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Foreign Direct Investment in R&D and Domestic Entrepreneurship in China's Manufacturing Industries

Sajid Anwar
School of Business
University of the Sunshine Coast
Maroochydore DC, QLD 4558, Australia
Email: SAnwar@usc.edu.au
Tel: 61-7-5430-1222
&

Sizhong Sun
School of Business, James Cook University
Townsville, QLD 4811, Australia
Email: Sizhong.Sun@jcu.edu.au
Tel: 61-7-4781-1222

Abstract

This paper argues that internationalisation of innovation and the related spillovers can also affect the likelihood of firm entry and exit into an industry. By making use of firm level panel data from China over the period 2005 to 2007, this paper examines the impact of foreign direct investment in R&D and the related linkages on entry and exit likelihoods of domestic firms in (i) transport equipment and (ii) electrical machinery and equipment manufacturing industries. In order to evaluate the region-of-origin effect, this paper also separately examines the impact of FDI in R&D originating from (i) all countries except Hong Kong, Macau and Taiwan and (ii) Hong Kong, Macau and Taiwan. Furthermore, the impact of FDI in R&D on entry and exit of Chinese firms in the two industries is examined by splitting the data into large and small firms within the two industries. The results of the pooled Probit regression reveal that FDI in R&D and the related spillovers can have a significant impact on the likelihood of entry and exit of domestic firms in transport equipment and electric machinery and equipment industries. The empirical analysis also suggests that the impact of changes in FDI in R&D and the related spillovers varies across firm size.

Key Words: internationalisation of innovation; R&D; entry; exit; China; Probit regression

1. Introduction

In addition to a rapid increase in foreign direct investment (FDI) flows, recent decades have also witnessed a significant increase in internationalisation of research and development (R&D) investment. Furthermore, developing countries such as China and India are fast becoming a popular destination for FDI in R&D (see Jones and Teegen, 2003; Iwasa and Odagiri, 2004; Ito and Wakasugi, 2007; Veliyath and Sambharya, 2011 and references therein). Among other things, internationalisation of R&D can improve a multinational corporation's competitiveness thereby enhancing its location specific advantages (Dunning, 1988). Dunning and Narula (1995) categorise foreign investment in R&D as strategic asset seeking FDI. Such investment can also be viewed as protecting and in some cases maintaining technological advantage over local firms. Kuemmerle (1999) suggests that FDI in R&D can be used to exploit or build firm-specific industry advantages in host countries. R&D spending abroad can also be used in adapting products to suit host country taste/culture (see Cantwell and Iammarino, 2000; Rama, 2008 and references therein). In general, internationalisation of innovation can be categorised as asset-augmenting or asset-exploiting (Narula and Zanfei, 2008). While internationalisation of R&D may be beneficial to MNCs, it is not always beneficial to host countries. Dunning (1994) argues that in some cases foreign firms may transfer their low value-added technology to host developing countries. Others, such as Mowery (2001), argue that foreign firms may access a country's publicly funded R&D, which could disadvantage domestic firms.[1]

While a number of studies have considered the impact of FDI and the related spillovers on firm productivity and exports, relatively few studies have focused on the role of

[1] An interesting review of literature on the motives and determinants of MNC innovation activities in host countries can be found in Narula and Zanfei (2008), Rama (2008) and Dachs and Pyka (2010).

FDI in R&D.[2] Based on data collected in 1994, Kuemmerle (1999) considers the determinants of FDI in R&D in pharmaceutical and electronics industries. The focus of this study is on the behaviour of European and Japanese firms. Kuemmerle concludes that spending on R&D allows foreign firms to augment their stock of knowledge. Ambos (2005) argues that, as compared to the US or Swedish firms, the timing and organisation of German MNCs spending on R&D relatively closely resembles Japanese or French firms. Asakawa and Som (2008) argue that as far as the management of FDI in R&D in China and India is concerned a different approach is required. By focusing on the role of subsidiaries of multinational corporations, Phene and Almeida (2008) made an important contribution to the literature on globalisation of innovation. They argue that absorptive capacity of subsidiaries affects the scale and quality of innovation. Furthermore, the scale and quality of innovation also depends on knowledge assimilated from host country firms.

Fan (2011), among others, argues that innovation capacity has contributed to economic growth in China and India. It is well known that FDI affects industrial performance by increasing competition in host economies. Wei et al. (2012) argue that foreign invested firms are more likely to recognise the importance of R&D investment in terms of its effect on productivity and the level of competition. Furthermore, interaction with foreign firms can contribute to innovation and technological improvement. Anwar and Sun (2013) argue that presence of foreign firms can affect R&D behaviour of domestic firms.

Another strand of the related literature deals with the determinants of entry and exit decisions of domestic firms. While the earlier studies focused exclusively on domestic factors, recent studies have recognised the important role that foreign factors can play. For example, De Backer and Sleuwaegen (2003) showed that foreign direct investment is an important determinant of domestic entrepreneurship. It is argued that that entry of foreign firms,

[2] The importance of FDI linked spillover effects has also been highlighted by several empirical studies (see Meyers and Sinani, 2009). Tian (2010) argues that spillovers can be reduced through selection of entry modes.

through its impact on the level of market competition, can decrease the profitability of some relatively inefficient domestic firms, which can force these firms to exit the industry.[3] While focusing on domestic firms in Czech Republic, Ayyagari and Kosová (2010) argue that FDI related spillover effects can increase the productivity and hence profit of some domestic firms, which can encourage firm entry.

Internationalisation of innovation can take a number of forms such as cross-border commercialisation of national technology, technological and scientific collaborations (Narula and Zanfei, 2008).[4] In this paper, we argue that innovation related activities of foreign firms in host economies can also affect the entry/exit decisions of domestic firms. Internationalisation of R&D increases the level of competition which can affect the exit likelihood of domestic firms. FDI in R&D and the related spillovers increase the productivity of domestic firms, which encourages firm entry.[5] However, none of the available studies have empirically examined the impact of FDI in R&D on domestic entrepreneurship.

Among the developing economies, China is currently the most popular destination for FDI. At the same time there is also a rapid increase in FDI in R&D in China (see Asakawa and Som, 2008). The European debt crisis and the continuing weakness is the Japanese and the US economies make China an even more attractive destination for FDI. China's 12th (and the latest) 5-year plan aims to attract investment from foreign firms that plan to develop

[3] Entry is defined as a situation where a firm starts producing a product that it has not previously produced or when a firm sells product at a new geographical location. Exit occurs when a firm stops producing a product or stops selling at a different geographical location (Siegfried and Evans, 1994). It has been argued that entry occurs in profitable markets that are expanding. Exit is more frequent in markets where profits are declining and where sunk costs are high.

