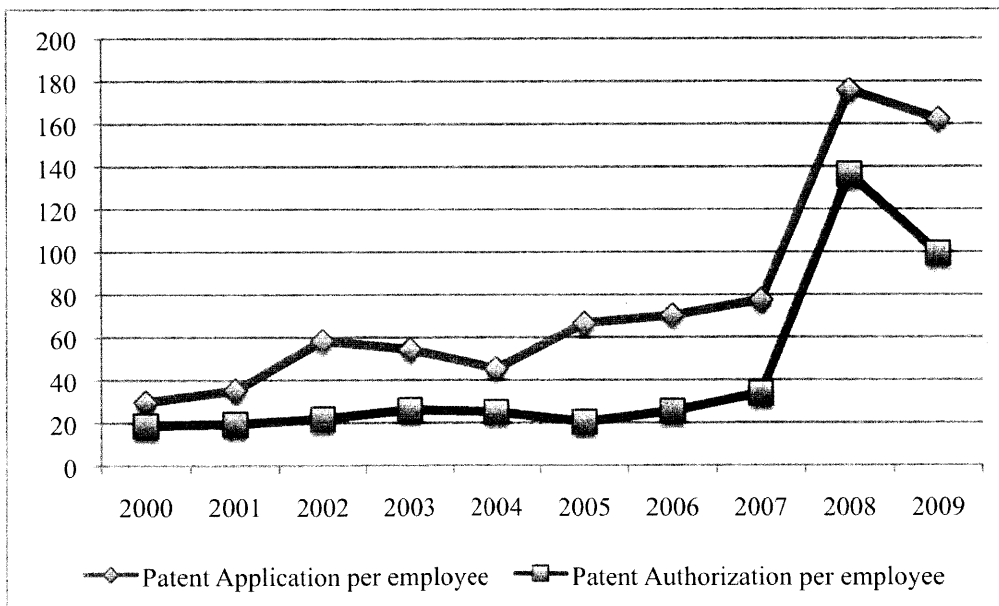


Table 5.3. Regression results

	Coefficient of the year	Coefficient of the policy	R Square	F Statistics
Patent Application	840.129 ^{***}	9329.978 ^{***}	0.993	<0.001
Patent Authorization	275.765 ^{**}	8906.676 ^{***}	0.977	<0.001
Patent Application per HNTe	0.026 ^{**}	0.580 ^{***}	0.989	<0.001
Patent Authorization per HNTe	0.005 (0.323)	0.527 ^{***}	0.988	<0.001
Patent Application per employee	6.022 ^{***}	84.209 ^{***}	0.976	<0.001
Patent Authorization per employee	1.093 (0.528)	88.547 ^{***}	0.947	<0.001

(^{***}Significant at 0.01, ^{**} significant at 0.05, ^{*} significant at 0.1)

Below are the regression graph of the patent application per employee and patent authorization per employee with 95% confidence interval. I specified stdf so as to obtain a confidence interval based on the standard error of the forecast rather than the standard error of the mean, and it's more useful for identifying outliers. I will attach the other four regression graphs in Appendix 7.

Figure 5.4. Regression of the patent application per employee with 95% confidence interval

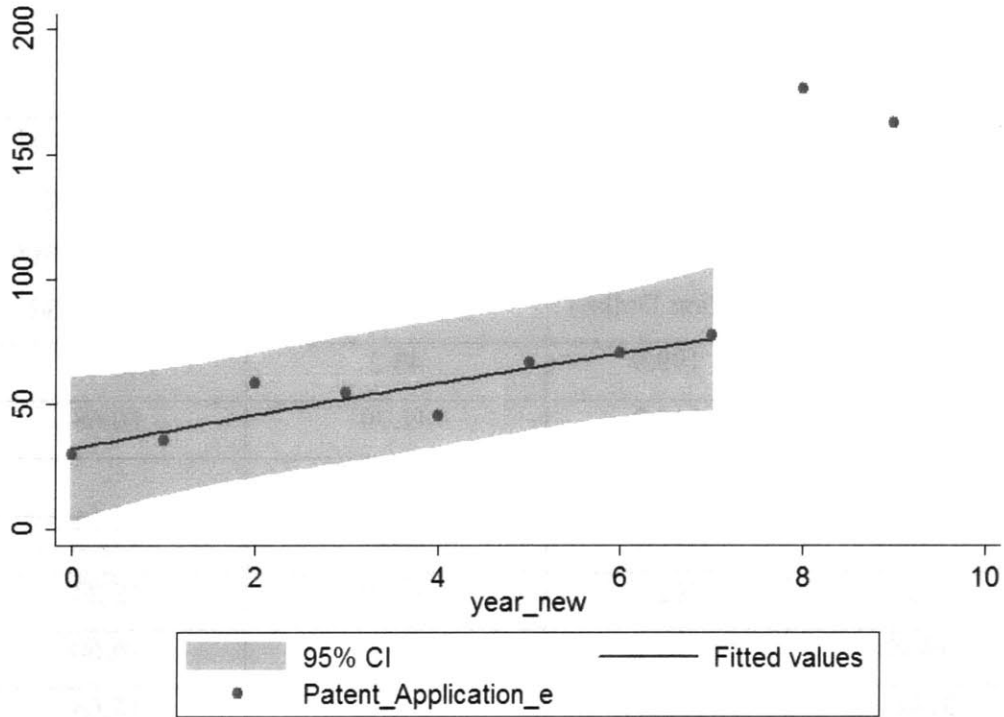
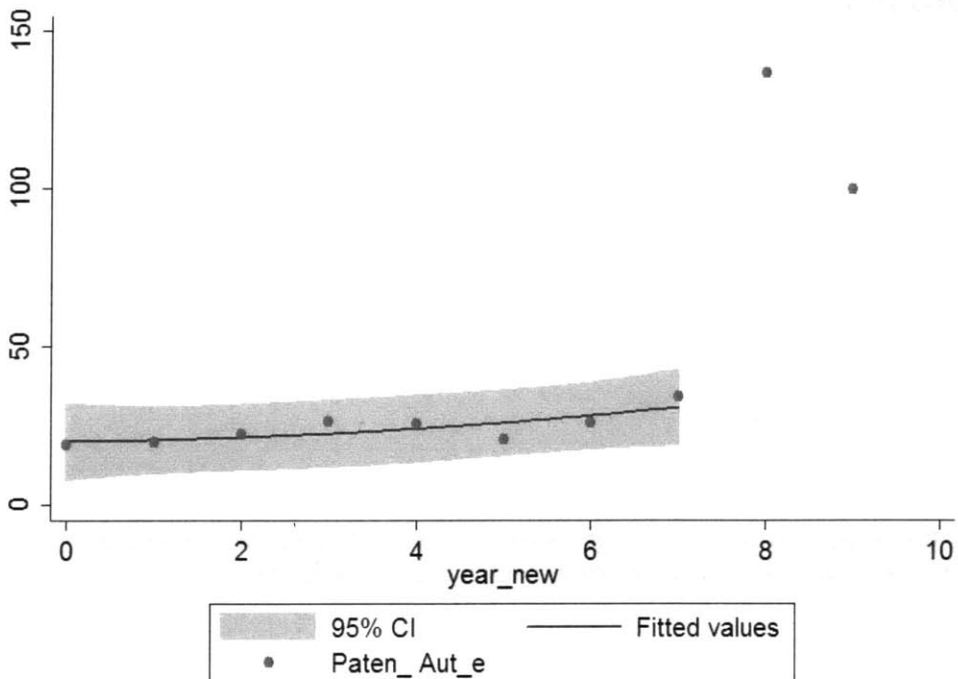


