Foreign Entry and Firm R&D: Evidence from Chinese Manufacturing Industries

Abstract

By making use of firm level panel data from 2005 to 2007, this paper empirically examines the relationship between R&D behaviour and the presence of foreign firms in China's four major manufacturing industries. The manufacturing industries considered are (i) Car manufacturing, (ii) Household electrical appliances, (iii) Electronics and (iv) Communication equipment manufacturing. We find that presence of foreign firms has resulted in a significant increase in R&D intensity of all four manufacturing industries in China. While the average R&D intensity in communication equipment manufacturing is the highest, the electronics industry, which has the highest level of foreign presence, has experienced relatively large increase in R&D intensity. This suggests that China's electronics manufacturing sector is responding to rising competition from foreign firms located in China. Foreign presence in China's car manufacturing sector is relatively small and this industry has experienced a relatively small increase in R&D intensity due to foreign presence.

KEY WORDS: R&D; FDI, Manufacturing firms, China, Panel data

1. Introduction

Spending on research and development (R&D) plays a crucial role in technological advancement. It can be argued that technological progress, by reducing the cost of transportation and communication, has made a significant contribution to increase in foreign direct investment (FDI) flows across the globe. Increase in FDI flows have contributed to an increase in market competition which has implications for firm R&D spending (Hill, 2011).

Why do foreign firms undertake R&D, especially in developing countries? It has been argued that among other things R&D allows foreign firms to adapt existing products to better meet the needs of the local market. R&D also enhances foreign firms' knowledge base and it can also enhance vertical integration (Kuemmerle, 1999). Presence of foreign firms creates competitive pressure that forces domestic firms to become more productive which involves among other things investment in R&D. In other words, entry of foreign firms increases the R&D spending of domestic firms. The spillover effects arising from the presence of foreign can also encourage R&D spending on the part of domestic firms.

A number of existing studies have investigated various aspects of spending on R&D. For example, Griliches (1975 & 1998), Wang and Tsai (2003), Tsai and Wang (2004), Balcombe and Bailey (2005), Kafouros (2005), Czarnitzki et al. (2009) and Lang (2009) have considered the link between R&D spending and productivity. Cassiman and Veugelers (2002), Negassi (2004), Belderbos et al. (2004), Schmidt (2005), Okamuro (2007), Lopez (2008) and van Beers et al. (2008) have examined the issue of why firms engage in R&D cooperation. A large number of studies have also

attempted to identify the determinants of R&D spending.[1] In a recent study, Sasidharan and Kathuria (2011) have considered the issue of whether or not R&D and FDI in India's manufacturing sector are substitutes or complements. They have also provided an excellent summary of the related literature in their Table 1.

Within the context of FDI, recent studies have acknowledged that R&D behaviour of local and foreign firms in a country may be different. For example, Kumar and Aggarwal (2005) found significant differences in the R&D behaviour of local and foreign firms in India's manufacturing sector. In addition, some studies have focused exclusively on R&D behaviour of multinational firms. For example, Shimizutani and Todo (2008) have focused on the Japanese firms operating in foreign countries. Prior to this, Yasuda (1996) has investigated the determinants of Japanese firms' overseas R&D investment. Hakanson and Nobel (1993) have considered R&D behaviour of the Swedish multinational enterprises. Entry of foreign firms in a country increases market competition, which can affect R&D behaviour of other firms.

This paper focuses on the link between firm R&D behaviour and the presence of foreign firms in a country. Only a few existing studies have focused on the impact of foreign entry on firm R&D behaviour. While examining the impact of technology import on firm R&D intensity, Kumar (1987) found a negative relationship between foreign presence and R&D intensity in the Indian manufacturing sector. Veugelers

[1] See Cohen and Klepper (1992), Himmelberg and Petersen (1994), Harmantzis and Tanguturi (2005), among others, for the case of the US. Gannicott (1984) have considered the case of Australia. Antonelli (1989) has considered Italy. Del Canto and Gonzalez (1999) have considered Spain. Lach (2002) and Shefer and Frenkel (2005) have considered the case of Israel. Clausen (2008), Czarnitzki and Kraft (2004), Roediger-Schluga (2006) and Jefferson et al., (2006) respectively have considered the case of Norway, Germany, Japan and China. Becker and Pain (2008) and Waterson and Lopez (1983) have focused on the UK, Howe and McFetridge (1976) and MacIntosh and Cumming (2000) have considered the case of Canada. Domadenik et al. (2008) have considered the case of Slovenia whereas Lall (1983), Siddharthan and Agarwal (1992) and Mishra (2007) have considered the case of India. In addition, some studies have explored the determinants of R&D in a cross country context - for example, see Falk (2006), Lee (2003) and Bertrand and Zuniga (2006).

and vanden Houte (1990) used a game theoretic approach to consider the link between foreign entry and innovative efforts of domestic firms. They conclude that foreign entry can have either positive or negative effect on innovative efforts of domestic firms. However, their empirical analysis revealed a negative relationship between presence of multinational firms and R&D intensity of domestic firms in Belgium's manufacturing industries.

By making use of the existing theoretical literature, such as the work of Veugelers and vanden Houte (1990), it can be argued that foreign presence affects R&D spending of domestic firms. The main aim of this paper is to empirically examine the link between foreign presence and R&D spending in China's (i) Car manufacturing, (ii) Household Electrical Appliance, (iii), Electronics and (iv) Communication Equipment manufacturing industries. These industries account for a significant proportion of China's total export revenue. None of the existing empirical studies have considered the case of China. China is an interesting case study as it has increased its aggregate R&D investment by about 10% over the last 10 years. In 2011, China is expected to invest approximately US$154 billion in R&D which is likely to be higher than the Japanese R&D investment (Swezey, 2011). As a result of the increased investment, the overall R&D intensity of China has significantly increased over time which is likely to help China to become more competitive in the production of high-tech and higher value-added products.

The rest of this paper is organized as follows. Based on the existing literature, section 2 contains a discussion of other important determinants of firm R&D behaviour. An empirical model is specified in section 3. Section 3 also contains a description of the data and variable construction. Empirical results are presented and discussed in section 4. Section 5 concludes the paper.

2. Determinants of Firm R&D Spending

A number of theoretical studies have explored the link between various aspects of foreign investment and R&D spending. For example, within the context of a duopoly multi-stage game, where firm R&D positively affects the demand for its product, Veugelers and vanden Houte (1990) have shown that the impact of foreign competition on firm R&D intensity depends on the relative demand-cost margin and substitutability of products. Sanna-Randaccio (2002), in a two-country, two-firm, three-stage game model, where R&D reduces firm marginal cost, has shown that the impact of foreign firm on domestic firm's R&D depends on the magnitude of spillovers, and firm and industry technological characteristics.

Foreign entry (i.e., an increase in foreign presence) affects the domestic firms through two channels. First due to positive productivity spillovers foreign entry reduces the marginal cost of production of domestic firms. This helps domestic firms to increase their output which also improves their capacity to invest in R&D. Second, the increase in foreign presence can also create a demand side shock that affects both domestic and foreign firms - the output of domestic and foreign firms depends on foreign presence. Increase in foreign presence and its positive impact on domestic firms forces foreign firms to reduce their output (due to increased competition). So even though there are more foreign firms in the economy, the output of each foreign firm decreases. As domestic firms increase their output and R&D due to increase in foreign presence increases, foreign firms in order to preserve their profit may respond by cutting their output and R&D investment. Our hypothesis therefore is that an increase in foreign presence leads to an increase in R&D spending of domestic firms.