[4] Narula and Zanfei (2008) argue that multinational firms tend to concentrate their relatively more strategic innovation activities at their home location.

[5] Strictly speaking R&D expenditures are not investment in the sense of FDI. FDI in R&D in this paper refers to foreign investor's R&D spending. However, the spillover effects arising from such spending are almost identical to FDI-related spillover effects.

advanced and new technologies is China (Roos, 2012).[6] This paper focuses on the impact of FDI in R&D on the likelihood of entry and exit of domestic firms in China's (i) transportation equipment and (ii) electrical machinery and equipment manufacturing industries. These industries have not only attracted significant FDI but also experienced strong growth.

In addition to considering the impact of FDI in R&D on entry and exit of domestic firms in the two industries in aggregate, we also separately consider the impact of FDI in R&D from (i) all countries except Hong Kong, Macau and Taiwan and (ii) Hong Kong, Macau and Taiwan. This disaggregation allows one to compare the impact of FDI in R&D originating from mostly Western countries with FDI in R&D originating from Hong Kong, Macau and Taiwan where the management practices are not very different from mainland China. Existing studies such as Du, Harrison and Jefferson (2012) have found that FDI from Hong Kong, Macau and Taiwan has not made a significant contribution to productivity of domestic firms in China. It is therefore useful to distinguish between FDI originating from Hong Kong, Macau and Taiwan and FDI originating from the rest of the world. Furthermore, the impact of FDI in R&D on entry and exit of domestic firms in the two industries is evaluated by dividing the sample into subgroups of large and small firms.

The rest of this paper is organised as follows. Section 2 includes a brief review of the related literature. Section 3 provides an overview of R&D in China. Section 4 contains data description and the empirical model. Section 5 examines the impact of FDI in R&D and the related spillovers on entry and exit of domestic firms in China's selected manufacturing industries. Section 6 contains some concluding remarks and policy implications.

[6] Other changes to guidelines for foreign investment in China to take effect from 30 January 2012 include (i) further opening-up of the services sector to foreign firms and (ii) the automobile industry is mostly closed to foreign investment (Roos, 2012).

2. Review of Related Literature

Globalisation has increased the location options for MNCs. Other developments, including technological improvement and outsourcing, have altered the spatial and organisational structure of MNC activities (Buckley and Ghauri, 2004). A large body of the existing literature considers the impact of FDI and FDI-related spillovers on firm productivity (see Meyers and Sinani, 2009 and references therein) and exports (see Wagner 2007 and references therein).

While a number of existing studies have considered the determinants of domestic entrepreneurship, few studies have considered the impact of international factors.[7] Rapid globalisation during the past few decades has led to increased interdependence among nations. The presence of foreign firms can foster domestic entry and entrepreneurship through (a) movement of workers from foreign to domestic firms, (b) management related knowledge spillover which can arise from the demonstration effect and (c) vertical backwards as well as vertical forward linkages that are established over time between foreign and domestic firms (Ayyagari and Kosová, 2010).[8] In other words, foreign presence can create new business opportunities in host countries, which can be described as the demand creation effect. At the same time, presence of foreign firms can also increase the exit rate of domestic firms. FDI increases market competition in host countries, which can reduce the profit of relatively inefficient domestic firms. De Backer and Sleuwaegen (2003) and Ayyagari and Kosová (2010), among others, further argue that increase in market competition arising from foreign

[7] An excellent review of literature that deals with the impact of domestic factors on domestic entrepreneurship, see Siegfried and Evans (1994).

[8] Some existing studies have considered the qualitative aspects of a wide range of linkages. These linkages include competitive pressures induced by the foreign firms on domestic competitors, which could force domestic firms to improve the quality of their products and, in some cases, might force them to exit the industry (e.g., see Scott-Kennel, 2007 and Giroud and Scott-Kennel, 2009). Jindra, Giroud and Scott-Kennel (2009) suggest that knowledge spillovers arising from vertical supply chain linkages between foreign subsidiaries and domestic firms can contribute to the economic development of host countries.

presence can lead to a situation where demand for goods produced by domestic firms shrinks which can force some domestic firms to exit the industry.[9] The presence of large sunk entry cost and foreign firms' superior technology and management skills can be viewed as entry barriers faced by domestic firms especially in less developed countries. In other words, it can be argued that FDI can affect both the entry and exit rates of domestic firms in host countries.

Recognising the important role that globalisation can play, Backer and Sleuwaegen (2003) and Ayyagari and Kosová (2010) have considered the impact of foreign direct investment (FDI) and FDI spillovers on domestic entrepreneurship. More specifically, by making use of pooled data from 1990 to 1995, Backer and Sleuwaegen considered the impact of FDI on firm entry and exit in Belgium's manufacturing industries. They found that entry of foreign firms decreases entry of domestic firms and its effect on the exit rate of domestic firms is positive. This allowed them to conclude that foreign investment can crowd out domestic entrepreneurship. However, as the business environment varieties varies from country to country, this conclusion cannot be applied to all countries. In fact, given that business environment also varies from industry to industry within the same country, there is a need for industry specific research.[10]

Ayyagari and Kosová extended the existing literature by examining the behaviour of domestic firms within some sectors of the Czech Republic. They used firm level panel data over the period 1994-2000 to examine the impact of FDI and FDI spillovers on entry of domestic firms. The found that entry of foreign firms encourages domestic entrepreneurship and that the resulting vertical entry spillovers are relatively more important. However, Ayyagari and Kosová did not consider the impact on the exit rate of domestic firms.

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[9] The level of market competition depends on a number of factors. For example, Colantone, Coucke and Sleuwaegen (2008) argue that opening of international trade leads to increased competitive pressure on domestic firms, which contributes to exit of some domestic firms.
[10] Other related studies include Huang and Rice (2012).

Within a cross country setting, level, Danakol et al. (2014) examined the impact of FDI, as measured by mergers and acquisitions, on domestic entrepreneurial entry in 70 countries. They used a micro-panel dataset for the period of 2000-2009. They found that FDI has a significant and negative impact on domestic entrepreneurship at both the aggregate and industry level. Moreover, this negative impact is robust with respect to different estimation strategies. The empirical work of Danakol et al. suggests that the negative crowding out effect arising from FDI dominates the positive technological spillover effect.

