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Globalization, Innovation and Productivity in Manufacturing Firms: A Study of Four Sectors of China

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Abstract: This paper investigates relationships between innovation input, innovation output and labor productivity in China for four major manufacturing sectors; textiles, wearing apparel, transport equipment and electronic equipment. It uses a large sample of firm level micro data and a structural model in the estimation. The data from 2005 to 2006 is estimated, and results of all the sectors show positive effects from innovation input to output, and then to firm performance. Globalization has various impacts on innovation, through exports. It has a positive effect on both the decision to carry out R&D, and intensity of R&D input in sectors with competitive advantage, such as textiles and transport equipment, but not in sectors with high levels of overseas capital control, such as electronic equipment and wearing apparel. Ownership reveals the same story in different sectors, namely that foreign firms tend to do less in innovation input and output, but they do have higher level of productivity. Moreover, market share, subsidy, firm size and other characters of firms are involved in the estimation, which explains significant difference in engaging in innovation and production. Thus, in all the sectors, market share improves R&D input, continuous R&D input and exports improve new products output. Subsidy sustains R&D input, but not innovation output.

Keywords: R&D, New Product, Productivity, Export, CDM Model
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1. Introduction

Innovation is a key concept in moving into the knowledge-based economy, not only for the further development of developed economies such as the United States and European countries, but also for the reform and development of China. During the past thirty years of reform, China has achieved rapid growth and becomes a "world factory". In the new century, China is seeking for a new development approach to improve productivity, save energy and resources, but maintaining the fast pace of development and aiming to be the world's manufacturing center at the same time. The most practicable strategy is to establish a knowledge-based economy and make innovation a main factor in research and development, production and management, especially in manufacturing sectors at the firm level. The macro data in Table 1 shows the fast growth of R&D input and productivity in China during the past decade. Nevertheless, the absolute amount, measured as R&D input in business, the rate of R&D input in GDP, or GDP per capita, is still far less than in developed countries. Industrial productivity in China is less than one sixth of the United States' level in 2008 even at purchasing power parity (PPP), which is much higher than current values in China.

Table 1: R&D Expenditure and Productivity across Countries

	China	India	Germany	Japan	Korea	USA
Total expenditure on R&D 1997 (% of GDP)	0.64	0.70	2.24	2.87	2.48	2.56
Total expenditure on R&D 2007 (% of GDP)	1.44	0.83	2.53	3.44	3.21	2.65
Business expenditure on R&D 1997 (% of GDP)	0.30	0.16	1.51	2.07	1.80	1.87
Business expenditure on R&D 2007 (% of GDP)	1.04	-	1.77	2.68	2.45	1.91
Business expenditure on R&D 1997 (USD Billion)	2.83	0.67	32.75	88.08	9.30	155.41
Business expenditure on R&D 2007 (USD Billion)	35.25	-	58.91	117.45	25.68	269.27
GDP per capita 1997 (USD)	771	437	26445	33776	11237	31038
GDP per capita 2007 (USD)	2560	965	40430	34262	21655	46680
Productivity in industry 2000 (PPP, USD)	8512	6349	57902	52086	35106	69507
Productivity in industry 2008 (PPP, USD)	18196	9656	84601	70709	64169	120118

Source: IMD, World Competitiveness Yearbook, online database.

Globalization has been regarded as a key to world development since the last century, no matter whether people have positive or negative attitudes towards it. China always shows an active attitude towards globalization by opening its market, especially the manufacturing sector, encouraging foreign direct investment (FDI) and exports. FDI has been encouraged and has grown very quickly since the beginning of the reform process. It has higher levels of management and efficiency in production, brings a fresh atmosphere and new techniques, improves exports and helps the government gain foreign exchange. Nowadays, FDI is an important element in the Chinese economy, and it controls more than half of the firms in some key manufacturing sectors, especially in electronics-related high-tech sectors. At the same time, growth of exports supports the fast growth of the economy and helps the country obtain its reputation as "world factory". Table 2 shows the process of globalization. The Stock of incoming FDI has started from 0.15% of the world's total amount since the beginning of reform. It reached 2% in 1993, the highest to 3.46% in 1997, and nearly the same level with Canada in the first decade of this century. Export grew from less than 1% of the world to 5% in 2002, and nearly 10% in 2009. GDP grew from 2.58% of the world in 1980 to 8.21% in 2009, but the per capita value is still less than 10% of United States' level.

Table 2: Growth of FDI, Export and GDP in Mainland China

	1980	1990	2000	2005	2006	2009
Foreign direct investment stock-Inward (% of the world)	0.15	0.99	2.60	2.36	2.05	2.67
Total merchandise trade-Export (% of the world)	0.89	1.78	3.86	7.25	7.99	9.68
GDP (% of the world)	2.58	1.82	3.72	5.07	5.65	8.22
GDP per capita (% of USA)	2.66	1.61	2.84	4.40	5.02	8.21

Source: United Nations, UNCTAD database.

In the new century, China's development is focusing on sustainable development in a fast growing economy, and the improvement of residents' welfare. Innovation at the firm level is a key step in improving productivity, sustaining the reform of industrial structure and supporting manufacturing firms' competition in the global market. That is why the *Sustainable Development Strategy* and *Innovation-oriented Country Strategy* of China came into being in 2006.

Based on a large sample of firm level data, this paper will investigate why firms choose to carry out R&D, how R&D input supports new product output, how R&D activity affects productivity, and the effect of globalization, e.g. FDI and exports, on innovation during the process.

The paper focuses precisely on four major but distinctive manufacturing industries: Textiles (code 17), Wearing Apparel (code 18), Transport Equipment (code 37) and Electronic Equipment (code 40).[1] The first two industries are more labor intensive and low-tech, while the others are more capital intensive and high-tech. All four are important not only in the Chinese domestic market but also in the world market. The textile industry is the largest manufacturing sector in China in terms of the number of firms and the size of labor force. The textiles and wearing apparel industries are sectors with competitive advantages in the world market and also are sectors in which trade conflicts can easily arise. Furthermore, these sectors have sufficient power to influence the employment market in China, and the textile products market worldwide. The transport equipment sector has been a developed industry for more than half a century in China, and it will grow fast with the high-speed railway plan in Mainland China in the coming decades. More than half of the electronic equipment firms are controlled by overseas capital, which makes it a sector with two foreign markets: materials and components imported from abroad and products exported abroad, especially to developed countries. All the four sectors have grown extremely quickly and have been quite innovative in recent years. Our analysis thus relies on four firm samples separately for the 2 years: 2005-2006.

The paper is organized as follows. Section 2 summarizes the literature strands. Section 3 introduces the equations of the structural model and the estimation method of this paper. Section 4 describes data and variables selection. The empirical results are presented in section 5 and section 6 draws the conclusion and policy suggestions.