Figure 5.5. Regression of the patent authorization per employee with 95% confidence interval



5.2.2 Commercialized Output

I use the percentage of new product income in the total income and the percentage of technology income in the total income as commercialized indicators⁵².

Table 5.4. New product income and technology income in ZGC from 2000-2009

Year	New Product Income (Hundred Million Dollar)	Technology Income (Hundred Million Dollar)	Percentage of new product income in total income (%)	Percentage of technology income in total income (%)
2000	620	199.9	43.2	13.93
2001	860	215.2	42.70	10.68
2002	878.7	-	36.54	-
2003	727.6	419.3	25.21	14.53
2004	1355	562.3	36.70	15.23
2005	1838.4	809.6	37.70	16.60
2006	2544.41	1189.4	37.72	17.63
2007	3220.9	1473.2	35.65	16.30
2008	6061.9	1693.4	59.30	16.57
2009	6744	2093.7	51.90	16.11

(Source: Annual review of economic development in ZGC from 2000-2010; The almanac of ZGC from 2008-2010)

⁵² Since the base of the enterprises in ZGC change annually, it doesn't make sense to use the actual value of the new production income and technology income as indicators.

Figure 5.6: Percentage of new product income in the total income from 2000-2009

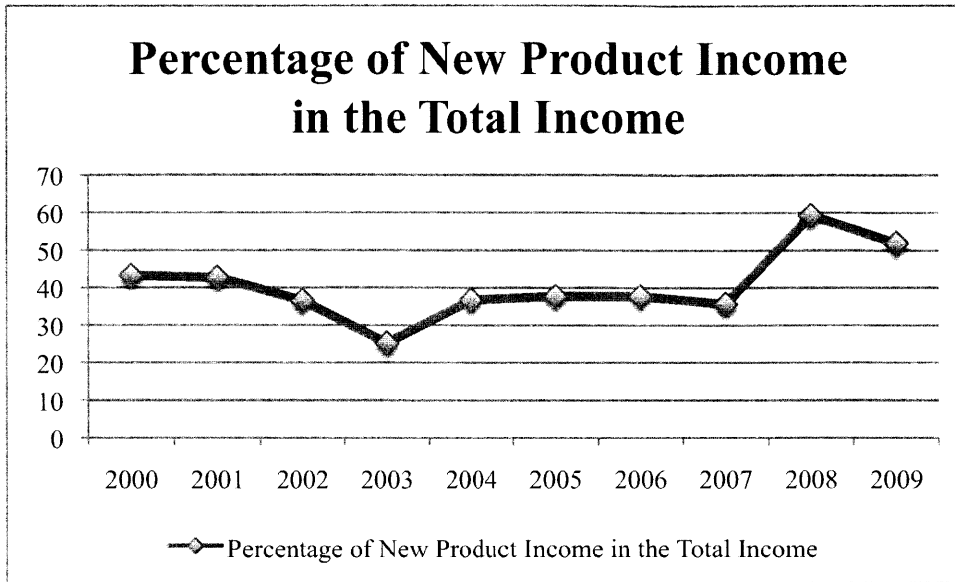


Table 5.5. Regression results

	Coefficient of the year	Coefficient of the policy	R Square	F Statistics
Percentage of New Product Income	-0.827 (0.360)	22.804 ^{***}	0.735	<0.01
Percentage of Technology Income	0.707 ^{**}	-2.031 (0.230)	0.666	<0.05

(^{***} Significant at 0.01, ^{**} significant at 0.05, ^{*} significant at 0.1)

Figure 5.7. Regression of the percentage of new product income with 95% confidence interval