While the focus is this paper is on the link between foreign presence and R&D spending of domestic firms in China's four major industries, the existing literature

suggests that firm R&D investment is also affected by other factors. A firm's profitability can significantly affect its R&D behaviour. However the relationship between profitability and R&D intensity can be either positive or negative. On the one hand, based on the Schumpeterian view, it can be argued that firm profitability enhances its R&D intensity as the retained earnings is a major funding source of R&D (Grabowski, 1968). The use of retained earning has the advantage over external funding in that it involves relatively lower transaction cost. This point may be particularly important in the case of the Chinese firms as they are faced with severe liquidity constraints (Jefferson et al., 2006). On the other hand, firms with losses or below average profits may have more incentive to conduct R&D as it can help firms to survive. A failure-inducement hypothesis of negative impact of profitability has been highlighted by Antonelli (1989). Besides, in China, the poor profit performance of state and collectively owned firms can result in R&D subsidies from the state government. Positive impact from firm profitability is found by Grabowski (1968) and Smyth et al. (1973) whereas Kumar (1987) the impact to be insignificant. However, a number of existing empirical studies have found a negative relationship between profitability and R&D intensity. For example, see Scherer (1965), Hamberg (1966), Bosworth and Westaway (1984), Caves et al. (1980) and Antonelli (1989). Some studies have found the direction of the relationship to vary across sample periods (for example, see Kumar and Aggarwal, 2005) or across econometric specifications (for example see, Jefferson et al., 2006) or across industries (for example, see Howe and McFetridge, 1976).

The existing empirical literature suggests that firm financial position through the availability of financial resources affects its R&D investment capacity. It has been suggested that R&D activities tend to be financed via internally generated funds and

equity and high levels of debt negatively affect R&D (Del Canto and Gonzalez, 1999). Due to information asymmetries, firms prefer to finance R&D via internal funds, namely the pecking order hypothesis (Myers and Majluf, 1984). The internally generated cash flow is conducive to R&D activities (Elliott, 1971; Branch, 1974; Baysinger and Hoskisson, 1989; and Teece and Pisano, 1994; Helfat, 1997). In addition, high levels of debt may prohibit R&D activities as debt holders do not prefer such specific assets as R&D (Del Canto and Gonzalez, 1999). Nevertheless not all empirical studies support such impact of financial resources. Del Canto and Gonzalez (1999) find firm equity resources are negatively associated with the probability of carrying out R&D. Switzer (1984) finds that firm dividend payment does not significantly affect R&D expenditure. In this paper, we use firm leverage, namely the debt-total assets ratio, to capture the potential impact of firm financial position.

A number of existing empirical studies have found that firm size plays an important role in firm R&D behaviour. Firm size can positively affect R&D intensity as relatively large firms are more capable of appropriating returns from their R&D activities (Nelson and Winter, 1982) and R&D activities may also be subject to economies of scale (Shefer and Frenkel, 2005). Nevertheless empirical evidence is mixed. Some studies, for example Lall (1983), Katrak (1985), and Kumar and Saqib (1996) on India, Antonelli (1989) on Italy, Wilder and Stansell (1974) and Mansfield (1964) on the US found a positive relationship. However, others studies found a U-shaped or a cubic relationship - for example Acs and Audretsch (1988), Culbertson (1985), Siddharthan (1988), and Czarnitzki and Kraft (2004) found a U-shaped relationship whereas Scherer (1965), Audretsch and Acs (1991), and Kumar and Aggarwal (2005) found a cubic relationship between firm size and R&D behaviour. Shefer and Frenkel (2005) and Sasidharan and Kathuria (2011) have found a negative

relationship respectively in northern Israel and India. Shefer and Frenkel have argued that smaller firms have invested heavily in R&D in northern Israel due to a large number of high-tech startups. The firm size can be measured in a number of ways. Some studies (such as Switzer, 1984; Kumar, 1987; Veugelers and vanden Houte, 1990; Odagiri and Yasuda, 1996; Lee, 2003; Harmantzis and Tanguturi, 2005; Domadenik et al., 2008; and Sasidharan and Kathuria, 2011) have used firm sales or growth of sales. Wilder and Stansell (1974), Czarnitzki and Kraft (2004) have used operating revenue. This paper utilises the number of employee as a measurement of firm size which tends to reduce the potential endogeniety problem.

Since R&D is a capital intensive activity, we expect firms that are relatively capital (both physical and human) intensive are more likely to be involved in R&D investment. The physical capital intensity is measured by net fixed assets per employee, whereas firm average wage is used as a proxy for human capital intensity (Wakelin, 1998). In a competitive labour market, the wage rate is based on the marginal product of labour and therefore higher average wage paid by a firm reflects higher labour quality. The technological opportunity is also found to be an important determinant of firm R&D behaviour (Scherer, 1965; Phillips, 1966; Scherer, 1967; Rosenberg, 1976; and Wilson, 1977; Shrieves, 1978). Higher capital intensity is closely associated with higher technological opportunities and therefore capital intensity is an important determinant of firm R&D intensity (Kumar, 1987). Empirical studies such as Czarnitzki and Kraft (2004) confirm a positive relationship between capital intensity and firm R&D intensity. On the other hand, Kumar (1987) in the case of India, found a negative relationship between capital intensity and R&D intensity. Kumar argues that there is a tendency among the Indian firms to neglect R&D

investment. The average wage is a proxy for human capital. Higher capital intensity is likely to have a positive impact on R&D intensity.

Exposure to international markets is expected to positively affect firm R&D intensity. First, such exposure is likely to increase the returns to R&D investment due to the increasing market size (Zimmerman, 1987); second, firms that are exposed to international markets are likely to be more aware of technological changes in international markets (Evenson and Joseph, 1997); and third, exposure to international markets forces firms to adapt their products and processes to meet the tastes and product standards in foreign markets (Kumar and Aggarwal, 2005). We use two variables to capture such exposure. One is a dummy variable that takes a value of 1 if a firm exports, and the other is firm export intensity, namely the proportion of exports in total sales. Empirical evidence has generally confirmed such positive relationship (see for example Antonelli, 1989; Braga and Willmore, 1991; and Suarez-Villa and Fischer, 1995; Kumar and Saqib, 1996; Lee, 2003; Czarnitzki and Kraft, 2004; Kumar and Aggarwal, 2005; Shefer and Frenkel, 2005 and Sasidharan and Kathuria, 2011).

Other firm characteristics that can potentially affect R&D intensity include the degree of firm diversification, age, ownership structure and market share. The degree of firm diversification is postulated to positively affect R&D intensity. Diversification necessitates R&D activities and it impact on profit is likely to be positive (Nelson, 1959). Scherer (1965), Grabowski (1968), Antonelli (1989) and Veugelers and vanden Houte (1990) found the impact of diversification on R&D activities to be positive. Firm age exerts two contrasting impact on R&D intensity. On the one hand, younger firms may be more innovative in that some are established with the introduction of innovations, while in contrast older firms are often reluctant to conduct “fundamental” innovations (Czarnitzki and Kraft, 2004). On the other hand,

older firms are more experienced and more likely to secure funding for large scale R&D. Shefer and Frenkel (2005) find significant impact of firm age in Israel. Hakanson and Nobel (1993) and Czarnitzki and Kraft (2004) found that the relationship between firm age and R&D activity to be insignificant whereas Lee (2003) and Sasidharan and Kathuria (2011) found a negative relationship. Czarnitzki and Kraft (2004) have used the market share as a proxy for the degree of competition faced by a firm. They found a significant and positive relationship between the level of competition and R&D activities. Since the empirical analysis presented in this paper is based on data from China, we also consider the role of firm ownership structure – specifically, whether or not a firm is state and collectively owned. This allows us to take in to account that R&D behaviour of the state and collectively owned firms might be different from their privately owned counterparts. As compared to privately owned firms, the state and collectively owned firms in China have better access to financing from the state and collectively owned banks.