[1] Electronic Equipment here means "Manufacture of Communication Equipment, Computers and Other Electronic Equipment". It is comparable with code 32 in UN ISIC 3.1.

2. Literature Review

The productivity ratio between input and output in production has been a classical area of study since the Cobb-Douglas production function was proposed in 1928. Since then, thousands of discussions, ameliorations and empirical studies have been contributed to this academic area, together with the remarkable improvements by Tinbergen (1942), Solow (1957), and Jorgenson (1987). Griliches (1979) develops the knowledge production function and gives innovation criteria a new position in the equation. Crépon Duguet and Mairesse (1998) propose a new system, combining the innovation selection function, the knowledge production function and the production function together to analyze the innovation procedure and production performance. That is what we call the CDM model.

The CDM model is a systematic attempt to understand the relationships and linkages among innovation input, innovation output and production performance, especially using firm level data. Most of the existing studies using a CDM model incorporate survey data, especially Community Innovation Surveys (CIS) data from European countries.[2] Lööf and Heshmati (2002) study Swedish CIS II data to analyze knowledge capital and firm performance. They give a good comparison of key parameters in earlier CDM models. The parameters are various but all are positive using French and Swedish data. Janz *et al*. (2004) compare innovation and productivity in Germany and Sweden by using CIS III firm data and get "a common story across countries". Ferreira *et al*. (2007) give both separate and simultaneous estimation of a CDM equations system and get different results by using Portuguese CIS II firm data. Mohnen *et al*. (2006) work on CIS I firm data to compare 7 European countries and develop the measure of *innovativity*, which combines the micro measurement and aggregate macro comparison. Benavente (2002) estimates the CDM model by using Chilean survey data designed under the reference of CIS, but the sample size is much smaller.

[2] Up to 2010, Eurostat has launched five innovation surveys under the direction of the "Oslo Manual". These surveys are known as CIS I to CIS V, mainly organized in 1993, 1997-1998, 2000-2001, 2004, and around 2010.

A CDM related model has been estimated in a few papers using hard data, including data from China.[3] Jefferson *et al*. (2006) studies R&D and firm performance of Chinese large and medium-size manufacturing firms by using a rich set of census data from 1997 to 1999, with original observations of nearly 20,000 in all manufacturing sectors before being cleaned each year.[4] Hu and Jefferson (2004) discuss the same question using sample survey data of state-owned enterprises located in Beijing. These results suggest substantial and significant returns to R&D, and a difference across industries.

Export and FDI based globalization is another interesting topic discussed in academic papers. Empirical study of the linkage between exporting and innovation using micro data has increased in recent years. One direction emphasizes the contribution of innovation to entry into the global market. Most of the results suggest a positive effect of innovation on exports, e.g. among Canadian manufacturing firms by Baldwin and Gu (2004), German service firms by Ebling and Janz (1999), and Chinese firms by Guan and Ma (2003).[5] Another is the reverse direction; i.e. investigating the causality from exports to innovation, i.e. the learning-by-exporting effect in firms. A positive impact of exporting on innovation at the firm level is presented in Salomon and Shaver (2005) for Spain, Hahn (2010) for Korea, and Tsou *et al*. (2008) for Taiwan. Moreover, Amiti and Freund (2008) find that China's export growth is supported by growth of existing products, rather than new products, Wang and Wei (2008) find that foreign firms do not conduct R&D to introduce new products.

This paper will focus on firm behavior, from the innovation process to firm performance. Effects of exporting and foreign ownership on innovation are investigated during the stepwise estimation. The contribution of this study is the subdivided sector level study which tests the effectiveness of the CDM model by not

[3] Hard data means not survey data where standard answers are selected, but real amounts of value in accounting and production, such as the value of exports, sales of new products and so on.

[4] The size is defined by the China National Bureau of Statistics. The standards are different among sectors using particular products, fixed assets and so on before 2002. The system was simplified in 2003 using three criteria i.e. labor force, sales of products and total assets, but most of them can be compared with the old standards. Here are the new standards for reference: medium-size manufacturing firms' must have at least 300 people, 30 million sales and 40 million assets; large-size must have 2000 people, 300 million sales and 400 million assets.

[5] Other inconsistent results by Willmore (1992), Sterlacchini (2001) and other papers suggest the contrary, though the amount is much smaller than the positive results.

using survey, but firm level hard data, and distinguishes the globalization effect on innovation.

3. Econometric Model

The CDM model gives us a systematic understanding of the innovation path in production. It brings together the three main fields of investigation in the econometrics of research and innovation, i.e. why firms select innovation inputs, innovation output efficiency, and innovation's impact on productivity. It has three steps and four equations written as follows, with ***i*** index firms and ***t*** index year. Vector x series are explanatory variables, vector b series are parameters and vector u series are error terms.

Innovation input: $$brd_{(t-1)i} = x_{0(t-1)i} b_0 + u_{0i} \quad (1)$$

$$lrdpl_{(t-1)i} = x_{1(t-1)i} b_1 + u_{1i} \quad (2)$$

Innovation output: $$\ln ppl_{ti} = \alpha * lrdpl_{(t-1)i} + x_{2ti} b_2 + u_{2i} \quad (3)$$

Innovation performance: $$lp_{ti} = \gamma * \ln ppl_{ti} + x_{3ti} b_3 + u_{3i} \quad (4)$$

Step one, known as the innovation function, explains innovation input with two equations shown as equations (1) and (2). The first equation is a probit model as a selection equation to understand firms' decisions about whether or not to input innovation. The second equation is a Tobit model to explain why they would like to spend more or less on innovation. We use the Heckman procedure in the STATA software to estimate the first two equations, in which the data is one year earlier than the following two steps.[6] Explained variables in innovation input are measured by a binary variable (*brd*) in the probit model to identify whether firms have made an innovation input or not, and R&D intensity measured by R&D expenses per labor unit

[6] The result for electronic equipment is difficult to converge by using data of 2005. We use the pooled 2005-06 data in all the 3 steps after comparing the 2006-only result.

(*lrdpl*, in logarithm) in the Tobit model to explain why they would choose to spend different amounts on innovation. The regressors are market share, capital intensity, binaries of exporting and subsidy, as well as control variables such as firm size dummies and ownership dummies.[7]

Step two with equation (3) is a knowledge production function, proposed by Griliches (1979), which explains innovation input and its influence on innovation output. Innovation output is measured by new product output per labor unit (*lnppl*, in logarithm) to identify the extent to which firms have innovation output. Here we estimate its predicted value (*lnppl*) and input it as an explained variable in the third step, so that all the firms can be involved in the last equation. The predictor variables are predicted value of R&D expenses (*lrdpl*), capital intensity, a binary of export and subsidy, and dummy groups of firm size and ownership.