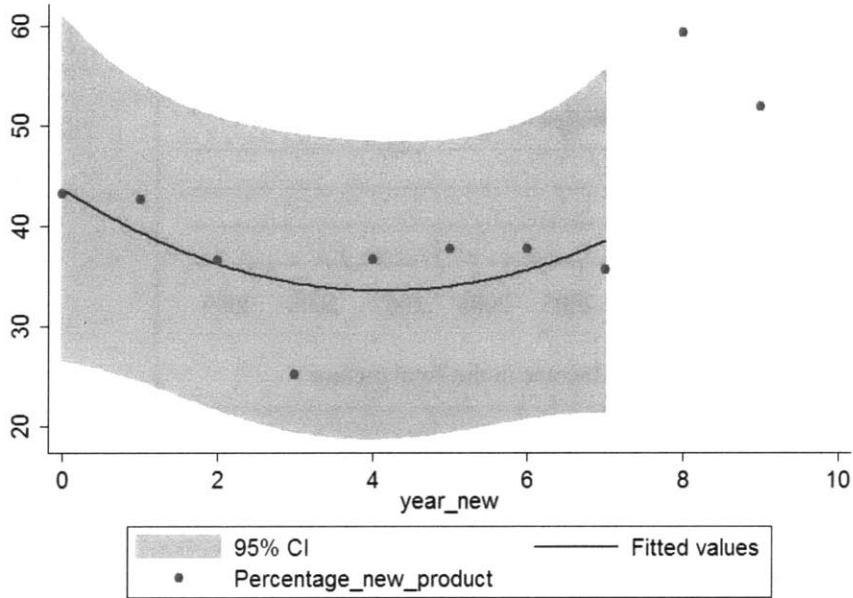
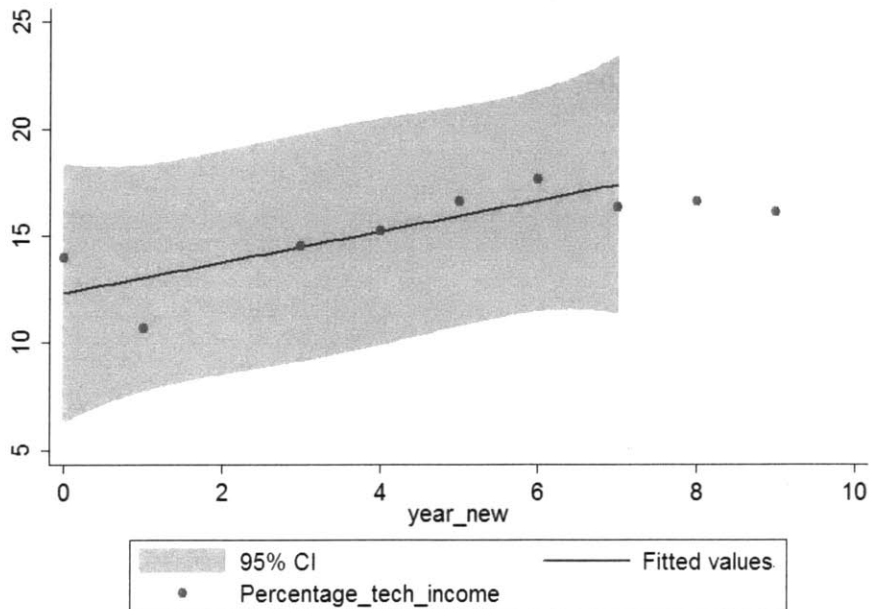


Figure 5.8. Regression of the percentage of technology income with 95% confidence interval



The regression shows that the new performance is highly correlated with the six indicators of intermediate innovation output, and its correlation with the commercialized output is more complicated. There is evidence of significant change of the percentage of new product income before and after the performance standard, but the correlation is negative for the percentage of technology income.

5.3 Further Hypothesis Test

Based on the result, I conduct two further hypothesis tests. First, I use the intermediate innovation output in Beijing excluding ZGC as a control group to check whether there is influence of other variable on the intermediary innovation output. Second, I collect data on the input level in ZGC to identify whether the improvement of intermediary innovation output is just due to increase of input level. If so, it might undermine the hypothesis.

5.3.1 A comparison with enterprises in Beijing excluding ZGC

The regression result shows the correlation between new performance standard and the intermediate innovation output, but we can't infer any causal relationship only based on the regression. Other variables might have caused the increase in patent application and patent authorization, such as macro-economy change. In order to at least try to eliminate the influence of other variables, I use the enterprises in Beijing excluding ZGC as a control group. If the control group also gone through rapid increase in patent application and authorization in 2008, the growth in ZGC itself might also be caused by variables other than the performance standards. The data of the enterprises in Beijing excluding ZGC is list in Table 5.6 and 5.7.

Table 5.6. Patent application in ZGC and in Beijing excluding ZGC

Year	Patent Application in ZGC	Patent Application in Beijing excluding ZGC	Growth of Patent Application in ZGC	Growth Rate of Patent Application in Beijing excluding ZGC
2000	871	9473	125.65	29.11
2001	1273	10901	46.15	15.07
2002	2370	11472	86.17	5.24
2003	2660	14343	12.24	25.03
2004	2525	15877	-5.08	10.70
2005	4607	17965	82.46	13.15
2006	5570	20985	20.90	16.81
2007	6967	24713	25.08	17.77
2008	16547	26961	137.51	9.10
2009	17225	33011	4.10	22.44

Table 5.7. Patent authorization in ZGC and in Beijing excluding ZGC

Year	Patent Authorization in ZGC	Patent Authorization in Beijing excluding ZGC	Growth Rate of Patent Authorization in ZGC (%)	Growth Rate of Patent Application in Beijing (%)
2000	550	5355	-	-
2001	706	5540	28.36	3.45
2002	890	5455	26.06	-1.53
2003	1279	6969	43.71	27.75
2004	1398	7607	9.30	9.15
2005	1409	8691	0.79	14.25
2006	2022	9216	43.51	6.04
2007	3046	11908	50.64	29.21
2008	12842	4905	321.60	-58.81
2009	10554	12367	-17.82	152.13

From the Table 5.6, 5.7, no significant growth in patent application and authorization in 2008 has been observed for the enterprises in Beijing excluding those in ZGC, and it doesn't show evidence against the hypothesis that the rapid growth in patent application and authorization is due to the new performance standard.

5.3.2 Double-check on the innovation input

I also check the innovation input in the two time periods. If the innovation input didn't go through rapid growth, it might imply that the efficiency of the high-tech promotions has been improved after the new performance standard.

According to the innovation input indicator in ZGC, I use the percentage of employee with bachelor, master and doctor degree, percentage of scientific and technological personnel and R&D personnel in total employees and percentage of R&D in the total income as indicators for innovation input. No significant growth has been showed in Figure 5.8, 5.9 and 5.10.