In the case of China, Anwar and Sun (2012) found that FDI affects the entry and exit of domestic firms in the manufacturing sector. Using firm level survey data from China and employing a propensity score matching technique, Liu, Lu and Zhang (2014) found that entrepreneurs with work experience in foreign-invested firms perform better in managing private firms. However, none of the existing studies have explored the impact of internationalisation of innovation on domestic entrepreneurship.

In summary FDI creates both barriers and new business opportunities in host economies. The barriers arise due to advance technology that foreign firms may introduce in the host economy but spillover effects can improve the domestic business environment. Innovation activities of foreign firms are directly linked to both the barriers and the size of spillover effects. An overview of China's R&D policy is presented in Section 3.

3. R&D in China

Rapid economic growth in China has coincided with a significant increase in R&D spending. China's 12th Five Year Plan (2011-2015) aims to improve its technological capability in three ways. First, it calls for an increase investment in advanced research infrastructure, which not only enhances technological advancement but also creates jobs in related infrastructure producing industries. Second, the 12th plan also calls for increased spending on education. Education quality plays an important role in enhancing a country's innovation capacity. There is evidence to suggest that education standard in China is rising. How efficiently this money will be spent and the extent of its contribution to improvement in productivity is an open question. Third, the 12th plan aims to encourage both domestic and foreign firms to undertake R&D activities in China. The focus is on energy efficiency, high value-added manufacturing, new generation IT, environment protection, bio-technology and clean energy vehicles. The plan envisages tax credits and tariff reductions on the import of selected high-tech products (Berthelsen, 2011).

Figure 1 shows some interesting trends in China's R&D. In 2011, China's spending on R&D accounted for approximately 1.84% of its GDP, which represents a 9.2% increase as compared to 2010. The share of R&D spending in China's GDP increased to 1.98% in 2012. From 1997 to 2011, the number of published scientific and technical journal articles grew at an average annual rate of 15.44% (NBS, 2012).

--- insert Figure 1 about here ---

In recent years, Chinese firms are taking a leading role in development of new technologies. For example, Chinese company Huawei registered a large number of patents in 2008 and was ranked 2nd in the world in 2009 in terms of patent registration. By early 2008, the number of research institutes established by multinational corporations in China reached 1,160 (Thorpe, 2008). The number of engineering and science graduates produced by these institutes is rapidly growing.

For the transport equipment and electrical machinery and equipment manufacturing industries, R&D activities, firm entry and exit appears to be positively correlated. Figure 2 presents the average R&D intensity and the proportion of entry and exit firms for the two industries from 2005 to 2007, and all three variables exhibit upward trending in both industries. In the transport equipment manufacturing industry, on average firms spend 0.27 per cent of their sales revenue in R&D, and at the same time 5.69 per cent of firms are entry firm while 29.62 per cent of firms are exit firms. Similarly in the electrical machinery and equipment manufacturing industry, firms' average R&D intensity is 0.28 per cent, while 4.9 per cent and 29.35 per cent of firms are entry and exit firms respectively.

In the next section, an empirical model is specified that can be used to examine the impact of FDI in R&D and the related spillover effects on entry and exit of domestic firms in China's two major manufacturing industries.

--- insert Figure 2 about here ---

4. Theoretical Model and Hypotheses Development

In order to examine the impact of FDI in R&D on domestic entrepreneurship (i.e., firm entry and exit), we utilise a simple theoretical model. The model is then used to develop testable hypotheses. The aim of this section is to demonstrate that foreign direct investment in an industry can influence the probability of firm entry and exit in that industry. Foreign direct investment in R&D is a part of total foreign direct investment.

As per usual, the model presented in this section involves the interaction of supply and demand. On the demand side, consumers have constant elasticity of substitution utility function as follows:

$$U = \left[\int_{\omega \in \Omega} q(\omega)^{\rho} \, d\omega \right]^{\frac{1}{\rho}} \tag{1}$$

where Ω is the set of all available goods, and q denotes the quantity of goods. All goods are substitutes for each other $(0 < \rho < 1)$.

Consumer utility maximisation yields the demand function as follows:

$$q(\omega) = Ap(\omega)^{\frac{1}{\rho - 1}} \tag{2}$$

$$A \equiv \frac{R}{\int_{\omega\in\Omega} \frac{p(\omega)^{\frac{1}{\rho-1}}}{B(\omega)^{\frac{1}{\rho-1}}} d\omega}$$

where p is the price; A is a measure of the aggregate demand; and R is the consumer income.

Each producer supplies only a very small proportion of the market supply and thus takes A as given.

On the supply side, firms discover their productivity upon entry to the industry. The production process involves both fixed (F) and constant marginal cost $\frac{c(\gamma)}{\theta}$, where c is the unit cost of inputs that are used in the production process, θ is the level of firm productivity, and γ is an index that captures the level of FDI presence in the industry which also includes measures of forward and backward linkages. An increase in the presence of foreign firms (γ) increases the level of market competition, which leads to increase in the cost of resources; i.e., $\frac{\partial c(\gamma)}{\partial \gamma} > 0.$ Following Melitz (2003), we assume that firm productivity is drawn from a probability distribution with density function of $g(\theta, \gamma)$. Upon entry, each firm discovers its productivity, which ranges from zero to infinity $(0, \propto)$. Foreign firms generate positive productivity spillovers to domestic firms and hence domestic firms in an industry with higher level of foreign presence are more likely to discover a relatively higher level of θ. In other words, domestic firms located in industries with relatively higher level of foreign presence will discover a higher level of productivity; i.e., $\frac{\partial g(.)}{\partial \gamma} < 0.$

Due to the presence of monopolistic competition, the optimal pricing strategy employed by each firm involves setting the price as a mark-up over the marginal cost, i.e., $p = \frac{c(\gamma)}{\rho\theta}$. Accordingly, the optimal profit (π) of a representative firm is as follows:

$$\pi = A(1-\rho)\left[\frac{c(\gamma)}{\theta\rho}\right]^{\frac{\rho}{\rho-1}} - F \qquad (3)$$