In addition to firm characteristics, industry level variables (such as the market structure and concentration of manufacturing activities) can also affect firm R&D behaviour (see Sasidharan and Kathuria, 2011). Firms in a relatively more competitive market are likely to have a greater incentive to conduct R&D. On the other hand, firms in a less competitive market, for example within an oligopolistic market, are usually more capable of financing R&D activities, especially when potentially large entry cost is involved. Schumpeter (1950) has argued that oligopolistic market is more conducive to R&D as compared to perfectly competitive market where firms do not have surplus to invest on potentially risky R&D activities. Previous empirical studies have found mixed evidence with insignificant impact found by Czarnitzki and Kraft (2004) and Switzer (1984), negative impact found by

Kumar (1987) and nonlinear inverse U-shaped impact found by Culbertson (1985) and Jefferson et al. (2006). In addition, Veugelers and vanden Houte (1990) found the relationship to be statistically insignificant (however they found a positive relationship within a sub-sample with low product substitutability). The concentration of manufacturing activities across industry-regions also affects firm R&D behaviour due to the existence of potential spillover effect. Such effect can be captured by the overall industrial concentration.

3. Empirical Model and the Data

Based on the literature review and our hypothesis that presence of foreign firms affects R&D behaviour of domestic firms, we specify an empirical model as follows:

$$\begin{aligned} rd_{i,t} = {} & \beta_{0,i} + \beta_{1,i} profitability_{i,t} + \beta_{2,i} \ln\left(firmsize_{i,t} \right) + \beta_{3,i} \ln\left(sales_{i,t} \right) + \beta_{4,i} k_{i,t} + \\ & \beta_{5,i} diversification_{i,t} + \beta_{6,i} dex_{i,t} + \beta_{7,i} ein_{i,t} + \beta_{8,i} leverage_{i,t} + \\ & \beta_{9_i} \ln\left(averagewage_{i,t} \right) + \beta_{10,i} age_{i,t} + \beta_{11,i} ownership_{i,t} + \\ & \beta_{12,i} marketshare_{i,t} + \beta_{13,i} herfindahl_{i,t} + \beta_{14,i} oic_{i,t} + \\ & \beta_{15,i} fe_{i,t} + \beta_{16,i} dyear + u_{i,t} \end{aligned} \quad (1)$$

where $rd_{i,t}$ is firm R&D intensity in industry *i* during period *t*; *profitability*, *firmsize*, *sales*, *k*, *diversification*, *dex*, *ein*, *leverage*, *averagewage*, *age*, *ownership*, *marketshare*, *herfindahl*, and *oic* respectively are the firm profitability, size, sales, capital intensity, diversification, whether the firm exports or not, firm export intensity, leverage, firm average wage, firm age, ownership structure (whether or not state and collectively owned), market share, market structure (Herfindahl index) and overall industrial concentration respectively.

The variables listed in the above have been found by a number of existing studies to have a significant impact on firm R&D behaviour. The empirical model also includes *dyear* which is a set of year dummies that capture the time variant effects. Based on the theoretical model, equation (1) also includes *fe* (foreign entry) as an independent variable and *u* is the usual error term which is assumed to be *i.i.d.* normal.

The variables in equation (1) are constructed as follows: the R&D intensity is equal to the share of R&D expenditure in total sales; firm profitability is the share of firm profits in its total sales; firm size is measured as the number of employees; sales are deflated value (in 2005 price) of firm sales; capital intensity (*k*) is the net value of fixed assets per employee; firm diversification is measured by the value of new products as a proportion of the value of total output; export participation (*dex*) is a dummy variable that takes a value of 1 if a firm exports, and export intensity (*ein*) is the share of firm exports in its total sales; firm leverage is measured by the ratio of debts to total assets; average wage is equal to total salaries divided by the number of employees; firm age is the number of years since its has been in business; firm ownership structure is a dummy variable that takes a value of 1 if the firm is privately owned and 0 if state and collectively owned; market share is the percentage of a firm's sales in the four-digit industries; Herfindahl index is also calculated at the four-digit industry level and is equal to the sum of squared market share in the four digit industry – the value of the index ranges from 0 to 1, where 0 indicates a perfectly competitive market and 1 indicates monopoly; following Aitken et al. (1997), the overall industry concentration (*oic*) is calculated as the province-industry (four digit) share of national industry employment divided by the province share of national

manufacturing employment; and foreign entry which is the main variable of interest is measured as the proportion of foreign firms in the four-digit industries.

Equation (1) is estimated by making use of a firm level dataset from 2005 to 2007. The data were collected by the China National Bureau of Statistics. The empirical analysis presented in this paper utilises the data on (i) firms that have employed more than eight workers as firms with less than eight employees may not have reliable accounting systems; (ii) firms that did not report negative net values of fixed assets and non-positive output, negative R&D, value added or wages; (iii) firms that are not located in the upper and lower tails of their productivity distributions – i.e., within four standard deviations from the means of the distributions of Value Added/L, L/ Value Added, Value Added /K, K/ Value Added (L and K respectively are the number of employees and net value of fixed assets). All nominal variables were deflated to 2005 prices, using the producer price index for manufactured goods from *China Statistical Yearbook 2008*. Tables 1 to 4 present descriptive statistics of the variables in each of the four industries that are considered in this paper. One distinct feature that emerges from these tables is that all variables exhibit significant variations. In relative term, foreign presence is highest in China's electronics manufacturing and lowest in car manufacturing industries. The average age of the firms in China's car manufacturing industry is the highest but lowest in electrical appliance industry. The average R&D intensity in relative terms is high in China's communications equipment manufacturing but lowest household electrical appliances which is not surprising given that the later is mostly a standardised product (e.g., washing machine, fridge, and microwave).