Figure 5.9. Percentage of employees with bachelor, master and doctor degree from 2000 to 2009

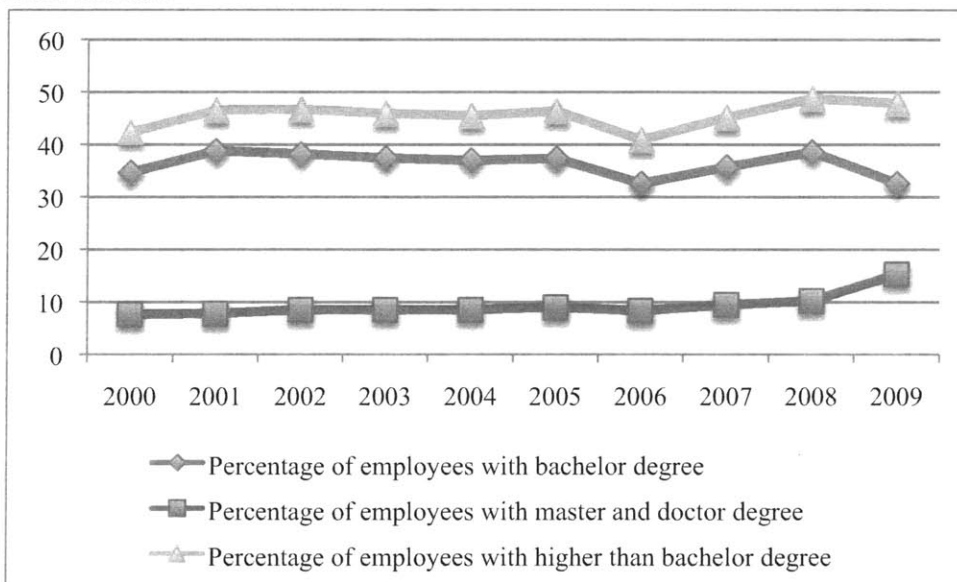


Figure 5.10. Percentage of scientific and technological personnel and R&D personnel in total employees from 2000 to 2009

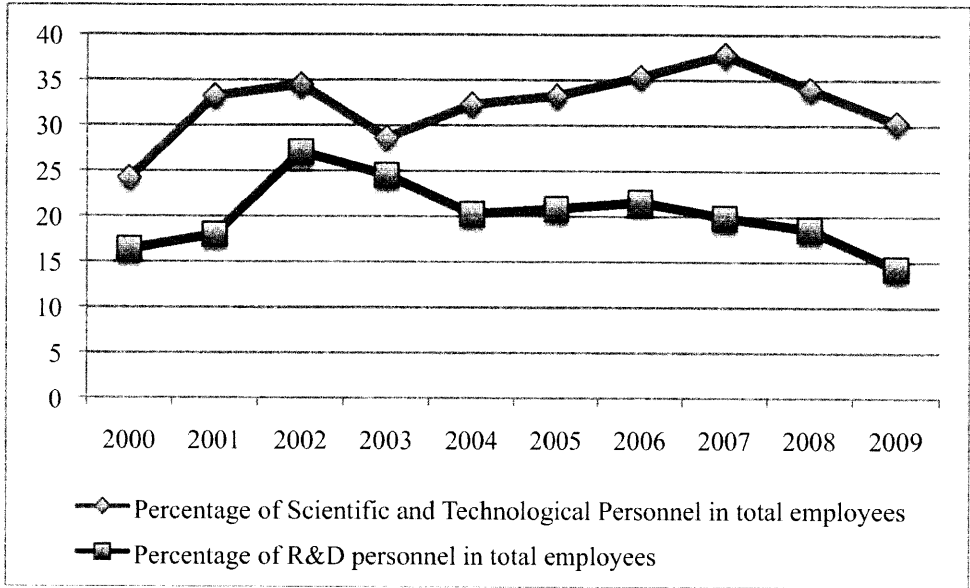
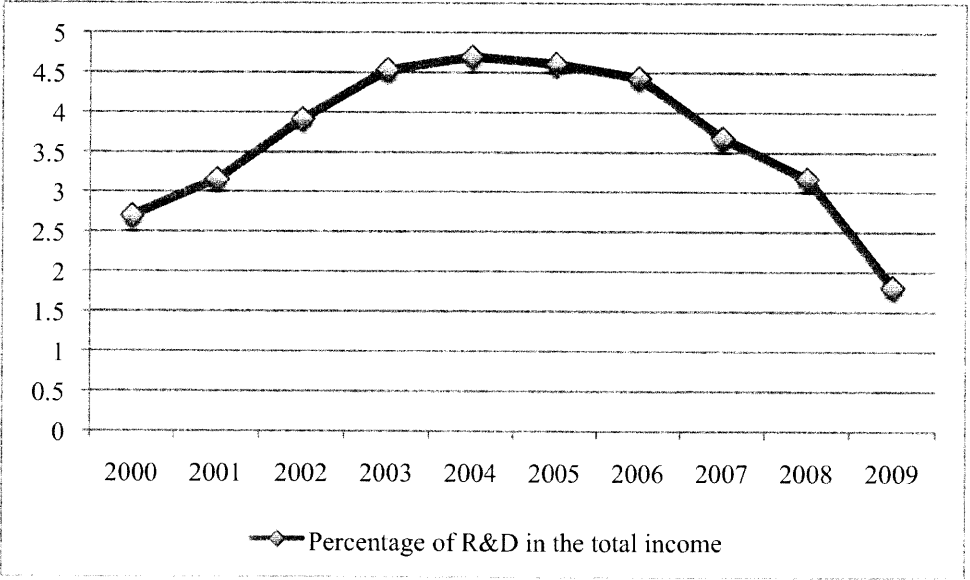


Figure 5.11. Percentage of R&D in the total income from 2000 to 2009



5.4 Conclusion

From the simple regression model, I find out that the performance standard is closely correlated with the intermediate innovation output, and its correlation with the commercialized output is more complicated. There is evidence showing significant changes of the percentage of new product income before and after the performance standard, but the correlation is negative for the percentage of technology income.