Since the optimal profit is a monotonic and increasing function of productivity (θ), we can derive the cut-off productivity (θ_{cutoff}) as:

$$\theta_{cutoff} = \left[\frac{c(\gamma)}{\rho}\right]\left[\frac{F}{A(1-\rho)}\right]^{\frac{1-\rho}{\rho}} \qquad (4)$$

θ_{cutoff} is the productivity level that corresponds to zero economic profit. For any realization of θ higher than θ_{cutoff}, firms will enter the industry. If the productivity of a firm that is not in the industry is above the cut-off level then that firm will have incentive to enter the industry. On the other hand, if a firm that is already in the industry and its level of productivity drops below the cut-off level then that firm is likely to exit the industry. Therefore, the probability of entry and exit can be written as:

$$\Pr(entry) = \int_{\theta_{cutoff}}^{+\infty} g(\theta,\gamma)d\theta \qquad (5)$$

$$\Pr(exit) = \int_{-\infty}^{\theta_{cutoff}} g(\theta,\gamma)d\theta \qquad (6)$$

Equations (5) and (6) suggest that probability of entry and exit depends on an index (i.e., $g(\theta,\gamma)$) that measures the presence of FDI. Foreign investment and the related spillovers can directly as well as indirectly, through their impact on firm productivity, affect the probability of firm entry and exit in an industry. In addition to FDI, other factors, such as productivity can also affect the entry and exit probability. These factors will be included in our empirical model in the form of control variables. Moreover, since firms are heterogeneous, it is also likely that the impact of FDI varies across firm size (i.e., across large and small firms).[11] Therefore, based on equations (5) and (6), the following hypotheses can be developed:

Hypothesis 1: FDI in R&D affects the likelihood of firm entry and exit.

Hypothesis 2: FDI linked backward linkages affect firm entry and exit.

Hypothesis 3: FDI linked forward linkages affect firm entry and exit.

Hypothesis 4: The impact of FDI in R&D on firm entry and exit varies across firm size.

5. Empirical Model and Data

In order to test the hypotheses developed in Section 4, making use of theoretical relations as presented by equations (5) and (6), we specify an empirical model as follows:

$$\begin{aligned} y_{i,t} &= \beta_0 + \beta_1 firm\_size_{i,t-1} + \beta_2 prod_{i,t-1} + \beta_3 capital\_\mathrm{int}_{i,t-1} + \beta_4 Ave\_wage_{i,t-1} \\ &+ \beta_5 diver_{i,t-1} + \beta_6 Ownership_{i,t-1} + \beta_7 R\&D\_\mathrm{int}_{i,t-1} + \beta_8 herfindahl_{i,t-1} \\ &+ \beta_9 oic_{i,t-1} + \beta_{10} F\_RnD_{i,t} + \beta_{11} backward_{i,t} + \beta_{12} forward_{i,t} + \vartheta_t + \varepsilon_{i,t} \end{aligned} \quad (7)$$

$$\begin{aligned} z_{i,t} &= \lambda_0 + \lambda_1 firm\_size_{i,t-1} + \lambda_2 capital\_\mathrm{int}_{i,t-1} + \lambda_3 prod_{i,t-1} + \lambda_4 Ave\_wage_{i,t-1} \\ &+ \lambda_5 diver_{i,t-1} + \lambda_6 Ownership_{i,t-1} + \lambda_7 R\&D\_\mathrm{int}_{i,t-1} + \lambda_8 herfindahl_{i,t-1} \\ &+ \lambda_9 oic_{i,t-1} + \lambda_{10} F\_RnD_{i,t} + \lambda_{11} backward_{i,t} + \lambda_{12} forward_{i,t} + \phi_t + \upsilon_{i,t} \end{aligned} \quad (8)$$

where $y_{i,t}$ is the likelihood of entry of a domestic firm in industry *i* in period *t*. $y_{i,t} = 1$ if a firm is a new firm; 0 otherwise; $z_{i,t}$ measures the likelihood of exit of a domestic firm from industry *i* in period *t*; $z_{i,t} = 1$ if a firm does not appear in the sample in each of the 3 years from 2005 to 2007,[12] 0 otherwise; $firm\_size$ is firm size; $prod$ is productivity; $capital\_\mathrm{int}$ is capital intensity; Ave_wage is average wage; $diver$ is diversification; $Ownership$ is ownership; F_RnD is the FDI in R&D; $R\&D\_\mathrm{int}$ is R&D intensity of the domestic firms; $herfindahl$ is the

[11] In addition, following the existing studies, such as Driffield (1999), it can also be argued that the probability of both entry and exit depends on FDI in R&D and the related spillovers that can affect expected future profits.

[12] It should be noted that, owing to data constraints, our definition of firm exit (see Section 4) is affected by sample attrition and unobserved exit behaviour of entry firms at the end of sample period (i.e., 2007). We are thankful to a reviewer for highlighting this issue.

Herfindahl index; *oic* is overall industry concentration; *backward* and *forward* respectively are FDI related backward and forward linkages; ϕ_t and ϑ_t represent year effects. As the dependent variables are dummies that take values of 0 or 1, we use a pooled Probit model, which is estimated by the maximum-likelihood technique where standard errors are clustered by firms.

While our focus is on the impact of innovation activities of foreign-invested firms on entry and exit of purely domestic firms, based on the existing literature, it can be argued that firm entry and exit likelihood also depends on firm and industry characteristics. We account for these characteristics by including a number of firm and industry control variables in our empirical model (i.e., equations 7 & 8). The innovation activities considered in this paper include FDI in R&D and FDI related backward and forward linkages with domestic firms. Firm characteristics include firm size, labour productivity, capital intensity, average wage (which measures the level of human capital), diversification, ownership, R&D intensity. Industry control variables include Herfindahl index and overall industry concentration.[13]

New firms (or firms entering the industry) are those firms that started their operations for the first time during the sample period of 2005 to 2007. Exiting firms are those firms that did not operate during the full sample period (i.e., from 2005 to 2007). F_RnD, which is the main variable of interest, is the share of FDI-invested firms' R&D expenditure within the four digit industry classification. The FDI based forward linkage within the four digit industry classification *j* is the sum of the weighted foreign presence in the four digit industries other than industry *j*. The weights are the proportion of the two digit industries that supply to the two digit industries that contain industry *j* (see Grima, Görg and Pisu, 2008; Harris and Li, 2009; and Ayyagari and Kosová, 2010). The FDI based backward linkage in a four digit industry *j* is the sum of weighted foreign presence in the four digit industries other than *j*. The weights are the proportion of two digit industries that purchase from the two digit

[13] The model is estimated after including the relevant time and industry dummies.

industries that contain industry *j* Grima, Görg and Pisu, 2008; Harris and Li, 2009; and Ayyagari and Kosová, 2010).