<insert Tables 1-4 here>

4. Empirical Results

An important characteristic of the dataset utilised in this paper is that it includes firms that have not been involved in R&D activities or firms that have not undertaken R&D activities during a particular year. Accordingly, export intensity which is the dependent variable in equation (1) can take a value of zero and hence we use Tobit model to estimate the empirical model. It is also possible that some of the independent variables in the model are endogenous. For example, the bigger firms may be more capable of conducting R&D but R&D can also contribute to firm growth. It is also possible that foreign firms tend to enter industries with higher level of R&D and hence foreign entry variable can also be endogenous. In order to address the issue of possible endogeniety we also estimated equation (1) by means of instrumental variable (IV) Tobit regression using lagged firm characteristics, foreign entry, and number of firms in the industry as instruments.[2]

The empirical results for each of the four manufacturing industries are reported in Tables 5 to 8. Each Table includes the results of both Tobit and IV Tobit regression. The empirical results provide a strong support for the view that foreign presence significantly affects R&D performance of domestic firms. The impact of foreign entry on R&D intensity is positive and significant in the case of all four manufacturing industries. The results of IV Tobit regression suggest that a 1 per cent increase in foreign presence leads to 3.336 per cent increase in domestic firm R&D intensity in the car manufacturing industry and one can be more than 95% confident

[2] It has been argued that lagged variables do not always serve as good instruments and the estimated results may be sensitive to the choice of instruments. Accordingly, one should try to use other suitable instrumental variables. Lack of data is an issue which prevents one from using other instrumental variables, especially in the case of developing countries such as China. Recent studies such as Barbosa and Eiriz (2009) and Suyanto, Salim and Bloch (2009) have also highlighted this problem but following other studies involving developing economies, they have also used lagged variables as instruments.

about this result. The IV Tobit results presented in Tables 6-8 indicate that a 1 per cent increase in foreign presence leads to 3.01 percent increase in the R&D intensity of household electrical appliance industry whereas the corresponding estimated values for the electronics and communication equipment industries respectively are 10.95 and 11.13 percent. In other words, the response of electronics and communication equipment industries is much larger. This is not surprising as product development and enhancement of the existing products is much more common in electronics and communication equipment industries whereas the car and house appliance industries are producing mostly standardized products where the emphasis is on cost reduction and there is a relatively large domestic market.

It is interesting to note that while the average R&D intensity in communication equipment manufacturing is the highest, the electronics industry, which has the highest level of foreign presence, has experienced relatively large increase in R&D intensity. It can therefore be argued that firms in China's electronics industry are responding to rising competition from foreign firms located in China. The empirical analysis presented in this paper suggests that foreign presence in China's car manufacturing sector is relatively small and this industry has experienced a relatively small increase in R&D intensity due to foreign presence.

<insert Tables 5-8 here>

As far as the control variables are concerned, firm profitability significantly and positively affects R&D intensity in the car manufacturing and the electronics industry which supports the Schumpeterian hypothesis.[3] The impact of firm size on R&D intensity of all four industries is positive and significant. The impact of capital intensity is positive and significant in all industries except household electronic

[3] These results and subsequent discussion is based on IV-Tobit estimation (please see Tables 5-8).

appliance. Market share is an important determinant of R&D intensity in car manufacturing industry whereas the impact of sales growth in this industry is negative. Sales growth has a negative and significant impact on R&D intensity of the electronics and communication equipment industries. Export behaviour significantly affects R&D intensity in household electrical appliance and electronics industries. The impact of diversification on R&D intensity of all four industries is positive and significant but the magnitude of the impact is much larger in electronics and communication equipment industries.

In order to consider the robustness of the empirical results, we also estimated the model for all four industries after excluding all control variables. The estimated equations are as follows:

Car manufacturing industry

$$Rd_{i,t} = \underset{(0.000)}{-0.0503} + \underset{(0.004)}{0.0394} * fp$$

The household electrical appliance manufacturing industry

$$Rd_{i,t} = \underset{(0.000)}{-0.0375} + \underset{(0.000)}{0.0493} * fp$$

The electronics manufacturing industry

$$Rd_{i,t} = \underset{(0.000)}{-0.1337} + \underset{(0.000)}{0.2021} * fp$$

The communication equipment manufacturing industry

$$Rd_{i,t} = \underset{(0.000)}{-0.0578} + \underset{(0.000)}{0.115} * fp$$

Estimated *p*-values are reported in the bracket underneath the estimated coefficients.

As all of the estimated coefficients are highly significant, the above estimated equations confirm our basic hypothesis that entry of foreign firms affects the R&D behaviour of domestic firms.

5. Concluding Remarks

By making use of firm level panel data over the period 2005-2007, this paper examines the impact of the presence of foreign firms on R&D intensity of the Chinese firms in its (i) Car manufacturing, (ii) Household Electrical Appliance, (iii) Electronics, and (iv) Communication Equipment industries. These four industries account for a significant proportion of China's total industrial output.

Empirical analysis based on Tobit and Instrumental Variables Tobit estimation reveals that the presence of foreign firms has resulted in a significant increase in R&D intensity of all four manufacturing industries. The electronics and communication equipment industries have experienced relatively large increase in R&D intensity whereas the presence of foreign firms in China has resulted in a much smaller increase in R&D intensity of domestic firms in the car and household electoral appliance industries. This suggests that China's electronics and communication industries are vigorously responding to rising competition from foreign firms located in China. Foreign presence in China's car and household electrical appliance industries is relatively small. The car industry in particular enjoys a huge domestic market which may explain a lower level of foreign presence and response to entry of foreign firms in China.

In addition to the impact of foreign presence, we also considered the impact of other firm and industry specific variables on R&D intensity of domestic firms in China's four leading manufacturing industries. These variables include firm profitability, size, diversification, whether or not firms export, export intensity, leverage, average wage, age, sales, market share, capital intensity, ownership structure, and overall industrial concentration. The Instrumental Variable Tobit estimation found the impact of overall industrial concentration, ownership, export status, export

intensity and leverage on R&D intensity of the car industry to be insignificant. In the case of household electrical appliance industry, firm size, diversification, export status and export intensity were found to have a significant impact on R&D intensity. The R&D intensity of the electronics industry was found to be significantly affected by firm profitability, size, diversification, export status, export intensity, average wage, sales and capital intensity. In the case of communication equipment industry, the firm R&D intensity was found to be significantly affected by firm size, diversification, average wage, sales and capital intensity.

There is ample empirical evidence suggesting that domestic firms in China are benefitting from the presence of foreign firms. Foreign firms located in China have introduced new technology as well as superior management skills. Given the pace of China's investment in R&D, it is likely that China like Singapore will eventually gain comparative advantage in the production of advanced technological products. Government policy can play a vital role in improving the absorptive capacity of Chinese firms. A targeted approach based on the current level of industry competitiveness can produce the best results.

References

Acs, Z. J. and Audretsch, D. B., 1988. 'Innovation in large and small firms: an empirical analysis', *American Economic Review*, 78**,** 678-690.

Aitken, B., Hanson, H. G. and Harrison, A. E., 1997. 'Spillovers, foreign investment, and export behavior', *Journal of International Economics*, 43**,** 103-132.

Antonelli, C., 1989. 'A failure-inducement model of research and development expenditure : Italian evidence from the early 1980s', *Journal of Economic Behavior & Organization*, 12**,** 159-180.

Audretsch, D. B. and Acs, Z. J., 1991. 'Innovation and size at the firm level', *Southern Economic Journal*, 57**,** 739-744.

Balcombe, K., Bailey, A. and Fraser, I., 2005. 'Measuring the impact of R&D on productivity from a econometric time series perspective', *Journal of Productivity Analysis*, 24**,** 49-72.

Barbosa, N. and Eiriz, V., 2009. 'Linking corporate productivity to foreign direct investment: An empirical assessment,' *International Business Review*, 18, 1-13.

Baysinger, B. D. and Hoskisson, R. E., 1989. 'Diversification strategy and R&D intensity in large multiproduct firms', *Academy of Management Journal*, 32**,** 310-332.

Becker, B. and Pain, N., 2008. 'What determines industrial R&D expenditure in the Uk?', *Manchester School*, 76**,** 66-87.

