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Government Support, Innovation and Productivity in the Haidian (Beijing) District

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Abstract

This paper examines whether the government support in favor of firms located in the Haidian district of Beijing, which includes the Zhongguancun Science Park, was effective in terms of innovation and economic performance. We use a dataset of 500 manufacturing firms that results from a merger of the 2007 nation-wide innovation survey and the Annual Survey of Industrial Enterprises databases from the National Bureau of Statistics. We find that among all firms (state-or-collectively-owned, non-state-or-collectively-owned and Hong Kong, Macau, Taiwan or other foreign funded firms) that received direct government support for innovative activities only the non-state-or-collectively-owned domestic firms invested more in innovation than the firms that did not receive such support. However, despite higher government support, domestic firms have lower labor productivity than foreign funded firms, including those funded from Hong Kong, Macau, or Taiwan.

Keywords: CDM, innovation policy, Haidian, evaluation

JEL codes: O38

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1. Introduction

Haidian District is located in the northwest area of Beijing city. It has 4.5 million habitants and the GDP per capita of the district is over US$ 10,000. The district is well-known because it hosts Zhongguancun Science Park, "China's Silicon Valley" as it is called, where many Chinese high-technology companies are based, including Lenovo, Sohu, Aigo, Baidu and Vimicro and so on. A number of prestigious universities including Peking University and Tsinghua University and research institutions such as the Chinese Academy of Sciences are also located in Haidian District. Zhongguancun Science Park in Haidian District is the first of this kind of national high-tech industry parks in China. After 20 years of development, Zhongguancun Park in Haidian District has hosted a total of about 18,000 high-tech companies, 86 listed companies in China, and half of the Chinese companies listed in Nasdaq in 2007. Many of the Fortune 500 companies have established their branches and R&D centers in Haidian, making it an area densely concentrated with multinational companies. During the period of 2006–2010, the total revenue of the companies located in the Zhongguancun Science Park in Haidian has grown by an annual average of 18 percent. In 2010, the total revenue exceeded RMB 600 billion and the tax revenue generated reached RMB 6 billion (Zhongguancun Administration Committee, 2010).

An important way to explain the rapid development of the high-tech industry in Haidian and fast growth of the companies located in the Zhongguancun Science Park is the favorable government policy. Since the establishment of Beijing New Technology Industry Development Zone (the predecessor of Zhongguancun Science Park) in 1988, the Chinese central government, Beijing municipal government, and the Haidian local government have enacted numerous policies to support the development of high-tech companies located in Haidian. The policies allowed the enterprises to add the R&D expenditure to the costs of production in their accounting system, reduced the value-added tax of the enterprises based on their R&D expenditure, allowed for accelerated depreciation of R&D equipment, gave the enterprises tax holidays, exempted tax on technology transfer, and provided financial subsidy and support for their R&D projects. However, despite the long duration and enormous variety of all kinds of government policies to support innovation, there are no systematic and rigorous studies to measure the effects of these policies and their impact on the performance of the firms. To fill the gap in the literature, we use a system of regression equations outlined in Crépon-Duguet-Mairesse (1998) to analyze a unique dataset of 500 manufacturing firms in Haidian. The dataset links the nation-wide innovation survey conducted in 2007 and the Annual Survey of Industrial Enterprises database from the National Bureau of Statistics. We find that only the non-state-or-collectively-owned domestic firms among state-or-collectively-owned firms, non-state-or-collectively-owned firms and Hong Kong, Macau, Taiwan or other foreign funded firms that received direct government support for innovative activities invested more in innovation than the firms that did not receive such support. However, although receiving government support, domestic firms including state-or-collectively-owned firms and non-state-or-collectively-owned firms have lower labor productivity than the Hong Kong, Macau, Taiwan or other foreign funded firms. The advantage given by favorable government policy has not led to productivity gain for these enterprises.

The remainder of the chapter is structured as follows. In section 2 we review past studies on the Crepon-Duguet-Mairesse (CDM) model and the relationship between ownership, productivity and innovation activities of the firms. Section 3 introduces the data. Section 4 presents our econometric analysis and results. Section 5 concludes the chapter.