I conduct further hypothesis test and find out no significant growth of the intermediate innovation output has been observed for the enterprises in Beijing excluding those in ZGC, so it doesn't show evidence against the hypothesis that the rapid growth in the intermediate innovation output is due to the new performance standard. Also, input level in ZGC has been checked, and it implies that the efficiency of the high-tech promotions has been improved after the new performance standard.

6. Conclusion

As a latecomer in the high-tech industries, Chinese government has viewed “the independent innovation capability and building an innovative country as the core of the national development strategy and the key to enhance the overall national strength”⁵³ and continued to play an important role in the industrialization. The government sets up concrete, measurable and monitorable performance standards in high-tech development zones, obliges those enterprises to meet these requirement, and grant qualified enterprises a special legal status “HNTEs” which is closely linked to preferential policies so the government is able to directly allocate resources to the HNTEs to “get the price wrong”.

Descriptive analysis of the national performance standards shows that the policy has been more systematic with uniform, concrete and measurable requirement, institutions-building for a top-down mechanism. Also, the new performance standard becomes more result-oriented and includes the innovation output into the requirement for the first time.

A statistic analysis of the ZGC with regression model shows that the performance standard is closely correlated with the innovation output indicators, such as patent application, patent authorization and the percentage of new product income while no significant change is observed in Beijing areas excluding ZGC. The new performance standard has been highly successful. However, I am reluctant to make general policy recommendations for three reasons. First, the new performance standard is implemented in 2008, and two years are too short to evaluate the effect of the policies. Second, a detailed study on the firm-level innovation in ZGC is essential to understand the mechanism that the performance standard influences the innovation output. Third, we can't separate the performance standard with the political system and institution structure, and the performance standard is only made possible by a strong state, but it's not always the case.

⁵³ http://www.qstheory.cn/tbzt/jkjjfzfszb/qwsy/201006/t20100610_32864.htm

Appendix:

Appendix 1

List of the 83 national High-tech development zones in China

No.	Name	No.	Name	No.	Name
1	Zhongguancun	31	Foshan	61	Yantai
2	Wuhan Donghu	32	Huizhou	62	An'yang
3	Nanjing	33	Zhuhai	63	Nanyang
4	Shenyang	34	Qingdao	64	Dongwan Songshan
5	Tianjing	35	Weifang	65	Zhaoqin
6	Xi'an	36	Zibo	66	Liuzhou
7	Chengdu	37	Kunming	67	Weinan
8	Weihai	38	Guiyang	68	Baiyin
9	Zhongshan	39	Nanchang	69	Changji
10	Changchun	40	Taiyuan	70	Tangshan
11	Ha'erbin	41	Nan'ning	71	Yanjiao
12	Changsha	42	Wulumuqi	72	Liaoyang
13	Fuzhou	43	Baotou xitu	73	Yanji
14	Guangzhou	44	Xiangfan	74	Qiqiha'er
15	Hefei	45	Zhuzhou	75	Shaoxing
16	Chongqing	46	Luoyang	76	Benbu
17	Hangzhou	47	Daqin	77	Quanzhou
18	Guizhou	48	Baoji	78	Xinyu
19	Zhengzhou	49	Jilin	79	Jingdezhen
20	Lanzhou	50	Mianyang	80	Yichang
21	Shijiazhuang	51	Baoding	81	Jiangmen
22	Ji'nan	52	An'shan	82	Yinchuan
23	Shanghai Zhangjiang	53	Yangling	83	Qinghai
24	Dalian	54	Ningbo		

25	Shenzhen	55	Taizhou
26	Xiamen	56	Xiangtan
27	Haikou	57	Yingkou
28	Suzhou	58	Kunshan
29	Wuxi	59	Wuhu
30	Changzhou	60	Ji'ning

(Source: The Ministry of Science and Technology of the People's Republic of China)

Appendix 2:

“Notification of the State Council on Providing Transitional Preferential Tax Treatments to High and new enterprises in Special Economic Zones and in Shanghai Pudong New District”

State Council [2007] no.40

The people's governments of all provinces, autonomous regions, municipalities directly under the Central Government, all ministries and commissions of the State Council, and all organs directly under the State Council,

According to Article 57 of the Enterprise Income Tax Law of the People's Republic of China, the State Council determines to provide transitional preferential tax treatments to the high-tech enterprises under the powerful support of the state, which were set up in the special zones set up by law for advancing foreign economic cooperation and technological communication and in the area where the State Council has offered to carry out the abovementioned special policy. The following issues are notified:

1. The expression "special zones set up by law for advancing foreign economic cooperation and technological communication" means Shenzhen, Zhuhai, Shanou, Xiamen and Hainan Special Economic Zones. The expression "the area where the State Council has provided for the implementation of the abovementioned special policy" means Pudong New District of Shanghai.
2. For a high-tech enterprise under the key support of the state in a special economic zone or in Pudong New District of Shanghai that completes the registration on or after January 1, 2008 (hereinafter referred to as the high-tech enterprise), the incomes acquired by it in the special economic zone and in Pudong New District of Shanghai shall be relieved from the enterprise income tax (hereinafter referred to as the EIT) for the first 2 years as of the tax year to which the first revenue coming from production or operation contributes , and shall be levied at half of the statutory tax rate of 25% for the third to the fifth years.

The expression "high-tech enterprises under the powerful support of the State" means the high-tech enterprises which have their own kernel independent intellectual property rights and meanwhile meet the conditions as referred to, in Article 93 of the Regulation on Carrying out of the Enterprise Income Tax Law of the People's Republic of China and have been realized in pursuance of the Measures for the Determination of High-tech Enterprises.

3. In case a high-tech enterprise newly set up in a special economic zone or in Pudong New District of Shanghai embarks upon production and operation in other areas aside from the special economic zone or Pudong New District of Shanghai at the same time, it shall separately calculate the incomes it acquires in the special economic zone or Pudong New District of Shanghai and rationally divide the expenses incurred during the corresponding period. In case it cannot calculate independently, it shall not enjoy the preferential treatments regarding enterprise income tax.