Firm size is the natural logarithm of number of employees. Labour productivity (i.e., *prod*) is the logarithm of value added per worker. Capital intensity is natural logarithm of net value of fixed assets per worker. Average wage is the natural logarithm of total salary divided by number of employees. Diversification is measured as the ratio of the value of new products as a proportion of the value of total output. Ownership is a dummy variable and takes a value of 1 if a firm is privately owned; 0 otherwise. R&D intensity is the ratio of R&D expenditure as a proportion of total sales. Herfindahl index captures the impact of market structure and it is the sum of squared market share in the four digit industry. Overall industry concentration intends to capture the impact of spillovers from the concentration of manufacturing activities and is equal to the province-industry (4 digit) share of national industry employment as a ratio of the province share of national manufacturing employment in percentage (see Aitken, Hanson and Harrison, 1997).

Improvement in labour productivity increases the likelihood of entry as it helps firms to compete with other firms and hence its impact on the likelihood of exit is expected to be negative. An improvement in capital intensity's overall effect on entry and exit is similar to an improvement in productivity. Average wage is a measure of human capital, which acts as a barrier to entry and hence its impact on entry can be negative. At the same time, higher level of human capital discourages exit. Diversification reduces business risk and hence its effect on entry is positive. R&D intensity can also acts as a barrier to entry. Higher spending on R&D, among other things, reflects higher initial capitalisation that may be necessary for market entry (see Siegfried and Evans, 1993). Higher R&D intensity can also reduce exit through improvement in productivity.[14] An increase in overall industry concentration (*oic*) can result in exit of relatively inefficient firms but it can also encourage entry due increased spillover effect. Herfindahl index which is the sum of squared market share in the four digit industry, which captures the domestic market structure (see Grima, Görg and Pisu, 2008 and Ayyagari and Kosová, 2010). An increase in monopoly power can result in exit but it can also encourage entry due to increased profits. Backward and forward linkages can facilitate entry as well as exit of domestic firms.

The empirical analysis presented in this paper is based on data sourced from the Enterprise Data, National Bureau of Statistics (NBS), Beijing, China. Each year, NBS collects data from firms to compile the 'Industry' section of the *China Statistical Yearbook.* The dataset, which covers the entire manufacturing sector, accounts for over 85 per cent of China's total industrial output. We focus on the transport equipment and electrical machinery and equipment manufacturing industries as technology (and R&D) plays an important role in these two industries. The sample includes the entry and exit of both domestic and foreign firms but in this paper we focus on domestic firms. The sample period is 2005-2007, where all nominal variables have been adjusted for inflation.[15] Table 1 provides summary statistics for all the variables where the variables marked with (1) refer to all countries except Hong Kong, Macau and Taiwan and variables marked with (2) refer to Hong Kong, Macau and Taiwan.[16]

--- insert Table 1 about here ---

[14] Within the context of oligopolistic rivalry, Colantone, Coucke and Sleuwaegen (2008) have shown that import competition can increase the exit rate of domestic firms. However, the market structure in the Chinese industries that are considered in this paper is close to competitive - the number of domestic firms in each industry is quite large.

[15] A complete list of these industries can be found at the NBS website (http://www.stats.gov.cn).

[16] Note that the sample size in Table 1 is different from that reported in Tables 2 to 7 because the estimated equations involve one year lagged values.

6. Empirical Results and Discussion

The estimated results are reported in Tables 2 to 9. Specifically, the estimated results pertaining to the transport equipment manufacturing industry are reported in Tables 2 to 4. Tables 5 to 7 contain a summary of the estimated results for the electrical machinery and equipment manufacturing industry, whereas Tables 8 and 9 show the estimated results for the two industries by firm size. In the following, we start by discussing the impact of FDI in R&D on China's transport equipment manufacturing industry.[17]

6.1 The impact of FDI in R&D on transport equipment manufacturing industry

The estimated results of Probit estimation over pooled data presented in Table 2 suggest that the impact of FDI in R&D on the likelihood of domestic entry in China's transport equipment manufacturing industry is insignificant. However, forward linkages arising from FDI in R&D contribute to a significant increase in the likelihood that domestic firms will enter the industry. The impact of backward linkages on the likelihood of entry is negative and significant when all control variables are excluded. As far as the impact on the likelihood of exit is concerned, FDI in R&D and its forward and backward linkages all significantly encourage exit of domestic firms.

--- insert Table 2 about here ---

Table 2 also includes the results of estimation without control variables. Exclusion of the control variables does not lead to a change in the sign of all but one estimated coefficient that is statistically insignificant.[18] The impact of backward linkages on likelihood of entry becomes significant when control variables are not included. It can therefore be argued that estimated results are robust.

[17] Equations (7) and (8) were also estimated by means of Instrumental Variable Probit technique but the estimated value of the Wald statistic was in almost all cases statistically insignificant, indicating that the null hypothesis of exogeneity cannot be rejected. This suggests that the results of Probit estimation are highly reliable. A good discussion of the statistical methods employed in this paper can be found in Greene (2012).

[18] This suggests that the estimated results concerning the main hypotheses that are being tested are robust.

So far we have focused on the impact of the aggregate FDI and not considered its source. We now separately examine the impact of FDI in R&D (and the associated forward and backward linkages) originating from (i) Hong Kong, Macau and Taiwan (HMT) region and (ii) non-HMT regions on the entry and exit of domestic firms in China's transport equipment manufacturing industry. The estimated results concerning the impact of FDI in R&D originating from non-HMT and HMT regions, respectively are presented in Tables 3 and 4. Once we exclude FDI in R&D from HMT region, there is no qualitative change in the impact of various factors on firm entry. In terms of the quantitative changes, as far as the impact of the likelihood of entry is concerned, the size of the estimated coefficient of forward linkages increases from 11.31 to 18.8. There is no significant change in the results concerning the exit of domestic firms, except that the estimated coefficient of forward linkages increases from 3.55 to 22.38.