2 Literature review

2.1 The Crépon-Duguet-Mairesse (CDM) model

Many studies have attempted to assess the technical performance of industrial enterprises. There is a vast literature that estimates the effect of R&D within a production function framework, particularly in OECD economies and the United States. Griliches (1979) laid the intellectual foundation for work in this area. In the late 1970s scholars started to analyze the relationship between innovation inputs and ensuing innovation outputs. Griliches and Mairesse (1984) did an empirical study based on the expanded Cobb-Douglas production function and considered a time lag of innovation input and output. They estimated an R&D production function both in levels and differences using a panel data of 133 large U.S. firms from 1966 to 1977. A three equations model was set up by Pakes and Griliches (1984) to investigate the elements that affected innovation input, the relationship between innovation input and innovation output, and firm performance affected by innovation output. This was the first time that the black-box theory of Rosenberg (1976) was modeled to explain the procedure and mechanism of innovation and its internal linkage to firms' performance.

By using a Poisson distribution model and the general method of moments (GMM) estimation, Crépon & Duguet (1997) measured the firms' R&D capital stock and undertook empirical research using the panel data set of 698 French firms from 1984 to 1989. Following Crepon and Duguet's work, Crépon, Duguet and Mairesse (1998) proposed a new three-stage model to explain firms' innovation behavior based on their study of 6145 firms in 18 French industries using Asympotic Least Squares (ALS) and GMM estimates. That is the CDM model that we adopt in this study.

After the CDM model was put forward, a lot of scholars applied this model to the European Community Innovation Survey (CIS) data to study the impact of innovation at the firm level. Some of them even used two waves from the CIS to apply this model in the time dimension. In the beginning, most of the studies used R&D expenditure as innovation input indicator. But as the model was developed, the measurement of innovation varied. Van Leeuwen(2002), Parisi et al (2006) and Duguet (2006) applied the CDM model respectively to firm data of the Netherlands, Italy and France and introduced product innovation, process innovation, fundamental innovation, and gradual innovation by constructing dummy variables to measure these innovation activities. Van Leeuwen and Klomp (2006) replaced the productivity level by the productivity growth in the third equation of the model to explore the impact of innovation on the growth of productivity in manufacturing firms. Griffith, Huergo, Mairesse, Peters (2006) and Lööf and Heshmati (2003) used this model to do cross-country comparisons between European countries. Almost all the studies conducted on European firms show that innovation activities enhance firms' productivity performance.

The CDM model has also gradually been applied to firm-level data on developing countries. However, the results are differ across countries. The empirical study on the 488 firms of 9 industries of Chile proved that the innovation activities were dominated and implemented mainly by large monopoly enterprises, and that once firm size, capital, industry, demand pull and technology push were controlled for, there was no significant impact of innovation sales on productivity (Benavente, 2006). The study on Tanzanian manufacturing firms also showed no significant evidence on the effect of innovation output on productivity growth (Goedhuys, Janz and Mohnen, 2008).[1] The CDM model has also been applied to study the technological development of Chinese industrial firms. Hu (2005) and Jefferson (2006) used the extended CDM model to study innovation of large and medium size firms of Chinese manufacturing industries. Their extended model includes three equations: an R&D input equation, a knowledge production function and a productivity equation. Zhen (2008) and Guo (2008) applied this model to the textile industry and pharmaceutical industry respectively to study innovation and firm competitiveness. Both of them found a positive effect of R&D input on innovation output and eventually a positive impact of innovation output on the firms' productivity. All these innovation studies on China verified the applicability of the CDM model on Chinese data.

2.2 Ownership, productivity and innovation activities

Ownership is a frequently discussed topic in the studies on the performance of China's manufacturing firms. Groves, Hong, McMillan and Naughton (1994) studied the impact of firm ownership and its relationship with firm productivity on China's state-own enterprises. Li (1997) found considerable

[1] See Bogliacino, Perani, Pianta and Supino (2010) for a review of studies linking innovation and productivity in developing countries.

growth in Total Factor Productivity (TFP) in state-owned enterprises in China. Although the state-owned firms had the lowest level of efficiency among the various types of ownership, Zhang et al. (2001) found they had a higher growth rate of technical efficiency than the collectively-owned firms. In contrast, Jefferson et al. (2000) found that TFP growth in collectively-owned firms was more rapid than in state-owned firms. The majority of the studies in the literature hold the view that the most rapid total factor productivity (TFP) growth in the Chinese industry was achieved by non-state-owned firms (Jefferson et al., 2000 and Wu, 1996). Productivity levels of state-owned firms were lower than those of the firms with any other type of ownership. An extreme finding was obtained by Woo et al. (1994), who indicated no TFP growth in the state sector. Hu (2001) adopted a production function framework to analyze the impact of R&D on productivity using a cross section of innovative firms from Beijing. He found that private R&D had a strong impact on firm productivity, whereas government R&D had a negligible impact on firm productivity, though there was a strong complementary relationship between the two types of R&D.