In the first two steps, we test an innovation related group of binary variables, export and subsidy, to explain the relative characters of globalization and government support for firms' innovation behavior.

Step 3 with equation (4) is an extended Cobb-Douglas production function to explain innovation output and its influence on productivity, measured by labor productivity (*lp*, in logarithm). The predicted value of innovation output (*lnppl*) is a regressor, except for the traditional variables of capital intensity and number of employees. Dummy variables for ownership, as well as region and sub-sector are also added in this step.

In order to include all the firms in the model, we follow the estimation method in Griffith *et al*. (2006) by using predicted values from earlier steps in later steps. Some groups of variables are added as binaries or dummies to specify characters of firms, such as ownership, region, size, sub-sector and so on. We also estimate the innovation input equation one year earlier than the innovation output and firm performance equations, assuming that innovation input has a time lag in influencing innovation

[7] "Subsidy" which is the income from government or international organizations, involves 3 main kinds. The first is innovation related income, e.g. subsidy for carrying out an R&D project or filing a patent, obtaining a development fund, or producing some special kinds of new products. The second is production related, e.g. return of added value tax for exports, subsidy for environment protection. The third is income of obtaining an award, e.g. bonus for pilot products, famous brand award and so on. Appendix Table A2 lists the average labor productivity of firms with or without subsidy. We will not discuss the table further due to the complex components of this variable.

output, but the effect of innovation output on performance is mainly in the same year. Similarly, we estimate the pooled four sectors to test the robustness of our findings.

The estimation using estimated values assumes that all firms have the potential for innovation. This is a simplification of the original CDM model, which is much more convenient than the other two methods. One of these is the simultaneous estimation of four equations using the Inversed Mills Ratio, estimated in the earlier step, to correct the standard error. The other is to give zero observations, especially those in innovation variables, a very small value like 0.0001 to avoid selectivity bias (Jefferson *et al*., 2006).

4. Data and Description

4.1. Data and Selection

This paper will use the industrial census data in 2005 and 2006.[8] They are the most recent firm level data that it is possible to obtain from the China National Bureau of Statistics. It is a yearly census of all state-owned firms, and those non-state-owned middle and large firms above a designated size.[9] The criteria are all hard data, and most of them are from yearly accounting reports by enterprises. The structure of the data is similar to but much richer than Jefferson *et al*. (2006) investigate, for the textile sector observations alone reach 20,000 before "cleaning" in 2006. The dataset gives us a wide field of research, but also poses challenges in terms of variances and other matters which require sector by sector investigation.

From the original data we delete those firms with fewer than 10 employees, or whose sales of products are less than RMB 5 million, or whose value added is less than zero.[10] Then we calculate the growth rates of sales, labor and capital for each firm.

[8] We do have a long panel before 2005, but there is a gap of observation changes and an unexpected absence of innovation criteria in 2004, which restricts the usage of the long run panel.

[9] The designated size means that Sales of Products is higher than RMB 5 million (about EUR550,000). Firms larger than this size are included in the census scheme and report their data every year by filling in a set of statistical forms. Firms smaller than this size are surveyed separately using sampling methods.

[10] The deletion of small sales firms can help us to get the same standard of state-owned and non-state-owned firms, since non-state-owned firms with sales less then 5 million are not included in the census scheme.

Firms with all the three growth rates between the 2.5 and 97.5 percentile are kept in the modeling. Thus we obtain two-year balanced data from 2005 to 2006.

Three groups of variables are selected to establish the CDM model. The first group is basic variables in innovation and the production function, including labor productivity calculated as value added divided by the number of employees, the number of employees, capital (shown as net value of fixed assets) per employee, all in logarithm.[11] The second group is innovation variables, with R&D expenses per labor unit (in logarithm), new products output per labor unit(in logarithm) and a binary to identify whether the firm has continuous R&D expenses or not in 2006, following its positive expenditure in 2005. The third group is extended variables including market size, measured by sales ratio in 3-digit sub-sectors, firm size by four dummies, categories of capital control by five ownership dummies to measure the ownership of each firm. All these variables are detailed in Appendix Table A1.[12]

4.2. Basic Description

Table 3 gives the basic description of variables in each sector and each corresponding year, with the pooled four sectors data in the last two columns for reference. For basic variables, average labor productivity increases more than 15% in textiles and transport equipment in 2006, about 10% in wearing apparel, but only 3.5% in electronic equipment, though this sector has the highest level of productivity. The average numbers of employees are around 300, 340 and 350 in the first three sectors respectively, and they do not change much across the two years. The number is much higher in electronic equipment firms, and it grows about 10% in 2006 to nearly 700 people. Capital intensity in wearing apparel is about 23,000 RMB, much lower than that of the other three sectors, whose intensity is about 70,000 to 80,000 RMB.

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[11] Capital per employee is also a predicted variable used in the innovation function to measure firm size, together with market size.

[12] It is the smallest sector category in China Industry Standard. The market size defined as sales ratio like: $lsts_{it} = \ln(S_{it} / \sum_{sub-sector} S_{it})$, with S_{it} index sales of products of firm i in year t, and $\sum_{sub-sector} S_{it}$ index of total sales of the 3-digit sub-sector that firm i involved in in year t. Each firm belongs to only one 3-digit sub-sector in the database. We do not have further information about different products in one firm.