Belderbos, R., Carree, M., Diederen, B., Lokshin, B. and Veugelers, R., 2004. 'Heterogeneity in R&D cooperation strategies', *International Journal of Industrial Organization*, 22**,** 1237-1263.

Bertrand, O. and Zuniga, P., 2006. 'R&D and M&A: Are cross-border M&A different? An investigation on OECD countries', *International Journal of Industrial Organization*, 24**,** 401-423.

Blomstrom, M. and Kokko, A., 1998. 'Multinational corporations and spillovers', *Journal of Economic Survey*, 12**,** 247-277.

Bosworth, D. and Westaway, I., 1984. 'The inlluence of demand and supply side pressures on the quantity and quality of inventive activity', *Applied Economics*, 16**,** 131-146.

Braga, H. and Willmore, L., 1991. 'Technological imports and technological effort: an analysis of their determinants in Brazilian firms', *Journal of Industrial Economics*, 39**,** 421-432.

Branch, B., 1974. 'Research and development activity and profitability: a distributed lag analysis', *Journal of Political Economy*, 82**,** 999-1011.

Buckley, P. J., Clegg, J. and Wang, C., 2002. 'The impact of inward FDI on the performance of Chinese manufacturing firms', *Journal of International Business Studies*, 33**,** 637-655.

Cassiman, B. and Veugelers, R., 2002. 'R&D cooperation and spillovers: Some empirical evidence from Belgium', *American Economic Review*, 92**,** 1169-1184.

Caves, R. E., Porter, M. and Spence, M. (1980). *Competition in the Open Economy: A Model Applied to Canada*. Cambridge, MA: Harvard University Press.

Cheng, L., 1984. 'International competition in R&D and technological leadership', *Journal of International Economics*, 17**,** 15-40.

Chuang, Y. and Hsu, P., 2004. 'FDI, trade, and spillover efficiency: evidence from China's manufacturing sector', *Applied Economics*, 36**,** 1103-1115.

Clausen, T., 2008. 'Do subsidies have positive impacts on R&D and innovation activities at the firm level?', *Working Papers on Innovation Studies 20070615*, Centre for Technology, Innovation and Culture, University of Oslo.

Cohen, W. and Klepper, S., 1992. 'The Anatomy of Industry R&D Intensity Distributions', *American Economic Review*, 82**,** 773-799.

Culbertson, J. D., 1985. 'Econometric tests of the market structural determinants of R&D investment: Consistency of absolute and relative firm size models', *Journal of Industrial Economics*, 34**,** 101-108.
Czarnitzki, D. and Kraft, K., 2004. 'Management Control and Innovative Activity', *Review of Industrial Organization*, 24**,** 1-24.
Czarnitzki, D., Kraft, K. and Thorwarth, S., 2009. 'The knowledge production of 'R' and 'D'', *Economics Letters*, 105**,** 141-143.
Del Canto, J. G. and Gonzalez, I. S., 1999. 'A resource-based analysis of the factors determining a firm's R&D activities', *Research Policy*, 28**,** 891-905.
Domadenik, P., Prasnikar, J. and Svejnar, J., 2008. 'How to increase R&D in transition economies? Evidence from Slovenia', *Review of Development Economics*, 12**,** 193-208.
Dunning, J. H., 1979. 'Explaining changing patterns of international production: in defence of the eclectic theory', *Oxford Bulletin of Economics and Statistics*, 41**,** 269-295.
Elliott, J., 1971. 'Funds flow vs. expectational theories of research and development expenditures in the firm', *Southern Economic Journal*, 37**,** 409-422.
Evenson, R. E. and Joseph, K. J. (1997). 'Foreign technology licensing in Indian industry: an econometric analysis of the choice of patterns, terms of contract and the effects on licensees performance', *Working paper no. 273*, Economic Growth Centre, Yale University.
Falk, M., 2006. 'What drives business Research and Development (R&D) intensity across Organisation for Economic Co-operation and Development (OECD) countries? ', *Applied Economics*, 38**,** 533 - 547.
Fang, R. and Richardson, M., 2011. 'Private and public incentives for mergers in the face of foreign entry', *Review of Development Economics*, forthcoming.
Gannicott, K., 1984. 'The determinants of industrial R&D in Australia', *Economic Record*, 60**,** 231 - 235.
Gelabert, L., Fosfuri, A. and Tribo, J. A., 2009. 'Does the effect of public support for R&D depend on the degree of appropriability?', *The Journal of Industrial Economics*, 57**,** 736-767.
Gorg, H. and Greenaway, D., 2004. 'Much ado about nothing? do domestic firms really benefit from foreign direct investment?', *World Bank Research Observer*, 19**,** 171-197.
Grabowski, H. G., 1968. 'The determinants of industrial research and development: A study of the chemical, drug, and petroleum industries', *Journal of Political Economy*, 76**,** 292-306.
Greenaway, D., Sousa, N. and Wakelin, K., 2004. 'Do domestic firms learn to export from multinationals?', *European Journal of Political Economy*, 20**,** 1027-1043.
Griliches, Z., 1975. Returns to research and development expenditures in the private sector. *New Developments in Productivity Measurement and Analysis*. J. W. Kendrick and B. N. Vaccara. Chicago, IL, University of Chicago Press**:** 419-461.
Griliches, Z., 1998. *R&D and Productivity*. Chicago, IL: University of Chicago Press.
Hakanson, L. and Nobel, R., 1993. 'Determinants of foreign R&D in Swedish multinationals', *Research Policy*, 22**,** 397-411.
Hamberg, D., 1966. *R&D: Essays on the Economics of Research and Development*. New York: Random House.
Harmantzis, F. and Tanguturi, V. P. (2005). 'Key Determinants of R&D Expenditures in the US Telecommunications Equipment Industry'.
Helfat, C., 1997. 'Know-how and asset complementarity and dynamic capability accumulation: the case of R&D', *Strategic Management Journal*, 18**,** 339-360.
Hill, C., 2011. Global Business, 7th edition. New York: McGraw-Hill.
Himmelberg, C. P. and Petersen, B. C., 1994. 'R&D and internal finance: A panel study of small firms in high-tech industries ', *Review of Economics and Statistics*, 76**,** 38-51
Howe, J. D. and McFetridge, D., 1976. 'The determinants of R&D expenditures ', *Canadian Journal of Economics*, 9**,** 57-71.