With regard to technology innovation, Jefferson et al. (1999) found that state-owned firms achieved higher profitability than township village enterprises. The authors also found that the competition between the state-owned and non-state-owned firms boosted innovative activity in Chinese industry. Examining the contribution of R&D to productivity by using a production function, Hu and Jefferson (2004) found that in state-owned firms, returns to R&D declined considerably over the period of 1991-1997. Jefferson et al. (2003), however, by comparing state-owned and non-state-owned firms in their samples, found that state-owned firms got higher returns from their innovations, but were less efficient in generating new product innovations than non-state-owned firms.

Regarding foreign versus domestic ownership, the literature suggests the effect of foreign ownership could be positive or negative on innovation. In an analysis of innovation among British, German and Irish manufacturing firms, Love and Roper (2001) found that external ownership has generally a negative effect on innovation intensity (number of innovations per employee) in Germany and Ireland. However, external ownership is positively associated with innovation success (the proportion of sales attributable to new products). As Brugger and Stuckey (1987) argue, foreign firms may have access to technological resources such as large-scale R&D facilities operated by the parent enterprise, or proprietary knowledge developed by the parent company . Alternatively, access may be available to a wide range of non-scientific resources such as finance, international marketing organization through which new products can be diffused, or through patenting or other support functions (Love et al., 2009). However, Malecki (1980) and Howells (1984) argue that the innovation performance of foreign firms may be limited by their parent enterprises. For example, the location of R&D activities is likely to be heavily influenced by corporate decisions, with basic scientific research, as opposed to applied research and development work, more likely to be centralized by the parent company.

Nevertheless, the majority of existing studies argue that foreign firms perform better in innovation than domestic firms. Foreign firms are generally more likely to be innovative than indigenously-owned firms in terms of product innovation (Harris and Trainor, 1995; Love and Ashcroft, 1999) and adoption of new process technologies (Hewitt-Dundas et al., 2005). Harris and Trainor (1995) concluded that foreign firms in Northern Ireland are more likely to innovate, at least in part because they devote more resources to R&D. Foreign-owned enterprises tend to be more productive (and by implication more profitable) than their indigenous counterparts (Stone and Peck, 1996; Griffith et al., 2004) largely because they are more technologically advanced (Oulton, 2001). This conclusion is supported by Love et al. (1996) and Love and Ashcroft (1999), who found evidence that the foreign manufacturing firms in Scotland are more likely to innovate than their indigenous counterparts.

We intend to reexamine on the basis of the micro data for Haidian district whether there is a link between firm ownership and public support for innovation on the one hand, and innovation and productivity on the other hand.

3 Data

The data analyzed in this study result from the merger of two datasets. The first dataset, which is constructed based on a nation-wide innovation survey undertaken by the National Bureau of Statistics in 2007, contains information on 638 firms in the Haidian district (hereafter “Haidian”). The questionnaire of the survey is similar to that of the Fourth European Community Innovation Survey (CIS-4), inquiring about the innovative activities of the firms during the period of 2004-2006.[2] The firms were asked questions about product and process innovation, innovation activities and expenditure, intellectual property rights, and basic economic information. The second dataset is from the Annual Survey of Industrial Enterprises that is implemented by the National Bureau of Statistics and covers the firms located in Haidian. The dataset contains more than 50 firm-level statistical indicators, including output, R&D expenditure, capital composition, employment, the industry in which a firm operates (at the four-digit level), ownership status, and assets and liabilities. In total, 563 firms from the two datasets are successfully matched. After data cleaning, we obtain a cross-section sample of 500 manufacturing firms.