--- insert Table 3 about here ---

As far as FDI in R&D originating from HMT region is concerned, the estimated results presented in Table 4 suggest that its impact (as well as the impact of the associated forward and backward linkages) on the entry likelihood is statistically insignificant. However, its impact on exit of domestic firms is positive and significant. The forward linkages discourage exit of domestic firms but backward linkages encourage exit. In other words, as compared to the impact of non-HMT FDI, the impact of HMT FDI on entry and exit of domestic firms in China's transportation equipment manufacturing industry is very different. These results also hold when the model is estimated after excluding all control variables, which suggests that the estimated results are reasonably robust.

--- insert Table 4 about here ---

6.2 The impact of FDI in R&D on electrical machinery and equipment manufacturing industry

Table 5 shows the impact of FDI in R&D from all sources on entry and exit likelihoods of domestic firms in China's electric machinery and equipment manufacturing industry. The empirical results suggest that the impact of FDI in R&D on entry or exit of domestic firms is statistically insignificant. However, backward linkages discourage both entry and exit of domestic firms in the industry. Once the control variables are excluded, the impact of FDI in R&D from all sources on the likelihood of exit becomes positive and significant.

--- insert Table 5 about here ---

Table 6 reports the impact of non-HMT FDI in R&D on entry and exit of domestic firms in China's electrical machinery and equipment industry. The results presented in this table suggest that as far as the impact on likelihood of entry and exit is concerned, exclusion of Hong Kong, Macau and Taiwan does not affect the main result in that only backward linkages significantly affect the likelihood of both firm entry and exit and this effect is negative.

--- insert Table 6 about here ---

The impact of FDI in R&D originating from HMT region on firm entry is insignificant (see Table 7). The same hold for the impact of forward linkages but the impact of backward linkages is negative and significant. The impact of FDI in R&D originating from HMT region and the associated forward linkages on exit of domestic firms is positive and significant but backward linkages discourage exit of domestic firms and this effect is significant. All of these results are unaffected when the model is estimated without the control variables.

--- insert Table 7 about here ---

6.3 The role of the control variables

Not surprisingly, the control variables also play an important role in explaining some variation in the likelihood of entry and exit of domestic firms but the impact of not all control variables is statistically significant. For example, in the case of the entry likelihood in China's transport equipment manufacturing industry, the impact of five out of nine control variables is significant (see Table 2). However, in the case of the exit likelihood in the same table, the impact of seven out of nine control variables is statistically significant. Firm size and average wage (which is a proxy for the firm human capital) have a negative and significant impact on both entry and exit of domestic firms. Improvement in labour productivity discourages exit. The impact of capital intensity on the likelihood of domestic entry is significant and positive, but its effect on exit is significant and negative. It is interesting to note that the 12^{th} five-year plan of China, which came into effect from January 2012, does not encourage foreign investment in automotive industry. This can be viewed as an attempt to protect the local car industry, which is growing fast (Roos, 2012).

In the case of the electric machinery and equipment manufacturing industry, the impact of the control variables as presented Table 5 is largely consistent with the results presented in Table 2, particularly in case of the exit likelihood estimation. For the entry likelihood estimation, the coefficients of capital intensity and Herfindahl index become insignificant, while the coefficient of labour productivity becomes significant at the five per cent level and the coefficients of diversification and R&D intensity are now significant at the ten per cent level.

6.4 The impact of FDI in R&D by firm size

In order to test Hypothesis 4, the sample was divided into two groups: large firms and small firms. Firms with number of employees higher than the industry average are categorised as large. In the case of the transport equipment manufacturing industry, Table 8 shows that the impact of non-HMT FDI in R&D on the likelihood of domestic entry in both the large and small firms is statistically insignificant.[19] However, the impact of FDI in R&D on the likelihood of exit of small firms is positive and statistically significant. In other words, FDI in R&D does not significantly affect the likelihood of exit of large firms but it does encourage exit of small firms. Furthermore, forward linkages increase the likelihood of entry as well as exit of both small and large domestic firms. However, backward linkages do not lead to a significant effect on entry likelihood but these linkages increase the exit likelihood of small firms.

--- insert Table 8 about here ---

The role of firm size in the case of the electric machinery and equipment manufacturing industry can be examined by means of the results presented in Table 9. Table 9 shows that the impact of non-HMT FDI in R&D on the likelihood of domestic entry and exit in both large and small firms is statistically insignificant. Backward linkages decrease the likelihood of exit of large domestic firms.

--- insert Table 9 about here ---

7. Concluding Remarks and Policy Implications

Foreign investment has contributed to increase in profitable business opportunities in China. The overall standard of living in China as measured by the real per capita income has significantly increased over time. Among other things, economic prosperity has resulted in a significant increase in R&D spending in China in recent years. China's 12th five-year plan places greater emphasis on innovation and encourages foreign investment in high-tech manufacturing. Existing studies such as Phene and Almedia (2008) have highlighted the importance of globalization of innovation. Globalisation of innovation can also affect

[19] While the sample was split into two groups of large and small firms, firm size still appears as a control variable in the empirical model. The impact of firm size within each group is found to be statistically significant. This follows from the fact that the sample size is very large and there is a large variation with each group. In other words, some of the small (large) firms are in relative terms very small (large).

business environment thereby affecting the entry and exit decisions of domestic firms. However, none of the existing studies have investigated the link between foreign direct investment (FDI) in R&D and the likelihood of firm entry and exit. By making use of a simple theoretical model, this paper argues that a number of factors including the presence of foreign firms and firm productivity can affect the entry and exit likelihood of domestic firms. FDI in R&D affects firm productivity, which can subsequently affect the likelihood of entry to and exit from an industry. The presence of foreign firms can also affect the likelihood of firm entry and exit through backward and forward linkages. Based on the theoretical model, a Porbit empirical model is specified, which is estimated by the maximum likelihood technique.

The empirical analysis presented in this paper is based on firm level panel data over the period 2005 to 2007 from China's (i) transport equipment and (ii) electric machinery and equipment manufacturing industries. In addition to considering the impact of FDI in R&D from all sources on the likelihood of domestic entry and exit in each industry, this paper also separately examines the impact of FDI in R&D from (i) all countries except Hong Kong, Macau and Taiwan and (ii) Hong Kong, Macau and Taiwan. This disaggregation allows one to focus on region of origin effect. In other words, one is able to compare the impact of FDI in R&D originating mostly from Western countries with that originating from Hong Kong, Macau and Taiwan.