Hu, A. G. Z., Jefferson, G. H. and Qian, J., 2005. 'R&D and Technology Transfer: Firm-Level Evidence from Chinese Industry', *Review of Economics and Statistics*, 87**,** 780-786.
Jefferson, G., Bai, H., Guan, X. and Yu, X., 2006. 'R&D performance in Chinese industry', *Economics of Innovation and New Technology*, 15**,** 345-366.
Jefferson, G. H., Thomas, G. R. and Zhang, Y., 2008. 'Productivity growth and convergence across China's industrial economy', *Journal of Chinese Economic and Business Studies*, 6**,** 121-140.
Kafouros, M., 2005. 'R&D and productivity growth: Evidence from the UK', *Economics of Innovation and New Technology*, 14**,** 479 - 497.
Katrak, H., 1985. 'Imported technology enterprise size and R&D in a newly industrialising country: the Indian experience', *Oxford Bulletin of Economics and Statistics*, 47**,** 213-230.
Kumar, N., 1987. 'Technology imports and local research and development in Indian manufacturing', *The Developing Economies*, 25**,** 220 - 233.
Kumar, N. and Aggarwal, A., 2005. 'Liberalization, outward orientation and in-house R&D activity of multinational and local firms: A quantitative exploration for Indian manufacturing', *Research Policy*, 34**,** 441-460.
Kumar, N. and Saqib, M., 1996. 'Firm size, opportunities for adaptation, and in-house R&D activity in developing countries: the case of Indian manufacturing', *Research Policy*, 25**,** 712-722.
Kuemmerle, W. (1999), 'The drivers of foreign direct investment into research and development: An empirical investigation', *Journal of International Business Studies*, Vol. 30 (1), 1-24.
Kyriazidou, E., 1997. 'Estimation of a panel data sample selection model', *Econometrica*, 65**,** 1335-1364.
Lach, S., 2002. 'Do R&D subsidies stimulate or displace private R&D? Evidence from Israel', *Journal of Industrial Economics*, 50**,** 369-390.
Lall, S., 1983. 'Determinants of R&D in an LDC : The Indian engineering industry', *Economics Letters*, 13**,** 379-383.
Lang, G., 2009. 'Measuring the returns of R&D: An empirical study of the German manufacturing sector over 45 years', *Research Policy*, 38**,** 1438-1445.
Lee, C., 2003. 'A simple theory and evidence on the determinants of firm R&D', *Economics of Innovation and New Technology*, 12**,** 385-395.
Li, X., Liu, X. and Parker, D., 2001. 'Foreign direct investment and productivity spillovers in the Chinese manufacturing sector', *Economic Systems*, 25**,** 305-321.
Liu, Z., 2002 'Foreign direct investment and technology spillover: evidence from China', *Journal of Comparative Economics*, 30**,** 579-602.
Liu, Z., 2008. 'Foreign direct investment and technology spillovers: Theory and evidence', *Journal of Development Economics*, 85**,** 176-193.
Lopez, A., 2008. 'Determinants of R&D cooperation: Evidence from Spanish manufacturing firms', *International Journal of Industrial Organization*, 26**,** 113-136.
MacIntosh, J. G. and Cumming, D. J., 2000. 'The determinants of R&D expenditures: A study of the Canadian biotechnology industry', *Review of Industrial Organization*, 17**,** 357–370.
Mahlich, J. and Roediger-Schluga, T., 2006. 'The determinants of pharmaceutical R&D expenditures: Evidence from Japan', *Review of Industrial Organization*, 28**,** 145-164.
Mairesse, J. and Hall, B., 1996. 'Estimating the productivity of research and development: an exploration of GMM methods using data on French and United Sates manufacturing firms', *NBER Working Paper 5501*.
Mañez, J. A., Rochina-Barrachina, M. E., Sanchis, A. and Sanchis, J. A., 2009. 'The role of sunk costs in the decision to invest in R&D', *The Journal of Industrial Economics*, 57**,** 712-735.
Mansfield, E., 1964. 'Industrial research and development expenditures: Determinants, prospects, and relation to size of firm and inventive output', *Journal of Political Economy*, 72**,** 319-340.

Mishra, V., 2007. 'The determinants of R&D expenditure of firms: evidence from a cross-section of Indian firms', *Economic Papers*, 26**,** 237-248.
Myers, S. C. and Majluf, N. S., 1984. 'Corporate financing and investment decisions when firms have information that investors do not have', *Journal of Financial Economics*, 13**,** 187-221.
Negassi, S., 2004. 'R&D co-operation and innovation a microeconometric study on French firms', *Research Policy*, 33**,** 365-384.
Nelson, R. R., 1959. 'The simple economics of basic scientific research', *Journal of Political Economy*, 67**,** 297-306.
Nelson, R. R. and Winter, G. S. (1982). *An Evolutionary Theory of Economic Change*. Cambridge and London: Harvard University Press.
Odagiri, H. and Yasuda, H., 1996. 'The determinants of overseas R&D by Japanese firms: an empirical study at the industry and company levels', *Research Policy*, 25**,** 1059-1079.
Okamuro, H., 2007. 'Determinants of successful R&D cooperation in Japanese small businesses: The impact of organizational and contractual characteristics', *Research Policy*, 36**,** 1529-1544.
Phillips, A., 1966. 'Patents, potential competition, and technical progress', *American Economic Review*, 56**,** 301-310.
Richardson, M., 1998. 'Foreign entry and domestic welfare', *Review of World Economics*, 134**,** 250-262.
Rosenberg, N., 1976. 'Research and market share: A reappraisal of the Schumpeter Hypothesis', *Journal of Industrial Economics*, 25**,** 101-112.
Saggi, K., 2002. 'Trade, Foreign Direct Investment, and international technology transfer: a survey', *World Bank Research Observer*, 17**,** 191-235.
Sanna-Randaccio, F., 2002. 'The impact of foreign direct investment on home and host countries with endogenous R&D', *Review of International Economics*, 10**,** 278-298.
Sasidharan, S. and Kathuria, V., 2011. 'Foreign direct investment and R&D: Substitutes or complements - A case of Indian Manufacturing after 1991 reforms,' *World Development*, available online.
Scherer, F. M., 1965. 'Firm size, market structure, opportunity and the output of patented inventions', *American Economic Review*, 55**,** 1097-1125.
Scherer, F. M., 1967. 'Market structure and the employment of scientists and engineers', *American Economic Review*, 57**,** 524-531.
Schmidt, T. (2005). 'Knowledge flows and R&D co-operation: Firm-level evidence from Germany', *Development and Comp Systems 0506006*, EconWPA.
Schumpeter, J. A. (1950). *Capitalism, Socialism and Democracy, 3rd ed.* New York: Harper & Row.
Shefer, D. and Frenkel, A., 2005. 'R&D, firm size and innovation: an empirical analysis', *Technovation*, 25**,** 25-32.
Shimizutani, S. and Todo, Y., 2008. 'What determines overseas R&D activities? The case of Japanese multinational firms', *Research Policy*, 37**,** 530-544.
Shrieves, R., 1978. 'Market structure and innovatoin: A new perspective', *Journal of Industrial Economics*, 26**,** 329-347.
Siddharthan, N. S., 1988. 'In-house R&D, imported technology and firm size: lessons from Indian experience', *Developing Economies*, 26**,** 212-221.
Siddharthan, N. S. and Agarwal, R. N., 1992. 'Determinants of R&D decisions: A cross-section study of Indian private corporate firms ', *Economics of Innovation and New Technology*, 2**,** 103 - 110.
Smeets, R., 2008. 'Collecting the pieces of the FDI knowledge spillovers puzzle', *World Bank Research Observer*, 23**,** 107-138.
Smyth, D. J., Samuels, J. M. and Tzoannos, J., 1973. 'Patents profitability liquidity and firm size', *Applied Economics*, 4**,** 77-86.
Sood, A. and Tellis, J.S., 2005. 'Technological evolution and radical innovation', *Journal of Marketing*, 69, 152–168.