4. In case a high-tech enterprise newly set up in a special economic zone or in Pudong New District of Shanghai no longer has the high-tech enterprise qualification because of review or because of its failure to pass a spot-check during the period when it enjoys the transitional preferential tax treatments stated in this Notification, once it does not have the high-tech enterprise qualification, it shall have no chance to enjoy the transitional preferential tax treatments from the tax year. Where it is once again approved as a high-tech enterprise later, it shall not continue to or re-enjoy the transitional preferential tax treatments.

5. This Notification shall enter into force as of January 1, 2008.

Appendix 3:

Law on additional benefits to the software industry and integrated circuit industry

Documents	Issued Government
Several Policies to Encourage the Development of the Software and Integrated Circuit Industries [2000] no.1	State Council
Notification on the “Several Policies to Encourage the Development of the Software and Integrated Circuit Industries ” [2000] no.25	Ministry of Finance
Circular of the State Administration of Taxation Concerning Withholding of Business Tax with Regard to Price for Software Paid by Chinese Enterprises to Foreign Enterprises [2000] no.179	State Administration of Taxation
Notice of the State Administration of Taxation on the Pre-tax Deduction Rates for the Relevant Expenses of Advertisement in Certain Industries [2001], no.89	State Administration of Taxation
Notice of the Ministry of Finance and the State Administration of Taxation on the Tax Policies for Further Encouraging the Development of Software and Integrated Circuit Industries[2002], no.70	Ministry of Finance, State Administration of Taxation
Circular of the State Administration of Taxation on the Implementation of the Preferential Policies Regarding the Enterprise Income Tax of Software Enterprises and High-tech Enterprises [2003], no.82	State Administration of Taxation

(Several Policies to Encourage the Development of the Software and Integrated Circuit Industries [2000] no.1; Notification on the “Several Policies to Encourage the

Development of the Software and Integrated Circuit Industries ” [2000] no.25; Circular of the State Administration of Taxation Concerning Withholding of Business Tax with Regard to Price for Software Paid by Chinese Enterprises to Foreign Enterprises [2000] no.179; Notice of the State Administration of Taxation on the Pre-tax Deduction Rates for the Relevant Expenses of Advertisement in Certain Industries [2001], no.89; Notice of the Ministry of Finance and the State Administration of Taxation on the Tax Policies for Further Encouraging the Development of Software and Integrated Circuit Industries[2002], no.70; Circular of the State Administration of Taxation on the Implementation of the Preferential Policies Regarding the Enterprise Income Tax of Software Enterprises and High-tech Enterprises [2003], no.82)

Appendix 4

Preferential Policies to the Incubator Enterprises

National University Science and Technology Park can be exempted from business tax concerning income from plant or house rent to incubator enterprises. (“Notification of Ministry of Finance and State Administration of Taxation on certain taxation policies questions concerning scientific and technological enterprise incubator, [2007], no.121”)

From January 1, 2008 to Dec 31, 2010, qualified scientific and technological park can be exempted from house property tax concerning house property or land provided to incubator enterprises, no matter whether it is used by the park or not, provided freely and rent to incubator enterprises. (“Notification of Ministry of Finance and State Administration of Taxation on certain taxation policies questions concerning scientific and technological enterprise incubator, [2007], no.121”; “Notification of Ministry of Finance and State Administration of Taxation on certain taxation policies questions concerning national university science and technological park, [2007], no.120”)

From January 1, 2008 to Dec 31, 2010, qualified scientific and technological park can be exempted from urban land use tax concerning house property or land provided to incubator enterprises, no matter whether it is used by the park or not, provided freely and rent to incubator enterprises. (“Notification of Ministry of Finance and State Administration of Taxation on certain taxation policies questions concerning scientific and technological enterprise incubator, [2007], no.121”; “Notification of Ministry of Finance and State Administration of Taxation on certain taxation policies questions concerning national university science and technological park, [2007], no.120”)

Appendix 5

Notification of the State Council on Carrying out the Transitional Preferential Policies concerning Enterprise Income Tax

Guo Fa [2007] No.39

The people's governments of all provinces, autonomous regions, municipalities directly under the Central Government, all ministries and commissions of the State Council, all institutions directly under the State Council,

The Enterprise Income Tax Law of the People's Republic of China (hereinafter referred to as the EITL) and the Regulation on Carrying out the Enterprise Income Tax Law of the People's Republic of China (hereinafter referred to as the RIEITL) shall put into effect as of January 1, 2008. According to Article 57 of the EITL, you are hereby informed of the following issues related to the preferential policies with regard to enterprise income tax:

1. The measures for the transition of preferential tax treatments to enterprises set up before the promulgation of the EITL

Enterprises enjoying the preferential policies with regard to enterprise income tax under the former tax law, administrative regulations and documents with the effects of administrative regulations shall be subject to a transition under the following measures:

Enterprises which enjoy the preferential policies of low tax rates in the past time shall be gradually transitioned to be enjoying the statutory tax rate within 5 years after carrying out the EITL as of January 1, 2008. Among them, the enterprises which enjoy the enterprise income tax rate of 15% shall be subject to the enterprise income tax rate of 18% in 2008, 20% in 2009, 22% in 2010, 24% in 2011 and 25% in 2012. The enterprises that enjoy the tax rate of 24% in the past time shall be subject to the tax rate of 25% as of 2008.

As of January 1, 2008, the enterprises that enjoy "2-year exemption and 3-year half

payment in the past time", "5-year exemption and 5-year half payment" of the enterprise income tax and other preferential treatments in the form of periodic tax deductions and exemptions may, after carrying out the EITL, go on to enjoy the relevant preferential treatments under the preferential measures and the time period set down in the previous tax law, administrative regulations and relevant documents until the expiration of the said time period. However, Its preferential time period shall be counted from 2008 if such an enterprise has not enjoyed the preferential treatments yet because of its failure to make profits.