The results of the estimated Probit models reveal that FDI in R&D affects the likelihood of exit of domestic firms from the two manufacturing industries but its impact on the likelihood of entry of domestic firms is statistically insignificant. Specifically, irrespective of the region of origin, FDI in R&D increases the likelihood of firm exit from China's transport equipment manufacturing industry. Further analysis shows that it is mostly small firms that exit the industry and the impact on the likelihood of exit of large domestic firms is statistically insignificant. In other words, FDI in R&D is contributing to a movement towards an oligopolistic market structure in China's transport equipment industry. The forward linkages arising from non-HMT FDI are beneficial to both the large and small domestic firms in China's transport equipment manufacturing industry because such linkages increase the likelihood of entry of domestic firms in the industry. In other words, through forward linkages, non-HMT FDI tends to improve business conditions for both large and small domestic firms within the industry. Both forward and backward linkages arising from non-HMT FDI increase the likelihood of exit of some domestic firms form the industry. While forward linkages affect both small and large firms, backward linkages affect only the small firms. Forward linkages arising from the HMT FDI decrease the likelihood of exit of domestic firms but backward linkages increase the likelihood of exit.

Analysis of the impact on electric machinery and equipment industry shows that FDI in R&D does not affect the likelihood of entry of domestic firms in the industry. However, FDI-related backward linkages decrease the likelihood of entry as well as the likelihood of exit of domestic firms. This result holds for both HMT and non-HMT FDI. The HMT FDI in R&D and its forward linkages increase the likelihood of exit of domestic firms from the industry.

Our empirical results suggest that firm and industry specific factors also play a crucial role. However, except in the case of entry involving large firms in transport equipment manufacturing industry, the role of overall industry concentration was found to be insignificant in all cases. The region of origin effect was found to be significant. For example, the impact of non-HMT FDI in R&D and the related linkages on the likelihood of entry of domestic firms in transport equipment industry was found to be insignificant. But the impact of HMT FDI-related backward linkages from Hong Kong, Macau and Taiwan on the likelihood of entry of domestic firms in transport equipment industry was found to be negative and significant. The estimated results also suggest that the impact of FDI in R&D and the related spillovers on entry and exit likelihoods of domestic firms varies across firm size. For example, increase in FDI in R&D increases the likelihood of exit of small firms from transport equipment industry but it has no effect on exit likelihood of large firms. The empirical models were also estimated after excluding all the control variables and most empirical results were found to be statistically robust.

While this paper does not specifically consider partnerships with local firms, the existing literature suggests that such arrangements can be very fruitful. Partnerships with local firms allow foreign firms to take advantage of China's local talent and customer network. This option can yield rich dividends to foreign firms with relatively less risk in China. Chinese government has recently earmarked US$18 for promoting partnership with foreign firms in targeted industries (Johnson, 2012). Local content requirement has resulted in transfer of some peripheral technology but more can be done. Top Chinese universities are now involved in joint R&D activities with foreign firms. Foreign firms can further improve their standing in China by continuing to fund training programs or through providing equipment. Due to lack of funding, a number of Chinese universities rely on training programs offered by foreign firms (Thorpe, 2008). While there has been a rapid increase in R&D spending in China in recent years, Chinse firms still lag behind in innovation (Jing, 2013). In order to encourage innovation, the Chinese government needs to relax state control over education and create a level playing field between private and state-owned domestic firms.

Managerial Relevance

The main message to the managers is that R&D activities of foreign-invested firms can lead to two effects: (a) an opportunity creating effect, which encourages some productive domestic firms to enter the industry and (b) increased competition effect, which forces some less productive domestic firms to exit the industry. However these effects vary across manufacturing industries. Furthermore, managers of mainland Chinese firms need to be aware that partnership with Hong Kong, Macau and Taiwan-based firms is not the same as the partnership with the rest of the world.

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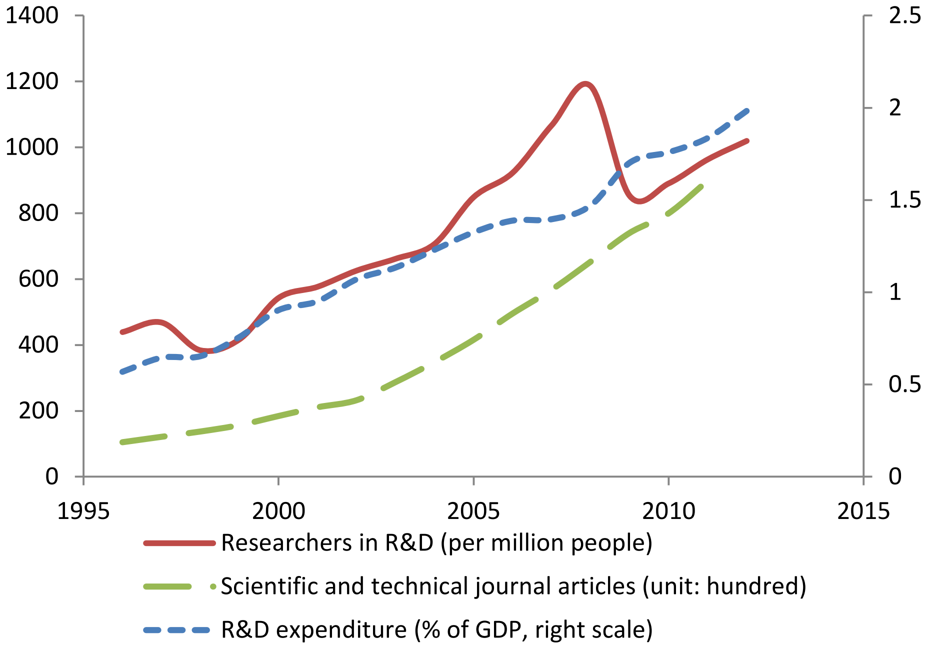
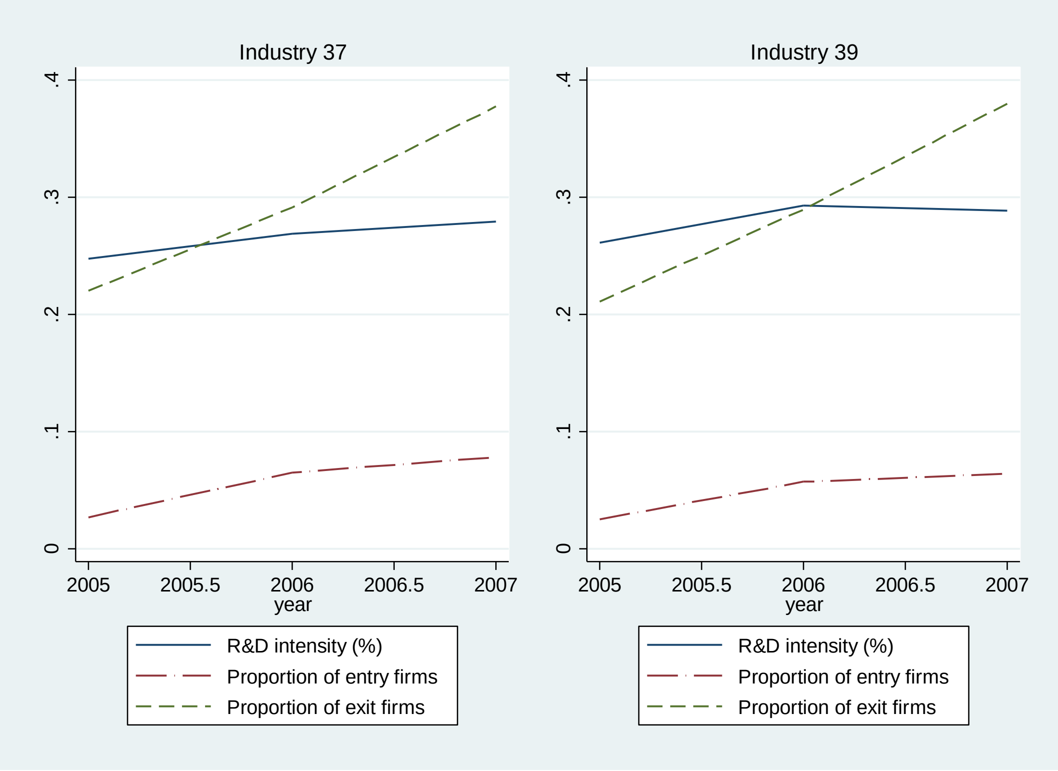
Figure 1: R&D Spending Trend in China