Table 3: Means of Variables across Sectors and Years

	Textile		Wearing Apparel		Transport Equipment		Electronic Equipment		Pooled 4 Sectors	
	2006	2005	2006	2005	2006	2005	2006	2005	2006	2005
Basic*										
Productivity	80.3	68.7	50.2	45.7	104.1	90.0	117.8	113.9	84.0	74.6
Labor	307	303	342	333	362	355	684	622	382	367
Capital per Employee	67.7	64.3	23.4	22.5	74.2	70.7	80.8	80.2	61.2	58.8
Innovation										
R&D *	2.5	1.5	1.7	1.9	10.1	8.5	18.3	16.9	11.0	9.7
R&D>0	0.062	0.057	0.048	0.047	0.215	0.192	0.281	0.251	0.121	0.110
Continuous R&D	0.035	-	0.025	-	0.148	-	0.202	-	0.080	-
New Product *	75.5	62.3	102.1	86.2	514.2	421.7	790.6	707.0	456.6	368.6
New Product>0	0.083	0.072	0.061	0.067	0.180	0.164	0.196	0.181	0.114	0.105
Dummy Variables										
Export=1	0.403	0.408	0.645	0.645	0.279	0.269	0.585	0.579	0.459	0.459
Subsidy=1	0.140	0.154	0.115	0.120	0.187	0.182	0.192	0.193	0.152	0.158
Firm Size										
Size:<50	0.128	0.130	0.033	0.032	0.110	0.116	0.082	0.085	0.097	0.099
Size:50-99	0.237	0.238	0.139	0.138	0.251	0.267	0.173	0.185	0.208	0.214
Size:100-249	0.350	0.349	0.401	0.407	0.345	0.341	0.287	0.283	0.350	0.350
Size:250-999	0.234	0.231	0.379	0.379	0.226	0.210	0.308	0.303	0.275	0.270
Size:>999	0.052	0.052	0.049	0.044	0.068	0.065	0.150	0.144	0.069	0.066
Ownership										
State-owned	0.009	0.010	0.006	0.006	0.049	0.052	0.018	0.018	0.018	0.018
Limited Liability	0.111	0.111	0.077	0.073	0.194	0.190	0.129	0.119	0.122	0.119
Share-holding	0.014	0.015	0.009	0.010	0.024	0.025	0.023	0.024	0.016	0.017
Private	0.586	0.575	0.422	0.414	0.426	0.415	0.252	0.251	0.469	0.460
HMT	0.135	0.134	0.239	0.238	0.081	0.078	0.261	0.259	0.166	0.165
Foreign	0.098	0.098	0.210	0.214	0.130	0.131	0.286	0.295	0.157	0.159
Number of Firms	13245		6645		5926		4534		30350	

Notes: (1) The table lists the balance panel data by year.
(2) Variables with "*" are original variables before logarithm, with the units of RMB000 in current prices, except labor which is headcount. Price is adjusted in the regression. The indices of the 4 sectors in 2006 are 102.1, 100.9, 99.5, and 96.6, respectively.
(3) R&D is the average R&D expense per employee of firms with R&D>0.
(4)New Product is the average new product output per employee of firms with New Product>0.
(5)HMT means Hong Kong, Macao and Taiwan.

For innovation variables, only about 5% to 6% of firms have R&D input in the first two low-tech sectors. This grows to about 20% in transport equipment, and nearly

30% in electronic equipment. In all these four sectors, for those firms with R&D input in 2005, more than half of them continue to input in innovation in the second year. This proportion is 77% in transport equipment and 80% in electronic equipment. Furthermore, R&D intensity is quite different among these sectors. Textile and wearing apparel firms have about 2,000 RMB R&D expenses per employee in those two years, while the number in transport equipment is about 10,000, and 18,000 in electronic equipment. The R&D expenses increase in three sectors and decrease in wearing apparel, but it is difficult to describe a long-term trend for the two-year data. For innovation output, the proportion of firms outputting new products firms is about 1% to 2% higher than the R&D input ratio in the two low-tech sectors, but is lower in the two high-tech sectors, especially about 7% to 8% lower in electronic equipment. The estimation result will explain why input is lower but output is higher in this sector. The intensity of new products output in all the sectors grows fast in 2006, though the average level is quite different among these sectors. High-tech sectors have much higher new product output than low-tech. This reaches 790,000 RMB in electronic equipment and 514,000 RMB in transport equipment. It is only around 100,000 RMB in wearing apparel, but this is higher than that in textiles.

The ratios of firms which export are about 40% in textiles, 64.5% in wearing apparel, and around 58% in electronic equipment. The export ratio is much lower in transport equipment, reaching only around 27% of all the firms in this sector. The ratio of firms receiving subsidy is higher in the high-tech sectors than in the low-tech sectors. Nearly 20% of high-tech firms have subsidy from the government, either for innovation or export. Only about 15% of textile firms and 12% of wearing apparel firms receive any subsidy from the government. The trend of this ratio goes slightly down in 2006 for all the sectors except transport equipment.

Firm size dummies show significant increases in the two smallest categories and decreases in the two largest categories in all these sectors. Ownership dummies show private firms are the largest ownership group in the first three sectors, comprising around 58% of textile firms, about 42% of wearing apparel firms and the same proportion in transport equipment firms. Overseas capital, including Hong Kong, Macao and Taiwan (HMT) and foreign capital, controls more than half of electronic equipment firms. Moreover, state-owned firms are a very small proportion in all these four sectors: 5% in transport equipment, and less than 2% in the other three sectors. Together with Limited Liability Corporations and Share-holding Corporations, firms controlled by state or public capital are less than 20% in all the sectors, except about 27% in transport equipment.

4.3. Innovation and Export in Firm Performance

Table 4 presents labor productivity in different innovation and/or export aggregations. In all these sectors, the productivity of R&D innovators is much higher than non-R&D innovators, and that of product innovators is much higher than non-product innovators in almost all cases, whether or not the firm is an exporter. For instance, the average productivity of innovators among electronic equipment firms is 46% larger than that of non-innovators in 2006, and 40% in 2005. The only exception is product innovators in wearing apparel, with 13% lower productivity than non-innovators in 2005. On the other hand, levels of productivity specifies by export are quite different among sectors. Non-exporters always have higher productivity than exporters in most cases in the low-tech sectors, but the productivity of exporters is higher than non-exporters in most cases in the high-tech sectors. The only two exceptions are textile product innovators in both years and non-product innovators in electronic equipment in 2006. Comparing these two methods of classifications, the difference between exporters and non-exporters is much smaller than that between innovators and non-innovators.

Table 4: Cross-table of Labor Productivity

	Textile		**Wearing Apparel**		**Transport Equipment**		**Electronic Equipment**	
	2006	**2005**	**2006**	**2005**	**2006**	**2005**	**2006**	**2005**
All firms	80.3	68.7	50.2	45.7	104.1	90.0	117.8	113.9
of which: Exporter	72.8	62.8	47.0	42.0	113.4	95.4	121.7	120.5
Non-Exporter	85.4	72.8	56.1	52.5	100.5	88.0	112.4	104.9
R&D Innovator	95.0	80.3	70.2	62.4	133.0	116.2	158.6	143.2
of which: Exporter	92.3	80.1	63.9	58.5	139.3	120.5	167.6	148.0
Non-Exporter	98.3	80.6	80.9	68.7	128.2	113.4	145.1	136.2
Non-R&D Innovator	79.4	68.0	49.2	44.9	96.2	83.8	102.0	104.1
of which: Exporter	71.0	61.4	46.1	41.3	100.7	85.5	103.2	111.0
Non-Exporter	84.8	72.4	54.8	51.6	94.8	83.3	100.3	94.7

Table 4: (continued) Cross-table of Labor Productivity

	Textile		Wearing Apparel		Transport Equipment		Electronic Equipment	
	2006	**2005**	**2006**	**2005**	**2006**	**2005**	**2006**	**2005**
Product Innovator	90.0	72.3	49.2	38.6	123.8	106.6	163.8	158.0
of which: Exporter	95.1	73.4	46.8	35.7	130.9	110.5	176.6	165.5
Non-Exporter	77.4	69.4	59.8	49.9	115.9	102.7	139.0	145.1
Non-Product Innovator	79.4	68.4	50.3	46.3	99.8	86.8	106.7	104.2
of which: Exporter	69.0	61.3	47.0	42.6	104.4	88.9	106.2	109.4
Non-Exporter	85.7	72.9	56.0	52.6	98.5	86.1	107.3	97.3

Notes: (1) The table lists the average value of balance panel data by year.
(2) The unit is RMB000 in current prices.
(3) Numbers of firms are omitted. The 3 smallest groups have 76, 89, and 118 firms.