The expression "enterprises enjoying the preferential policies" as referred to above means the enterprises set up and registered in the industrial and commercial administrative department and in other registration administrative departments before March 16, 2007. The items and scope of the transitional preferential policies shall comply with the Table for carrying out Transitional Preferential Policy on Enterprise Income Tax (see Attached Table).

2. Continuously carrying out the preferential tax policies for the Western Development Program

According to the relevant documents of the State Council on implementing the Western Development Program, the preferential policies for Western Development Program with regard to enterprise income tax which is mentioned in the Notification of the Ministry of Finance, State Administration of Taxation and General Administration of Customs on the Preferential Policies for Western Development Program with regard to Enterprise Income Tax (Cai Shui [2001] No. 202) jointly promulgated by the Ministry of Finance, State Administration of Taxation and General Administration of Customs shall be carry out continuously.

3. Other provisions on carrying out transitional preferential policies with regard to enterprise income tax

An enterprise enjoying the transitional preferential policies with regard to enterprise income tax shall calculate the taxable income amount under the provisions of the EITL and the RIEITL concerning the incomes and deductions and shall compute and enjoy the preferential tax treatments under section 1 of this Notification.

An enterprise may choose the most preferential policies, if there is any overlap between the transitional preferential policies with regard to enterprise income tax and those as offered in the EITL and the RIEITL. It fails to enjoy such policies repeatedly, and it shall not change it once it makes a choice,

Appendix 6

Combined data of ZGC from 1988 to 2010

Year	Export (Hundred Million Dollar)	Total Income (Hundre d Million Dollar)	New Product Income (Hundre d Million Dollar)	Tech Income (Hundre d Million Dollar)	Patent Applicat ion	Patent Authorizat ion	Number of HNTPs
1988	0.1	14	-	-	24	-	-
1989	0.3	17	-	-	27	-	-
1990	0.4	25	-	8.2	44	-	-
1991	0.5	37	-	-	35	-	-
1992	0.7	60	-	-	43	-	-
1993	1.1	100	-	-	50	-	-
1994	1.3	142.8	-	-	105	-	-
1995	2.3	219.5	-	-	74	-	-
1996	2.5	297.4	-	-	106	-	-
1997	3.1	407	-	-	95	-	-
1998	6.5	687	-	-	175	-	-
1999	9.6	1049	-	-	386	-	-
2000	18.2	1434.7	-	199.9	871	550	3941
2001	30.5	2014.2	-	215.2	1273	706	5569
2002	28.8	2404.8	878.7	-	2370	890	6550
2003	32.9	2886.4	727.6	419.3	2660	1279	7924
2004	53.6	3692.2	1355	562.3	2525	1398	9280
2005	94.9	4876.8	1838.4	809.6	4607	1409	12834
2006	137.3	6744.7	2544.41	1189.4	5570	2022	14164
2007	197.1	9035.7	3220.9	1473.2	6967	3046	14480
2008	207.4	10222.4	6061.9	1693.4	16547	12842	-

2009	208.2	12995.1	6744	2093.7	17225	10554	-
2010	223.1	-	-	-	-	-	-

(Source: Annual review of economic development in ZGC from 2000-2010; The almanac of ZGC from 2008-2010; Development review on the twentieth anniversary in ZGC)

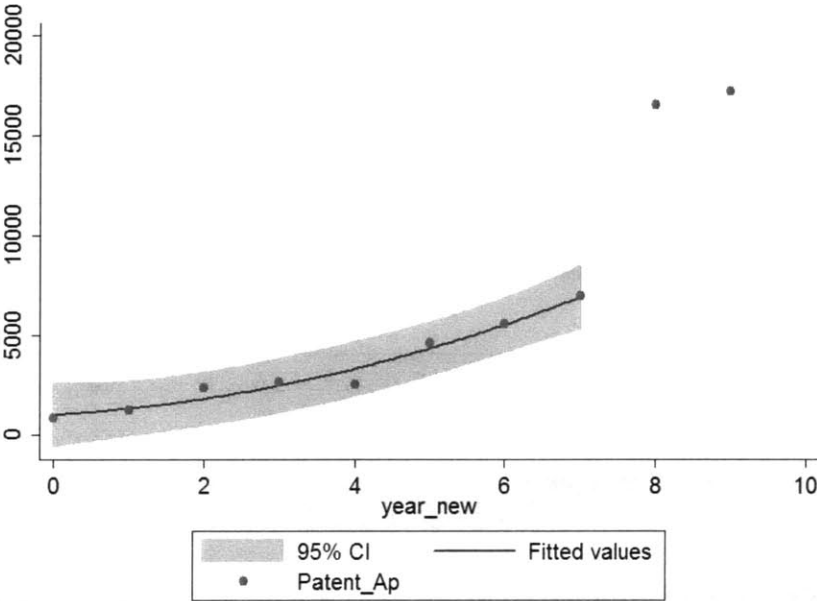
Year	Total Number of employees	Employees with Bachelor Degree	Employees with Master Degree	Employees with Doctor Degree	Scientific Staff	R&D Staff
1988	1	-	-	-	-	-
1989	-	-	-	-	-	-
1990	-	-	-	-	-	-
1991	-	-	-	-	-	-
1992	6.9	-	-	-	-	-
1993	10.8	-	-	-	-	-
1994	11.26	-	-	-	-	-
1995	12	4.56	-	-	-	-
1996	12.5	4.75	-	-	-	-
1997	15.9	5.6763	-	-	-	-
1998	17.3	6.1761	-	-	-	-
1999	24.3	8.8938	-	-	-	-
2000	29.3	10.1594	1.8556	0.385	7.1	4.8
2001	36.1	14	2.3262	0.4867	12	6.5
2002	40.6	15.5092	2.8826	0.5684	14	11
2003	48.9	18.2886	3.4719	0.6846	14	12
2004	55.7	20.6	4.0086	0.7415	18	11.3
2005	69.1	25.8	5.3167	0.9143	23	14.4
2006	79.2	25.8	5.6432	0.9547	28	17.1
2007	89.9	32.1	7.4	1.1	34	17.9
2008	94.1	36.3	8.4	1.2	32	17.5
2009	106.2	34.6	14.3	1.9	32.2	13.6
2010	-	-	-	-	-	-