Suarez-Villa, L. and Fischer, M. M., 1995. 'Technology, organization and export-driven R&D in Austria's electronic industry', *Regional Studies*, 29**,** 19-42.
Sun, S., 2009a. 'How does FDI affect domestic firms' exports? Industrial evidence', *The World Economy*, 32**,** 1203-1222.
Sun, S., 2009b. 'Testing technology spillovers of FDI: A stochastic frontier approach', *Empirical Economics Letters*, 9**,** 933-940.
Sun, S., 2011. 'Foreign direct investment and technology spillovers in China's manufacturing sector', *The Chinese Economy*, forthcoming.
Suyanto, S., Salim, R.A. and Bloch, H., 2009. 'Does foreign direct investment lead to Productivity spillovers? Firm level evidence from Indonesia', *World Development*, 37, 161-1876.
Swezey, D. (2011), China R&D investment to grow faster than U.S., http://thebreakthrough.org/blog/2011/02/china_rd_investment_to_grow _fa.shtml.
Switzer, L., 1984. 'The determinants of industrial R&D: A funds flow simultaneous equation approach', *Review of Economics and Statistics*, 66**,** 163-168.
Teece, D. and Pisano, G., 1994. 'The dynamic capabilities of firms: An introduction', *Industrial and Corporate Change*, 3**,** 537-556.
Tsai, K. and Wang, J., 2004. 'R&D productivity and the spillover effects of high-yech industry on the traditional manufacturing sector: The case of Taiwan', *World Economy*, 27**,** 1555-1570.
van Beers, C., Berghäll, E. and Poot, T., 2008. 'R&D internationalization, R&D collaboration and public knowledge institutions in small economies: Evidence from Finland and the Netherlands', *Research Policy*, 37**,** 294–308.
Veugelers, R. and Vanden Houte, P., 1990. 'Domestic R&D in the presence of multinational enterprises', *International Journal of Industrial Organization*, 8**,** 1-15.
Wakelin, K., 1998. 'Innovation and export behaviour at the firm level', *Research Policy*, 26**,** 829-841.
Wang, J. and Tsai, K. (2003). 'Productivity growth and R&D expenditure in Taiwan's manufacturing firms', *NBER Working Papers: 9724*, National Bureau of Economic Research, Inc.
Waterson, M. and Lopez, A., 1983. 'The determinants of research and development intensity in the UK ', *Applied Economics*, 15**,** 379 - 391.
Wilder, R. P. and Stansell, S. R., 1974. 'Determinants of research and development activity by electric utilities', *Bell Journal of Economics*, 5**,** 646-650.
Wilson, R. W., 1977. 'The effect of technological environment and product rivalry on R&D effort and licensing of inventions', *Review of Economics and Statistics*, 59**,** 171-178.
Zimmerman, K. F., 1987. 'Trade and dynamic efficiency', *Kyklos*, 40**,** 73-87.

Table 1: Summary Statistics - Car Manufacturing Industry

Variable	Obs	Mean	Std. Dev.	Min	Max
R&D intensity	17891	0.0025	0.0153	0	0.8573
Herfindahl index	17891	0.0077	0.0103	0.0040	0.2601
overal industry concentration	17891	11.9134	51.9733	0.0034	3238.9140
age	17891	10.1078	11.1756	1	141
ownership	17891	0.5647	0.4958	0	1
profitability	17891	0.0344	0.0935	-0.9995	0.9564
firm size	17891	-2.2125	1.0313	-4.8283	3.6425
diversification	17891	0.0525	0.1743	0	1
whether export	17891	0.1449	0.3520	0	1
export intensity	17891	0.0554	0.1929	0	1
leverage	17891	0.0903	0.3767	0	18.85
average wage	17891	2.5871	0.4903	-2.0036	5.2345
sales	17891	10.0727	1.3199	4.0648	17.5160
market share	17891	0.0006	0.0053	0	0.4310
capital intensity	17891	3.5869	1.1544	-2.6626	8.1373
foreign presence	17891	0.2029	0.0458	0.0833	0.2829

Source: the authors' calculation from NBS, Beijing, 2005-2007.

Table 2: Summary Statistics - Household Electrical Appliance Industry

Variable	Obs	Mean	Std. Dev.	Min	Max
R&D intensity	4150	0.0018	0.0097	0	0.3631
Herfindahl index	4150	0.0687	0.0508	0.0129	0.2004
overal industry concentration	4150	19.7669	52.4147	0.0416	1504.4490
age	4150	7.3311	6.4371	1	52
ownership	4150	0.7402	0.4386	0	1
profitability	4150	0.0308	0.0708	-0.8062	0.8576
firm size	4150	-2.1114	1.0541	-4.8283	3.7136
diversification	4150	0.0728	0.2163	0	1
whether export	4150	0.3737	0.4839	0	1
export intensity	4150	0.2275	0.3698	0	1
leverage	4150	0.0509	0.1636	0	2.2381
average wage	4150	2.6384	0.4337	-0.0600	5.0851
sales	4150	10.3397	1.2818	5.4813	17.8059
market share	4150	0.0032	0.0143	0	0.4224
capital intensity	4150	3.2319	1.2117	-2.5539	7.7207
foreign presence	4150	0.2930	0.0702	0.1601	0.4144

Source: the authors' calculation from NBS, Beijing, 2005-2007.

Table 3: Summary Statistics - Electronics Industry

Variable	Obs	Mean	Std. Dev.	Min	Max
R&D intensity	1781	0.0166	0.0488	0	0.6932
Herfindahl index	1781	0.0285	0.0142	0.0123	0.0668
overal industry concentration	1781	9.7929	20.9482	0.0181	224.1140
age	1781	8.9983	9.3060	1	58
ownership	1781	0.5531	0.4973	0	1
profitability	1781	0.0455	0.1264	-0.9949	0.7796
firm size	1781	-2.0501	1.1519	-4.8283	2.1092
diversification	1781	0.1455	0.3026	0	1
whether export	1781	0.3043	0.4602	0	1
export intensity	1781	0.1175	0.2585	0	1
leverage	1781	0.0938	0.3310	0	6.6444
average wage	1781	2.8361	0.5990	1.1394	5.4308
sales	1781	10.2756	1.2734	5.7137	14.9277
market share	1781	0.0021	0.0051	0	0.0554
capital intensity	1781	3.4898	1.4919	-2.9957	7.9356
foreign presence	1781	0.5402	0.0706	0.3624	0.6356

Source: the authors' calculation from NBS, Beijing, 2005-2007.

Table 4: Summary Statistics - Communication Equipment Industry

Variable	Obs	Mean	Std. Dev.	Min	Max
R&D intensity	2076	0.024139	0.058204	0	0.906973
Herfindahl index	2076	0.062277	0.051754	0.018725	0.184928
overal industry concentration	2076	16.1779	43.25713	0.056515	850.2292
age	2076	9.345857	9.211195	1	70
ownership	2076	0.509152	0.500037	0	1
profitability	2076	0.045351	0.133197	-0.8877	0.875881
firm size	2076	-2.24587	1.159665	-4.82831	3.812667
diversification	2076	0.192037	0.345848	0	1
whether export	2076	0.16763	0.373627	0	1
export intensity	2076	0.058874	0.192275	0	1
leverage	2076	0.051293	0.152838	0	2.271908
average wage	2076	2.98618	0.635911	-0.16252	5.746047
sales	2076	10.31451	1.361002	5.480639	18.05955
market share	2076	0.003182	0.013783	0	0.316663
capital intensity	2076	3.383825	1.31267	-2.4651	7.262886
foreign presence	2076	0.355879	0.115826	0.249123	0.645914

Source: the authors' calculation from NBS, Beijing, 2005-2007.