5. Empirical Result

Empirical results of the CDM model help to answer the following questions, (i) why or why not the firms decided to engage in R&D input, and what is their reason for expending more or less in innovation if they decided to spend at all, (ii) whether innovation output is the result of R&D input or not, (iii) whether firms' innovation output improves their product output performance, and (iv) the effect of globalization variables, such as exporting and ownership, on innovation.

The results can be interpreted in two dimensions: the equation and variable level, and the sector level. The equation level tells us the main relationships of the innovation process, globalization and firm performance by the parameters of key variables. The sector level may tell a different story in different industries when they practice innovation. We will follow the equation level to organize the discussion.

5.1. Innovation Input

We start the interpretation by considering why and to what extent firms choose to innovate. The eight columns in Table 5 give estimates of the four selected sectors, and compare selection and intensity equations sector by sector. The innovation input equations show that firms' capital intensity and market share are significantly positive in improving R&D input for all the four sectors, in both selection and intensity equations, in 2005. They are extremely similar among sectors and between selection and intensity equations.

Table 5; Innovation Input: Selection and Intensity Equation

Dep. Var.= R&D	Textile		Wearing Apparel	
	Selection	Intensity	Selection	Intensity
	(1)	(2)	(3)	(4)
Market Share	0.109***	0.349***	0.130***	0.271**
	(0.017)	(0.071)	(0.021)	(0.119)
Capital per Employee	0.109***	0.510***	0.137***	0.251**
	(0.018)	(0.074)	(0.028)	(0.123)
Export	0.120***	0.327*	-0.059	-0.291
	(0.041)	(0.171)	(0.060)	(0.216)
Subsidy	0.223***	0.633***	0.318***	0.732**
	(0.046)	(0.186)	(0.073)	(0.329)
Size:50-99	0.181***	-	0.115	-
	(0.071)		(0.179)	
Size:100-249	0.211***	-	0.116	-
	(0.069)		(0.171)	
Size:250-999	0.448***	-	0.202	-
	(0.072)		(0.171)	
Size:>999	0.772***	-	0.376*	-
	(0.091)		(0.205)	
State-owned	0.146	-0.498	0.808***	-1.008
	(0.154)	(0.540)	(0.219)	(0.779)
Limited Liability	0.126**	-0.043	-0.039	-0.070
	(0.056)	(0.214)	(0.103)	(0.366)
Share-holding	0.234**	-0.097	0.018	1.089*
	(0.120)	(0.413)	(0.216)	(0.655)
HMT	-0.280***	-1.110***	-0.302***	-0.241
	(0.063)	(0.261)	(0.077)	(0.323)
Foreign	-0.115*	-0.509*	-0.254***	-0.253
	(0.066)	(0.262)	(0.078)	(0.306)
Constant	-1.394	-4.125	-0.904	-1.924
	(0.205)	(0.727)	(0.293)	(1.192)
Rho		0.825		0.660
		(0.040)		(0.229)
Wald		95.56		28.05
Log Likelihood		-4053.9		-1773.9
Observation		12982		6645

Note: Year=2005.

Table 5: (continued) Innovation Input: Selection and Intensity Equation

Dep. Var.= R&D	Transport Equipment		Electronic Equipment	
	Selection	Intensity	Selection	Intensity
	(5)	(6)	(7)	(8)
Market Share	0.039***	0.194***	0.156***	0.196***
	(0.014)	(0.036)	(0.014)	(0.042)
Capital per Employee	0.236***	0.574***	0.070***	0.227***
	(0.021)	(0.067)	(0.013)	(0.038)
Export	0.060	0.110	0.010	-0.656***
	(0.050)	(0.126)	(0.037)	(0.098)
Subsidy	0.289***	0.129	0.663***	0.731***
	(0.050)	(0.129)	(0.036)	(0.151)
Size:50-99	0.265***	-	0.007	-
	(0.092)		(0.068)	
Size:100-249	0.519***	-	-0.002	-
	(0.088)		(0.070)	
Size:250-999	0.982***	-	0.060	-
	(0.093)		(0.084)	
Size:>999	1.493***	-	0.228**	-
	(0.120)		(0.104)	
State-owned	0.402***	-0.326	0.710***	-0.216
	(0.089)	(0.223)	(0.108)	(0.272)
Limited Liability	0.330***	0.195	0.478***	0.623***
	(0.055)	(0.165)	(0.049)	(0.154)
Share-holding	0.307**	0.562**	0.602***	0.686***
	(0.121)	(0.277)	(0.100)	(0.225)
HMT	-0.199**	-0.415*	-0.352***	-0.633***
	(0.086)	(0.251)	(0.047)	(0.149)
Foreign	0.102	0.287	-0.363***	0.074
	(0.067)	(0.178)	(0.046)	(0.146)
Constant	-2.222	-1.471	0.372	1.191
	(0.187)	(0.466)	(0.180)	(0.343)
Rho		0.370		0.322
		(0.086)		(0.119)
Wald		136.88		159.88
Log Likelihood		-4634.2		-9673.5
Observation		5926		9068

Note: Year=2005 for Transport Equipment, but pooled 2005 & 2006 for Electronic Equipment.

Export parameters are significantly positive in textiles and negative in electronic equipment, but are not significant in the other two sectors. Textiles is a traditional sector with a world competitive advantage that may encourage firms to decide to undertake R&D so as to keep their advantage, and the high profits from potential markets, by spending more on innovation. Transport equipment firms have the same ownership structure as textiles and some degree of advantage in the world market, which supports the positive but not significant coefficients in both equations. The opposite is true in electronic equipment; that is, a small positive but not significant coefficient is shown in choosing to innovate, but a large negative coefficient appears in the intensity equation, which means that the more firms export, the lower their level of R&D intensity. The result is partly because of the high proportion of overseas capital control in this sector. They pay more attention to exports, but do not necessarily do much research work since most of this kind of work has been done, or even the key component elements have been finished in foreign institutes and factories. A high level of globalization in this high-tech sector is a kind of product globalization, but not a globalization of research activity. Wearing apparel shows the same story, with large negative coefficients of export due to the similar ownership structure, and design work done abroad in exporting firms.