We classify the 500 firms into three types based on their ownership: state-or-collectively-owned firms, non-state-or-collectively-owned domestic firms and Hong Kong, Macau, Taiwan or other foreign funded firms.[3] Among the 500 Haidian manufacturing firms, 53 are state-or-collectively-owned firms, 361 are non-state-or-collectively-owned domestic firms and 86 are Hong Kong, Macau, Taiwan or other foreign funded firms (Table 1). About 60 percent of the firms fall into three sectors: special machinery, electronic and communication equipment, and precision instruments and office machinery.

insert here Table 1)

[2] The first Community Innovation Survey was conducted in European countries in 1993. It is the first survey on innovation that was implemented at the same time in multiple countries on the basis of a harmonized questionnaire. The second and third surveys were conducted in 1997/1998 and 2000/2001, respectively. The CIS-4 was conducted in 2004. After the previous three exercises, the questionnaire was improved to enhance the clarity and usefulness of the questions. Moreover, the length of the questionnaire was shortened significantly.

[3] The definition of ownership status of a firm in this paper is based on the registered status of the firm in the Administration for Industry & Commerce.

4 Model and Econometric Analyses

4.1 The model and variables

The central research question of this study is whether Haidian firms with different ownership (private or public, domestic or foreign) benefit in the same way from government support for innovation activities or whether the impact of that government support on innovation activities and productivity differs by ownership status.. To answer this question, we carry out the analysis based on a system of recursive equations as in the original CDM model. The first equation of the system explains a firm's

innovation expenditure intensity, which is defined as a firm's innovation expenditure divided by its sales revenue.As some firms have no innovation expenditure we use a simple tobit model. The key explanatory variables are five ownership dummies corresponding to the state-or-collectively-owned firms *with* government support for innovation, the state-or-collectively-owned firms *without* government support for innovation, the non- state-or-collectively-owned firms *with* government support for innovation, the non-state-or-collectively-owned firms *without* government support for innovation and the Hong Kong, Macau, Taiwan or other foreign funded firms *with* government support for innovation. The reference group is the Hong Kong, Macau, Taiwan or other foreign funded firms *without* government support for innovation. Government support for innovation means direct funding or tax rebates for innovative activities. Through these five key explanatory variables, we can examine whether the impact of government support on innovation expenditure intensity differs according to ownership. We control for the firm size, which is defined as the logarithm of the number of employees, and for sector-specific effects for the industries special machinery, electronic and communication equipment, and precision instruments and office machinery, which altogether account for more than 60 percent of the total sample of firms.

The second equation consists of another standard Tobit modelto examine the determinants of a firm's innovation output. Innovation output is measured by new product share, which is defined as the firm's value of new product sales divided by the value of its gross industrial output. Innovation expenditure intensity (innovation input) enters this equation together with the three sector dummies. The third equation is an ordinary least squares model that estimates the impact of a firm's innovation output on its productivity. The dependent variable is the logarithm of the firm's labor productivity. The explanatory variables include new product share and the capital/labor ratio, which is defined as the logarithm of fixed assets divided by the number of employees. As in the first equation, five ownership/government support dummies and the sector dummies enter as explanatory variables. We are interested in investigating from the coefficients of the five ownership/government support dummies whether firms with different ownership status with or without government support would achieve equal or different labor productivity. The definition of the variables can be found in Table 2. (Here insert Table 2)

The simple descriptive statistics show that among the firms that benefited from government support for innovation the percentage of the domestic firms that are not state-owned or collectively-owned is almost twice as high as the percentage of firms that are state-or-collectively-owned firms and as high as the percentage of Hong Kong, Macau, Taiwan or other foreign funded firms (Table 3). The innovation expenditure intensity of the non-state-or-collectively-owned domestic firms is almost the same as that of the state-or-collectively-owned firms (the difference is not statistically significant) but higher than that of the Hong Kong, Macau, Taiwan or other foreign funded firms (the difference is statistically significant). The new product share of the highest for domestic firms that are not state- or collectively owned, although the difference with the Hong Kong, Macau, Taiwan or other foreign firms in terms is not statistically different. The Hong Kong, Macau, Taiwan or other foreign firms have a higher labor productivity than the domestic firms.