Table 5: Foreign Presence and R&D behaviour - Car Manufacturing Industry

	Tobit			IV Tobit		
	Coef.	Robust Std. Err.	t	Coef.	Std. Err.	z
Herfindahl index	0.3594	0.2444	1.47	0.3058***	0.0579	5.28
Overall industry concentration	-0.000007	0.00001	-0.54	-0.00001	0.00001	-0.57
age	0.0001**	0.00005	2.19	0.0001**	0.0001	2.03
ownership	-0.0036***	0.0014	-2.59	-0.0017	0.0013	-1.33
profitability	0.0268**	0.0107	2.5	0.0660***	0.0120	5.5
firm size	0.0139***	0.0020	6.86	0.0139***	0.0013	10.96
diversification	0.0416***	0.0044	9.48	0.0549***	0.0043	12.81
whether export	0.0087***	0.0020	4.33	0.0040	0.0035	1.13
export intensity	-0.0052	0.0041	-1.28	0.0015	0.0057	0.26
leverage	-0.0003	0.0010	-0.32	0.0045	0.0048	0.94
average wage	0.0127***	0.0020	6.39	0.0148***	0.0026	5.61
sales	-0.0007	0.0010	-0.68	-0.003***	0.0010	-3.15
market share	-0.0434	0.2387	-0.18	0.6047***	0.2362	2.56
capital intensity	0.0049***	0.0009	5.62	0.0056***	0.0008	6.85
foreign presence	0.0324**	0.0135	2.4	0.0336**	0.0144	2.33
year dummy	yes			yes		
constant	-0.0788***	0.0126	-6.24	-0.056***	0.0129	-4.38
Number of obs	17891			9864		
F/Wald chi2	9.55			1277.81		
Endogeneity test				106.08		

Note: ; *** denote significance at 1 per cent level; ** denote significance at 5 per cent level; and * denote significance at 10 per cent level.

Table 6: Foreign Presence and R&D behaviour - Household Electrical Appliance Industry

	Tobit			IV Tobit		
	Coef.	Robust Std. Err.	t	Coef.	Std. Err.	z
Herfindahl index	0.0007	0.0165	0.04	-0.0074	0.0156	-0.47
Overall industry concentration	0.000004	0.00001	0.46	0.00001	0.00001	0.67
age	-0.00001	0.0001	-0.09	0.00005	0.0001	0.43
ownership	-0.0011	0.0021	-0.52	-0.0001	0.0017	-0.07
profitability	-0.0185	0.0156	-1.18	-0.0088	0.0206	-0.43
firm size	0.0046***	0.0014	3.29	0.0061***	0.0017	3.63
diversification	0.0268***	0.0065	4.12	0.0272***	0.0051	5.39
whether export	0.0104***	0.0026	4.02	0.0132***	0.0034	3.83
export intensity	-0.0085***	0.0033	-2.57	-0.0137***	0.0043	-3.2
leverage	0.0008	0.0047	0.17	-0.0086	0.0091	-0.95
average wage	0.0044**	0.0020	2.2	0.0090	0.0045	2.01
sales	0.0018	0.0012	1.5	-0.0005	0.0015	-0.36
market share	-0.0325	0.0376	-0.87	-0.0470	0.0382	-1.23
capital intensity	0.0011	0.0007	1.5	0.0013	0.0009	1.4
foreign presence	0.0402***	0.0150	2.68	0.0301***	0.0112	2.67
year dummy	yes			yes		
constant	-0.0724***	0.0181	-4.0000	-0.0460	0.0190	-2.43
Number of obs	4150			2283		
F/Wald chi2	5.82			225.49		
Endogeneity test				14.95		

Note: ; *** denote significance at 1 per cent level; ** denote significance at 5 per cent level; and * denote significance at 10 per cent level.

Table 7: Foreign Presence and R&D behaviour - Electronics Industry

	Tobit			IV Tobit		
	Coef.	Std. Err.	*t*	Coef.	Std. Err.	z
Herfindahl index	-0.3007	0.2419	-1.24	0.0974	0.2147	0.45
Overall industry concentration	0.00002	0.0001	0.17	-0.00003	0.0001	-0.25
age	0.000003	0.0004	0.01	0.000001	0.0003	0
ownership	-0.0115*	0.0069	-1.68	-0.0057	0.0061	-0.93
profitability	0.0851**	0.0346	2.46	0.1157***	0.0467	2.48
firm size	0.0133***	0.0046	2.91	0.0151***	0.0048	3.17
diversification	0.0775***	0.0118	6.56	0.0837***	0.0122	6.84
whether export	0.0294***	0.0078	3.77	0.0408***	0.0122	3.34
export intensity	-0.0334**	0.0132	-2.52	-0.0388**	0.0200	-1.94
leverage	-0.0067	0.0100	-0.67	-0.0065	0.0115	-0.56
average wage	0.0478***	0.0072	6.68	0.0568***	0.0086	6.57
sales	-0.018***	0.0053	-3.39	-0.0271***	0.0051	-5.33
market share	0.5672	0.5697	1	1.0776	0.8311	1.3
capital intensity	0.0039	0.0025	1.58	0.0043*	0.0025	1.73
foreign presence	0.0946*	0.0509	1.86	0.1095*	0.0560	1.95
year dummy	yes			yes		
constant	-0.0448	0.0571	-0.79	0.0207	0.0605	0.34
Number of obs	1781			900		
F/Wald chi2	6.94			265.4		
Endogeneity test				42.52		

Note: ; *** denote significance at 1 per cent level; ** denote significance at 5 per cent level; and * denote significance at 10 per cent level.

Table 8: Foreign Presence and R&D behaviour - Communication Equipment Industry

	Tobit			IV Tobit		
	Coef.	Std. Err.	t	Coef.	Std. Err.	z
Herfindahl index	-0.0072	0.0557	-0.13	-0.0249	0.0558	-0.45
Overall industry concentration	-0.00002	0.00004	-0.43	0.00001	0.0001	0.18
age	-0.0005*	0.0003	-1.68	-0.0004	0.0003	-1.3
ownership	-0.0123**	0.0062	-1.99	-0.0024	0.0065	-0.37
profitability	0.0153	0.0238	0.64	-0.0355	0.0417	-0.85
firm size	0.0254***	0.0046	5.54	0.0314***	0.0051	6.1
diversification	0.0756***	0.0113	6.68	0.0845***	0.0109	7.78
whether export	0.0180**	0.0080	2.26	-0.0018	0.0151	-0.12
export intensity	-0.0586***	0.0157	-3.74	-0.0295	0.0285	-1.03
leverage	0.0162	0.0129	1.25	-0.0006	0.0316	-0.02
average wage	0.0598***	0.0072	8.27	0.0850***	0.0083	10.19
sales	-0.0245***	0.0042	-5.81	-0.0309***	0.0046	-6.65
market share	0.2606**	0.1104	2.36	0.1434	0.2391	0.6
capital intensity	0.0013**	0.0023	0.58	0.0064**	0.0029	2.21
foreign presence	0.0891***	0.0263	3.38	0.1113***	0.0252	4.42
year dummy	yes			yes		
constant	0.0639*	0.0385	1.66	0.0445	0.0521	0.85
Number of obs	2076			1127		
F/Wald chi2	9.86			289.41		
Endogeneity test				19.2		

Note: ; *** denote significance at 1 per cent level; ** denote significance at 5 per cent level; and * denote significance at 10 per cent level.