In all these four sectors, firms with subsidies choose to carry out R&D and the subsidy helps to improve R&D intensity. The parameters in all the equations show significantly positive effects, except only one positive but not significant coefficient in the intensity equation for transport equipment.

Firm size dummies suggest that larger firms tend to choose to carry out R&D, the same as suggested by market share. The parameters quickly go up in textiles and transport equipment, while the largest group of firms in the other two sectors have significantly positive effects.

Ownership dummies tell a common story in all the sectors, and we specially emphasize the effect in electronic equipment since the rule is especially clear in it. Compared with private domestic firms, firms controlled by overseas capital especially firms controlled from Hong Kong, Macao and Taiwan (HMT firms), tend not to undertake R&D, or to input less if they do. Firms controlled by state or public capital tend to carry out more R&D. This is a similar result to that derived from our earlier research, and we can get further explanation in the following steps. We can also obtain a successfully positive test in part of the Schumpeter hypothesis, by parameters of either market share or firm size. That is, large firms have a higher tendency towards innovation selection and innovation input.

5.2. Innovation Output

The knowledge production function in table 6 shows that predicted R&D expenses were significantly positive in improving innovation output in 2006. The marginal effects are similar (about 0.15 to 0.20) in the first three sectors, and up to 0.84 in electronic equipment. And if firms continue to do R&D in the second year, they will produce more new products.

Table 6: Innovation Output: Knowledge Production Function

Dep. Var.= New Product	Textile	Wearing Apparel	Transport Equipment	Electronic Equipment
	(1)	(2)	(3)	(4)
R&D_hat	0.152***	0.190**	0.156*	0.844***
	(0.049)	(0.081)	(0.082)	(0.097)
Continuous R&D	0.996***	1.110***	0.914***	0.528***
	(0.075)	(0.123)	(0.060)	(0.050)
Capital per Employee	0.059*	-0.040	0.036	-0.103***
	(0.035)	(0.037)	(0.055)	(0.032)
Export	0.641***	0.360***	0.611***	0.959***
	(0.047)	(0.071)	(0.056)	(0.075)
Subsidy	0.084	-0.062	0.106*	-0.306***
	(0.052)	(0.088)	(0.056)	(0.083)
Size:50-99	0.052	-0.067	0.018	-0.182**
	(0.073)	(0.174)	(0.098)	(0.073)
Size:100-249	0.005	-0.129	0.091	-0.166**
	(0.073)	(0.165)	(0.095)	(0.071)
Size:250-999	0.178**	0.020	0.414***	-0.236***
	(0.082)	(0.167)	(0.104)	(0.080)
Size:>999	0.506***	0.050	0.719***	-0.220**
	(0.112)	(0.205)	(0.139)	(0.104)
State-owned	0.476***	Dropped	0.159	0.427***
	(0.166)		(0.116)	(0.125)

Table 6: (continued) Innovation Output: Knowledge Production Function

Dep. Var.= New Product	Textile	Wearing Apparel	Transport Equipment	Electronic Equipment
	(1)	(2)	(3)	(4)
Limited Liability	0.148**	-0.150	0.065	-0.129
	(0.059)	(0.108)	(0.063)	(0.083)
Share-holding	0.363***	-0.210	0.096	-0.117
	(0.130)	(0.265)	(0.145)	(0.129)
HMT	-0.009	-0.197**	-0.095	0.147*
	(0.080)	(0.080)	(0.108)	(0.082)
Foreign	-0.064	0.027	-0.294***	-0.463***
	(0.073)	(0.078)	(0.088)	(0.057)
Constant	-0.980	-0.511	-1.081	-0.255
	(0.412)	(0.444)	(0.449)	(0.164)
Pseudo R^2	0.2899	0.1838	0.3065	0.2333
Log Likelihood	-2638.3	-1240.5	-1935.1	-3343.5
Observation	12962	6514	5892	9046

Notes: (1) Year=2006 for the first 3 sectors, but 2005 & 2006 pooled data for Electronic Equipment.
(2) R&D_hat is the estimated result in the innovation input equation, with 1 year lag to the innovation output equation, except the same year in the Electronic Equipment sector.

Export improves innovation output in all the sectors, which suggests that firms serving the global market tend to engage in producing new products, whether or not they themselves choose to undertake R&D.

Subsidy only significantly impacts innovation output in the two high-tech sectors, but in opposite directions. It is positive in transport equipment, but negative in electronic equipment since firms in the latter sector gain new products not by doing subsidy supported R&D, but more often by directly using technology transferred from abroad. Furthermore, domestic firms in the electronic equipment sector with low levels of output tend to obtain a variety of support from government in the name of innovation, since this sector has been defined as a core high-tech sector, and emphasized by the government as an area to be encouraged in innovation policy. Foreign firms get less in subsidy, but they hold their competitive advantage by using technology from abroad, which can sufficiently support the high efficiency of their product innovation. On the other hand, the insignificant coefficients in low sectors indicate two things. The first is that low-tech sectors like textiles and wearing apparel obtain subsidies for exporting to a greater extent than from innovation. The second is that the government pays more attention to the linkage of innovation and high-tech business, but ignores the importance of innovation in keeping a competitive advantage for those low-tech sectors that have already found global competitiveness.

Firms size dummies tell the same story of the importance of size in the first three sectors, supporting the opinion that large firms tend to have more new product output. On the other hand, large electronic equipment firms tend to have low new product intensity. Ownership in all the four sectors indicates that firms controlled by state or public capital have a high intensity of innovation output and firms controlled by overseas capital have less. Comparing with the R&D input equations in the first step, we get common results in ownership dummies, and similar results in at least three sectors except for electronic equipment in innovation output.

5.3. Innovation Performance

Finally, we interpret the firm performance estimation of the production equation as shown in Table 7. The parameters of estimated new product output in all four sectors give a positive effect. The elasticity of each sector is from 0.246 in transport equipment, to 1.112 in electronic equipment.