(Insert here Table 3)

Crépon, Duguet and Mairesse (1998) used the method of asymptotic least squares to estimate the above mentioned recursive equation system. They estimated the reduced form coefficients in each equation separately and inferred from these auxiliary parameters the structural form parameters of the model using a minimum distance estimator or so called asymptotic least squares estimator. The asymptotic least squares estimator has the advantage of controlling for the potential endogeneity of the innovation expenditure intensity in the second equation and of the new product share in the third equation. In addition, it can accommodate the nature of the censured dependent variables (innovation expenditure intensity and new product share). For comparison we present the estimates of the asymptotic least squares and those of the innovation output and productivity equations estimated separately, without correction for endogeneity.

4.2 Results

Table 4 reports the estimated coefficients of the model. It is surprising to notice that government support for innovation for state-owned or collectively-owned firms and for foreign firms (including firms from Hong Kong, Macau and Taiwan) does not *ceteris paribus* lead to a higher innovation expenditure intensity than in foreign firms without government support (the reference group). Government support for innovation only raises the innovation expenditure intensity of privately-owned (i.e. non-state-or-collectively-owned) domestic firms. Calculation of the marginal effect shows that the innovation expenditure intensity of the privately-owned domestic firms that receive government support for innovation is 3.8 percentage points higher than that of the firms in the reference group. Given that the mean of the innovation expenditure intensity of the sample of 500 firms is 8.2 percent, the impact of the government support on the privately-owned domestic firms is not trivial. Firms' innovation expenditure intensity decreases with firm size, i.e. if there is any increase in innovation expenditures related to size, it is less than proportional to the size increase. The firms in electronic and communication equipment and especially those in precision instruments and office machinery invest relatively more in innovation than the other firms.

(Insert here Table 4)

Innovation expenditure intensity has a positive and significant effect on innovation output. The marginal effect of a 1 percent increase in innovation expenditure intensity leads to a 1.9 percent increase of the observed new product share.[4] Innovation output is not necessarily higher in the two sectors that we have controlled for.

Innovation output in turn has a positive and significant effect on labor productivity. A 1 percentage point increase of new product share results in an increase of labor productivity of 4.9 percent, about two and a half times as high as the elasticity reported by Mairesse et al (2005) for France.[5] The total effects of ownership and government support for innovation on labor productivity have to be calculated on the basis of the coefficients of the three equations. For example, if we multiply the effect of government support for privately-owned domestic firms in the innovation input equation (.038) by the marginal effect of innovation expenditure intensity in the innovation output equation (1.9) and the marginal effect of new product share in the productivity equation (4.9) we obtain .35. If we sum .35 and the direct coefficient of -1.1 of the dummy for non-state-or-collectively-owned domestic firms with government support for innovation in the productivity equation, we obtain a total effect of government support for innovation on labor productivity of -.75. This indicates that in comparison to Hong Kong, Macau, Taiwan or other foreign funded firms, privately-owned domestic firms have lower labor productivity. The induced higher productivity due to increased innovation stimulated by government support is overshadowed by the direct negative effect of government support for innovation on labor productivity. Firms benefiting from such a support may not be encouraged to be as

[4] The marginal effect of innovation expenditure intensity on the share of innovative sales equals the coefficient of the structural form equation multiplied by the probability that the predicted new product share is positive (Greene, 2003, p.765).

[5] Mairesse, Mohnen and Kremp (2005) report a derivative of the logarithm of labor productivity with regard to the logit transformation of new product share of .225, which yields a derivative of the logarithm of labor productivity with regard to new product share of 2.

efficient as non-supported firms. Because the coefficients of the other ownership status dummies in the innovation input equation are not significantly different from zero, only the direct effect of ownership on labor productivity matters, which is for all of them negative. We can thus conclude that for all firms the labor productivity is lower than for the foreigned-owned firms that do not get any government support for innovation. This finding is consistent with the descriptive statistics reported in Table 3.

The coefficients of innovation expenditure intensity and new product share are statistically insignificant in the innovation output and productivity equations when endogeneity is not controlled for. The scale of the coefficients in the innovation output and productivity equations is also smaller when these equations are estimated separately without controlling for endogeneity than with the asymptotic least squares estimation method. These signs of attenuation bias confirm the findings reported in Mairesse, Mohnen and Kremp (2005) that the data of the innovation surveys are noisy.