(Source: Annual review of economic development in ZGC from 2000-2010; The almanac of ZGC from 2008-2010; Development review on the twentieth anniversary in ZGC)

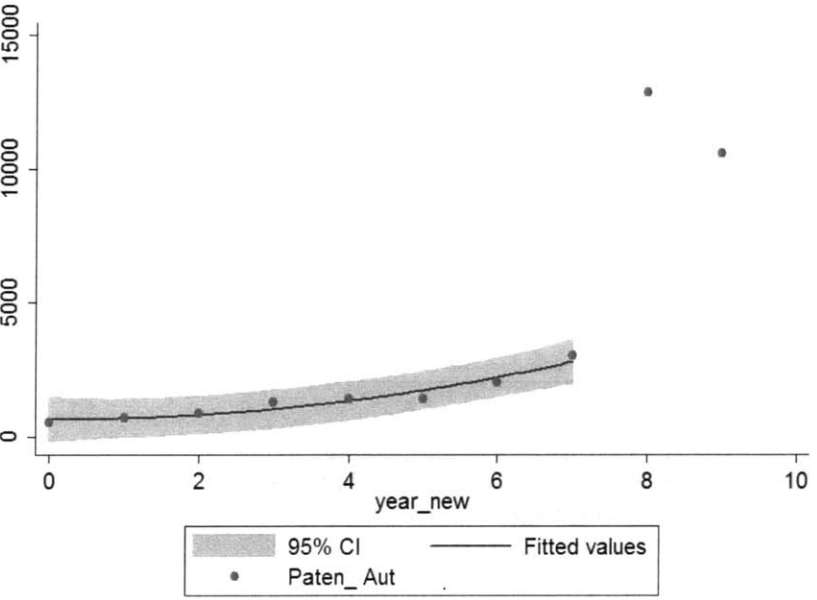
Appendix 7

Regression Graphs

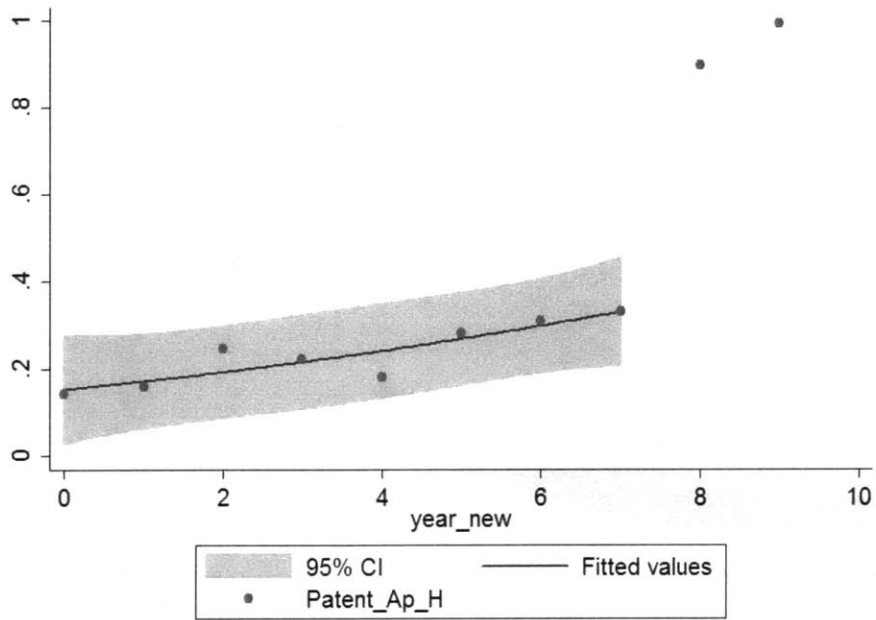
Regression of the patent application with 95% confidence interval



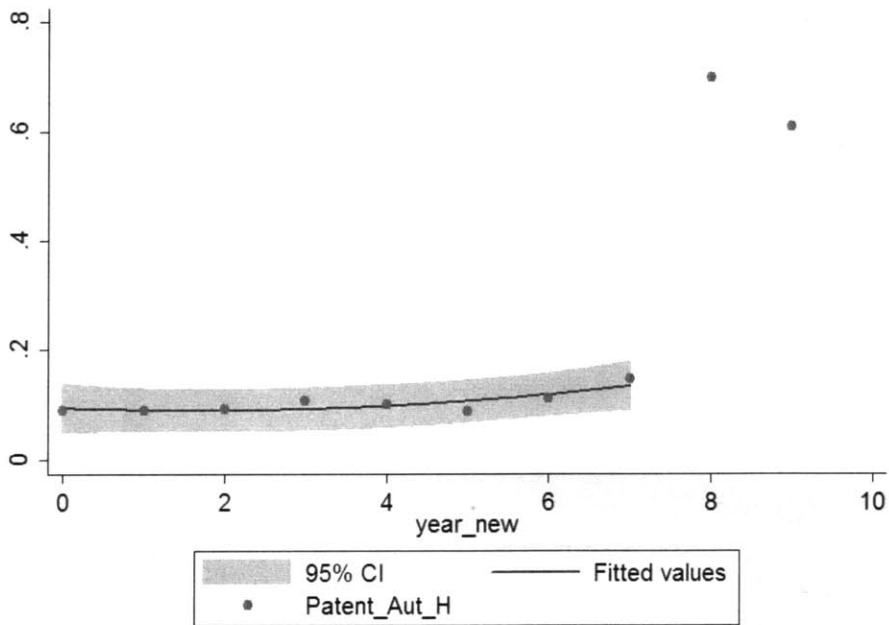
Regression of the patent authorization with 95% confidence interval



Regression of the patent application per HNTTE with 95% confidence interval



Regression of the patent authorization per HNTTE with 95% confidence interval



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