Table 7: Innovation Performance: Production Function

Dep. Var.= Productivity	Textile	Wearing Apparel	Transport Equipment	Electronic Equipment
	(1)	(2)	(3)	(4)
Capital per Employee	0.209***	0.188***	0.233***	0.125***
	(0.007)	(0.010)	(0.012)	(0.009)
Labor	-0.300)	-0.214***	-0.188***	-0.294***
	(0.008)	(0.013)	(0.015)	(0.010)
New Product_hat	0.354***	0.467***	0.246***	1.119***
	(0.017)	(0.040)	(0.026)	(0.029)
State-owned	-0.646***	Dropped	-0.427***	-0.683***
	(0.090)		(0.059)	(0.084)
Limited Liability	-0.118***	0.060	-0.068**	-0.386***
	(0.024)	(0.038)	(0.028)	(0.033)
Share-holding	-0.215***	0.242**	0.026	-0.439***
	(0.069)	(0.104)	(0.077)	(0.067)

Table 7: (continued) Innovation Performance: Production Function

Dep. Var.= Productivity	Textile	Wearing Apparel	Transport Equipment	Electronic Equipment
	(1)	(2)	(3)	(4)
HMT	0.037*	0.054**	0.029	0.258***
	(0.021)	(0.025)	(0.043)	(0.026)
Foreign	0.058**	-0.033	0.351***	0.453***
	(0.023)	(0.024)	(0.038)	(0.028)
Constant	4.964	4.607	4.289	5.535
	(0.071)	(0.108)	(0.163)	(0.091)
F	96.86	46.70	40.71	103.32
R^2	0.2913	0.1803	0.2927	0.3979
Observation	12962	6514	5892	9046

Notes: (1) Year=2006 for the first 3 sectors, but 2005 & 2006 pooled data for Electronic Equipment.
(2) Region dummies and sub-sector dummies are estimated, but omitted in the table.

In contrast with the results of the R&D input equations and new product output equations, the results for firm performance are quite different for the ownership dummies. Compared with private domestic firms, firms controlled by overseas capital tend to have higher productivity, though they input less in R&D terms, and produce fewer new products. On the other hand, firms controlled by state and public capital tend to have lower productivity, though they are apt to carry out R&D and have more new products. According to this point, one advantage of globalization is that the competition among firms in the global market leads to a positive effect on productivity growth in mainland China.

5.4. Globalization and Innovation

Comparing coefficients of the exports and foreign ownership dummies in the first two steps, the globalization of Chinese manufacturing sectors tells the following story. Exports and foreign markets are not necessarily the causation for R&D. It depends on whether the sector has a technological advantage controlled domestically or from abroad. The domestic control tends to improve performance and market growth by innovation, whilst the foreign control tends to finish the R&D and core technical work abroad and to perform only the manufacturing step in mainland China. Neither high-tech nor low-tech decides the high R&D effort. Sectors with local technology control, including patenting and design, prefer innovation input. Otherwise, high-tech sectors do not necessarily input in innovation in an environment of globalization, for they can obtain full technology support from the foreign market if the competitive advantage remains abroad.

Analysis of globalization by capital control gives the same summary, i.e. foreign firms do less in R&D input and new product intensity, but they do have higher productivity compared with other ownerships.

5.5. Pooled Four

In order to test robustness and compare the results at the aggregate level, we estimate the equations by using pooled data from the selected four sectors. Table 8 gives the results of three steps with four equations.

The estimated coefficients are robust when compared with the separate estimation of sector level equations in Tables 4 to 7. Coefficients in the first six rows indicate that market share positively effects the decision to make an R&D input, and R&D intensity, R&D input drives new product output, and new product output promotes growth of productivity, and persistent R&D input is an active cause in encouraging innovation output.

Table 8: Innovation Input, Output, and Performance: Pooled 4 Sectors

	(1) Selection	(2) Intensity	(3) Output	(4) Performance
Market Share	0.092***	0.250***	-	-
	(0.008)	(0.026)		
R&D-hat	-	-	0.114***	-
			(0.026)	
New Product-hat	-	-	-	0.344***
				(0.013)
Capital per Employee	0.137***	0.421***	0.066***	0.237***
	(0.010)	(0.035)	(0.016)	(0.005)
Labor	-	-	-	-0.219***
				(0.006)
Continuous R&D	-	-	0.939***	-
			(0.033)	
Export	0.037	-0.126	0.528***	-
	(0.025)	(0.078)	(0.026)	
Subsidy	0.394***	0.696***	0.115***	-
	(0.026)	(0.086)	(0.030)	

Table 8: (continued) Innovation Input, Output, and Performance: Pooled 4 Sectors

	(1) Selection	(2) Intensity	(3) Output	(4) Performance
Size:50-99	0.157***	-	-0.015	-
	(0.045)		(0.047)	
Size:100-249	0.247***	-	0.018	-
	(0.044)		(0.045)	
Size:250-999	0.475***	-	0.207***	-
	(0.046)		(0.048)	
Size:>999	0.736***	-	0.394***	-
	(0.056)		(0.060)	
State-owned	0.479***	-0.198	0.198***	-0.460***
	(0.062)	(0.174)	(0.073)	(0.043)
Collective	0.266***	0.256**	0.175***	-0.106***
	(0.031)	(0.104)	(0.034)	(0.016)
Corporate	0.389***	0.685***	0.306***	-0.029
	(0.066)	(0.180)	(0.075)	(0.043)
HMT	-0.303***	-0.798***	-0.136***	0.001
	(0.035)	(0.121)	(0.042)	(0.014)
Foreign	-0.178***	-0.123	-0.185***	0.136***
	(0.033)	(0.108)	(0.036)	(0.014)
Constant	-1.688	-3.017	-1.402	4.419
	(0.105)	(0.325)	(0.158)	(0.050)
Rho		0.626		
		(0.038)		
Wald		646.30		
F				270.21
R^2 / Pseudo R^2			0.2678	0.2777
Log Likelihood		-15335.7	-7831.9	
Observation		30087	30074	30074

Notes: Region dummies and sector dummies are estimated and significant, but omitted in the table.

In contrast to the various coefficients' direction of export in the separate four sectors, the aggregate estimation interprets that export to the global market does not significantly impact R&D input, but the overseas market demand does improve new product output.

Without the individual sector characteristics, subsidy retains positive significance in the first two steps using aggregate data, which suggests that subsidy is an important element in supporting the R&D input decision, innovation intensity and new product output. In addition, the effect might be varied in the different sectors that have been investigated in the former sections.

Size dummies indicate that large firms tend to make R&D input, and they also have a higher level of new product output intensity. Ownership dummies give the same result as before, namely that firms controlled by state and public capital have the contrary situation in innovation and productivity, compared with firms controlled by overseas capital. Firms controlled by state and public capital tend to undertake R&D and have a higher level of R&D intensity and new product output, but their productivity is lower than private domestic firms. However, firms controlled by overseas capital tend to do less in innovation but have higher productivity, compared with private domestic firms.

6. Conclusion and Policy Remarks

By using a separately estimated CDM model, this paper investigates innovation behavior and its ability to promote productivity in four Chinese manufacturing sectors. All "cleaned" firms are involved in the model by using predicted values of innovative variables in the estimation of the first two steps. Only four selected sectors are used in this paper due to the complex census data, but they do give sufficient results in different industries, as well as distinguishing the effects of exporting, subsidy, and ownership. Moreover, the results from pooled data sustain the robustness of the sector level estimations.