To summarize, the key finding in estimating the equation system through asymptotic least squares is that the privately-owned domestic firms in Haidian that received government support for innovative activities invested more in innovation in 2006 compared to those same firms that did not get any government support. Such a stimulating impact on innovation was not observed for state-owned and foreign-owned firms. However, all the firms with government support achieved a lower labor productivity than the Hong Kong, Macau, Taiwan or other foreign funded firms. This result demonstrates that the firms in Haidian did not react equally to government support for innovation. However, the government funding and tax rebate for innovative activities given to the privately-owned domestic firms did not result in productivity gains.

5 Discussion and policy implications

In this study we analyze a cross-sectional data set that includes 500 manufacturing firms in the Haidian District of Beijing, China, to investigate whether manufacturing firms with different ownership benefit equally from government's policy in support of innovation activities in terms of higher innovation and higher productivity gains. We rely on the CDM model framework to control for endogeneity in estimating the effects of innovation input on innovation output and of innovation output on labor productivity. We compare the results of the CDM model with those obtained when estimating the equations without controlling for endogeneity.

The key finding is that only privately -owned domestic firms in Haidian that received government funding or a tax rebate for innovative activities invested more in innovation than foreign funded firms that did not receive such government support. In addition, the domestic firms achieved lower labor productivity than the Hong Kong, Macau, Taiwan or other foreign-owned firms.

Our analysis shows that the innovation policy played out differently for Haidian firms depending on their ownership status. Privately-owned domestic firms that received support for innovation spent more innovation activities than state-owned (or collectively-owned) and foreign-owned firms. Contrary to the common belief that foreign firms are more likely to be discriminated against by the so-called indigenous innovation policy in China on the ground that they are often excluded from public procurement by the Chinese governments, our analysis actually shows that state-or-collectively-owned firms benefited even less in innovation and productivity performance than the Hong Kong, Macau, Taiwan or other foreign funded firms from government policy in support of innovation. More importantly, we find that the privately-owned firms that spent more on innovation thanks to government support than the Hong Kong, Macau, Taiwan and other foreign-owned firms without government support actually performed worse in terms of labor productivity than the latter. This casts doubt on the effect of government innovation policy. Government innovation support should target the firms with a great innovation potential, which can be demonstrated by a high innovation expenditure intensity or a high new product share. However, our results reveal that government support to the domestic firms apparently has not resulted in productivity gains vis-à-vis foreign firms.

It may take time for the benefits of government support for innovation to show up. For instance, Choi, Lee and Williams (2011) found a lagged public ownership effect on patenting in China. Because our data is cross-sectional, we are not able to test for lagged effects of government support on innovation output and labor productivity. Exploring dynamic models of innovation with protracted policy effects can be a promising topic for future research. We should also point out two other shortcomings of our analysis. First, it is quite possible that government support for innovation is endogenous as the government direct funding or tax rebates for innovative activities may be given to the firms with high innovation output (high new product share). The data do not enable us at this stage to examine this reverse causality. Second, we don't have information on the actual amount of government support that firms received. The lower effect of government support on innovation and productivity could be due to lower funding or lower effectiveness of such funding for state-owned and foreign-owned firms.

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Table1: Breakdown of the sample firms by ownership and industry

	State-or-collectively-owned firms	Non-state-or-collectively-owned domestic firms	Hong Kong, Macau, Taiwan or foreign-funded firms	Total	Percentage in total
Agri-food products	0	11	1	12	2.4
Food products	0	7	2	9	1.8
Beverages	0	1	1	2	0.4
Textiles	0	1	0	1	0.2
Wearing apparel and other fiber products	0	2	0	2	0.4
Leather, fur, down and related products	0	0	1	1	0.2
Printing, reproduction of recording media	5	1	0	6	1.2
Culture, education and sport products	1	0	0	1	0.2
Coke, refined petroleum products	1	1	0	2	0.4
Chemicals and chemical products	2	27	0	29	5.8
Medicine	0	12	4	16	3.2
Rubber products	1	1	0	2	0.4
Plastic products	0	1	2	3	0.6
Non-metallic mineral products	1	12	7	20	4
Smelting and pressing of ferrous metals	0	1	0	1	0.2
Smelting and pressing of non-ferrous metals	0	0	1	1	0.2
Metal products	0	4	1	5	1
General machinery	6	20	3	29	5.8
Special machinery	9	57	6	72	14.4
Transportation equipment	4	4	2	10	2
Electrical machinery and equipment	1	22	3	26	5.2
Electronic and communication equipment	8	99	35	142	28.4
Precision instruments and office machinery	13	61	11	85	17
Artifact and other manufacturing	1	16	6	23	4.6
Total	53	361	86	500	100