We conclude the paper by discussing four outcomes, which also indicate the directions for relative policy recommendation.

The main result is that the model proves the positive effect of innovation input on innovation output, and innovation output on productivity. It sustains the national innovation strategy of improving innovation input in research and development, especially at the firm level. Firm level innovation input is the key element in improving labor productivity and the foundation of welfare-based wealth accumulation.

The second outcome is that exporting improves innovation output but does not always sustain innovation input. The innovation output efficiency depends on the demands of the global market through exports, and the innovation input depends not on exports, but on the competitive advantage of the sector in the world market. Therefore creating a competitive advantage in technology is as important as, or even more important than, the advantage derived from exporting. The policy towards FDI should encourage not only foreign capital growth and foreign-owned manufacturing processes, but also technology transfer and the spillover of innovation. Besides exporting, customers' demand drives product innovation, which suggests that the exploration of the domestic market is another important means of promoting local R&D, especially for such a large market as mainland China. These are the key processes of the coming economic structure transformation in China.

The third outcome is the interesting opposite effect of different ownerships in innovation and productivity. Firms controlled by state and public capital innovate more due to their operation of the whole process of local production, though they tend to have low levels of productivity. Firms controlled by overseas capital innovate less but produce more, due to their lack of local R&D input, but transfer technology from abroad. In addition, native firms are sensitive to the influence of the government's innovation policies, but private firms controlled by overseas capital make their decision on innovation more simply, related to higher profits or lower taxes. The better way to encourage innovation is to open more and gives the decision to the firms, so that they can evaluate changes of the market through competition. The policy of encouragement of firms based on ownership criteria should be weakened, and the government should pay more attention to the construction of a fair market and competition environment.

For the above two conclusions, globalization is conducive to creating added value and to sustaining years of fast growth through exports and FDI. Moreover, the next step is to learn more from globalization, to establish a better environment of innovation by strengthening the protection of intellectual property rights, transferring policies from encouraging capital introduction to encouraging local innovation in an impartial market environment during the long term of sustainable development.

The last outcome is that innovation is effective not only in high-tech, but also low-tech sectors. Innovation has a positive effect in low-tech sectors such as textiles, which have already gained competitive advantage in long-term development through globalization. Innovation policy should pay more attention to encouraging R&D in this kind of sector, which is important for the maintenance of its competitiveness and for sustaining its employment.

Given the limitations of our work, and in particular to our using only 2 years' data from 4 selected sectors, these initial results should be merely taken as illustrative. We pay more attention to R&D and new product innovation rather than to exports in the systematic estimation, and leave a wide area for further investigation based on the large sample of firm level accounting data. One interesting field is the decomposition of productivity growth by R&D, exports, and FDI. Another is the specification of relationships between innovation and exports, the two key words in the Chinese economy. We will carry out further work in the rich mine of micro data.

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Appendix

Table A1: Variable Definition

Variable Name	Explanation
Basic	
Productivity	Value added per employee (in log.)
Labor	Number of employees (in log.)
Capital per Employee	Fixed assets per employee (in log.)
Market Share	Sales divided by total sales in 3-digit sub-sector (in log.)
Innovation	
R&D	R&D expenses per labor (in log.)
R&D_hat	Predicted value of R&D expenses per labor
New Product	New product output per labor (in log.)
tNew Product_hat	Predicted value of new product output per labor
Continuous R&D	Binary variable equals to 1 in year t if R&Dt>0 & R&Dt-1>0
Globalization	
Export	Binary variable equals to 1 if firm has export
Extended	
Subsidy	Binary variable equals to 1 if firm has subsidy income
Firm Size	
Size:<50	Dummy equals to 1 if employees<50 (for reference)
Size:50-99	Dummy equals to 1 if employees>=50 & <100
Size:100-249	Dummy equals to 1 if employees >=100 & <250
Size:250-999	Dummy equals to 1 if employees>=250 & <1000
Size:>999	Dummy equals to 1 if employees>=1000
Ownership	
State-owned	Dummy equals to 1 if it is a stat-owned firm
Limited Liability	Dummy equals to 1 if it is a limited liability Corporation
Share-holding	Dummy equals to 1 if it is a Share-holding Corporation
Private	Dummy equals to 1 if it is a private firm (for reference)
HMT	Dummy equals to 1 if it is a firm of Hong Kong, Macao and Taiwan funds
Foreign	Dummy equals to 1 if it is a foreign funded firm
Other Dummies	
Region Dummies	Dummies represent different provinces of China (Zhejiang for reference)
Sub-sector Dummies	Dummies represent 4-digit sub-sectors in each sectors (The first sub-sector for reference)
Sector Dummies	Dummies represent 2-digit sectors (Textile for reference)

Table A2: Average Labor Productivity of Firms With or Without Subsidy

	Textile		Wearing Apparel		Transport Equipment		Electronic Equipment	
	2006	**2005**	**2006**	**2005**	**2006**	**2005**	**2006**	**2005**
All firms	80.3	68.7	50.2	45.7	104.1	90.0	117.8	113.9
of which: Subsidy>0	76.1	67.4	62.8	56.3	112.9	103.0	134.5	126.1
R&D Innovator	95.0	80.3	70.2	62.4	133.0	116.2	158.6	143.2
of which: Subsidy>0	86.3	87.0	85.3	67.2	143.1	117.5	147.9	149.0
Non-R&D Innovator	79.4	68.0	49.2	44.9	96.2	83.8	102.0	104.1
of which: Subsidy>0	74.4	65.0	60.4	55.2	92.8	95.7	120.3	105.2
Product Innovator	90.0	72.3	49.2	38.6	123.8	106.6	163.8	158.0
of which: Subsidy>0	77.8	70.3	50.0	40.9	140.1	114.9	150.6	159.4
Non-Product Innovator	79.4	68.4	50.3	46.3	99.8	86.8	106.7	104.2
of which: Subsidy>0	75.8	67.0	64.1	58.5	100.3	99.2	125.6	110.9
Exporter	72.8	62.8	47.0	42.0	113.4	95.4	121.7	120.5
of which: Subsidy>0	72.7	66.6	63.1	55.7	115.4	97.8	122.7	118.2
Non-Exporter	85.4	72.8	56.1	52.5	100.5	88.0	112.4	104.9
of which: Subsidy>0	80.5	68.7	61.8	58.4	111.0	106.5	154.7	138.0

Notes: (1) The table lists the average labor productivity of balance panel by year.
(2) The unit is RMB000 in current price.

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