Table 2: List of Variables

Variables	Definition and measurement
Innovation expenditure intensity	Innovation expenditure in 2006/Sales revenue in 2006
State-or-collectively-owned firms *with* government support for innovation	If a domestic firm is state-or-collectively-owned and it received government funding or tax rebate for its innovative activities, the value is 1. Otherwise, 0.
State-or-collectively-owned firms *without* government support for innovation	If a domestic firm is state-or-collectively-owned but it did not receive government funding or tax rebate for its innovative activities, the value is 1. Otherwise, 0.
Non-state-or-collectively-owned domestic firms *with* government support for innovation	If a domestic firm is neither state-owned nor collectively-owned but it received government funding or tax rebate for its innovative activities, the value is 1. Otherwise, 0.
Non-state-or-collectively-owned domestic firms *without* government support for innovation	If a domestic firm is neither state-owned nor collectively-owned and it did not receive government funding or tax rebate for its innovative activities, the value is 1. Otherwise, 0.
Hong Kong, Macau, Taiwan or other foreign funded firms *with* government support for innovation	If a firm is a Hong Kong, Macau, Taiwan or other foreign funded firm and it received government funding or tax rebate for its innovative activities, the value is 1. Otherwise, 0.
Firm size	ln (number of employees)
New product share	New product value/Gross industrial output value
Labor productivity	ln (value added/number of employees)
Capital input per capita	ln (fixed assets/number of employees)
Special machinery	If a firm falls into the sector of special machinery, the value is 1. Otherwise, 0.
Electronic and communication equipment	If a firm falls into the sector of information and communications technologies, the value is 1. Otherwise, 0.
Precision instruments and office machinery	If a firm falls into the sector of measurement instrument and office equipment, the value is 1. Otherwise, 0.

Table 3: Descriptive statistics

	Total number	Percentage of firms with government support for innovation	Mean innovation expenditure intensity (in %)	Mean new product share (in %)	Mean logarithm of labor productivity
State-or-collectively-owned firms	53	9.4	8.8	46	2.8
Non-state-or-collectively-owned domestic firms	361	21.3	8.6	72	3.8
Hong Kong, Macau, Taiwan or other foreign funded firms	86	11.6	5.8	68	4.2

Table 4: Results of the asymptotic least squares estimation and separate estimation

	Asymptotic least squares			Separate estimation	
	Innovation input equation	Innovation output equation	Productivity equation	Innovation output equation	Productivity equation
Dependent variable	Innovation expenditure intensity	New product share	Log of labor productivity	New product share	Log of labor productivity
Innovation expenditure intensity	-	4.0(1.8)**	-	.45(.31)	-
New product share	-	-	4.9(.44)***		.25(.21)
State-or-collectively-owned firms *with* government support for innovation	.029(.065)	-	-.83(.90)*	-	-.79(.80)
State-or-collectively-owned firms *without* government support for innovation	.031(.027)	-	-.75(.40)*	-	-.74(.32)**
Non-state-or-collectively-owned domestic firms *with* government support for innovation	.071(.023)***	-	-1.1(.57)**		.075(.28)
Non-state-or-collectively-owned domestic firms *without* government support for innovation	.028(.019)	-	-.87(.33)***		-.36(.22)
Hong Kong, Macau, Taiwan or other foreign funded firms *with* government support for innovation	.047(.047)	-	-.80(.75)	-	.39(.58)
Firm size	-.006(.004)	-	-.18(.059)***	-	-.34(.055)***
Capital input per capita	-	-	.51(.035)***	-	.51(.035)***
Special machinery	.015(.020)	-.034(.12)	.088(.50)	.040(.11)	.22(.24)
Electronic and communication equipment	.030(.016)*	-.030(.10)	-.20(.40)	.082(.091)	.19(.19)
Precision instruments and office machinery	.058(.018)***	-.19(.15)	-.086(.47)	.029(.11)	.14(.22)
Number of observations	500	500	500	500	500

Asymptotic standard errors in parentheses. Significant at 1% ***, 5% **, 10% *.