Source: World Development Indicators, 2014

Figure 2 R&D and Domestic Entrepreneurship



Note: Industry 37 is the transportation equipment manufacturing industry;
Industry 39 is the electrical machinery and equipment manufacturing industry.
Source: National Bureau of Statistics, Beijing.

Table 1 Summary Statistics*

	Transportation Equipment Manufacturing					Electrical Machinery and Equipment Manufacturing				
Variables	Obs	Mean	Std. Dev.	Min	Max	Obs	Mean	Std. Dev.	Min	Max
whetherentry	29696	0.06				38272	0.05			
whetherexit	29696	0.30				38272	0.30			
firm size	29696	-2.17	1.10	-4.83	3.64	38272	-2.42	1.01	-4.83	3.71
labour productivity	29696	4.04	0.97	-2.73	8.42	38272	4.25	1.03	-1.56	8.45
capital intensity	29696	3.50	1.23	-4.89	9.16	38272	3.41	1.29	-4.11	10.07
average wage	29696	2.60	0.50	-2.00	5.23	38272	2.61	0.51	-2.04	5.37
diversification	29696	0.05	0.17	0	1	38272	0.06	0.19	0	1
ownership	29696	0.58				38272	0.63			
R&D intensity	29675	0.00	0.02	0	1.14	38269	0.00	0.02	0	0.78
herfindahl index	29696	0.02	0.04	0.004	0.72	38272	0.02	0.03	0.003	0.20
overall industry concentration	29696	28.58	148.28	0.003	8749.12	38272	13.52	42.56	0.01	2514.10
FDI in R&D	29696	0.38	0.22	0	0.97	38272	0.38	0.22	0.03	0.93
forward linkage	29696	0.14	0.02	0.11	0.17	38272	0.20	0.003	0.20	0.21
backward linkage	29696	0.08	0.00	0.07	0.09	38272	0.19	0.05	0.12	0.24
FDI in R&D (1)	29696	0.31	0.2	0	0.91	38272	0.26	0.19	0.01	0.87
forward linkage (1)	29696	0.10	0.01	0.08	0.11	38272	0.13	0.01	0.12	0.14
backward linkage (1)	29696	0.06	0.01	0.05	0.07	38272	0.13	0.03	0.08	0.16
FDI in R&D (2)	29696	0.07	0.07	0	0.97	38272	0.14	0.15	0.003	0.77
forward linkage (2)	29696	0.05	0.02	0.03	0.07	38272	0.08	0.002	0.07	0.08
backward linkage (2)	29696	0.03	0.01	0.01	0.04	38272	0.07	0.02	0.04	0.09

Note: whertherentry, whetherexit, and ownership are three dummy variables that take a value of 1 if a firm is an entry firm, exit firm, and privately owned respectively; (1) refers to all FDI except from Hong Kong, Macau, and Taiwan and (2) refers to FDI from Hong Kong, Macau and Taiwan. *some variables are in natural logarithms.

Table 2: FDI in R&D from All Countries – The Impact on Transportation Equipment Manufacturing

	Entry Likelihood				Exit Likelihood			
	Coef.	S.E.	Coef.	S.E.	Coef.	S.E.	Coef.	S.E.
firm size$_{t-1}$	-0.12***	0.02			-0.27***	0.02		
labour productivity$_{t-1}$	0.004	0.02			-0.11***	0.02		
capital intensity$_{t-1}$	0.05***	0.02			-0.03**	0.01		
average wage$_{t-1}$	-0.35***	0.05			-0.08**	0.03		
diversification$_{t-1}$	0.10	0.12			0.16*	0.08		
ownership$_{t-1}$	0.13***	0.04			-0.06**	0.03		
R&D intensity$_{t-1}$	-1.40	2.23			-0.12	0.77		
herfindahl$_{t-1}$	0.93**	0.37			0.95***	0.27		
oic$_{t-1}$	0.0001	0.0001			0.00001	0.0001		
FDI in R&D$_t$	0.04	0.25	-0.16	0.17	1.50***	0.23	1.27***	0.13
forward linkage$_t$	11.31***	1.39	16.95***	2.39	3.55***	1.17	-5.49***	1.69
backward linkage$_t$	-6.85	18.35	-35.16***	12.94	107.26***	15.57	87.31***	9.18
constant	-2.51*	1.51	-1.15	0.81	-11.31***	1.29	-7.55***	0.58
Number of obs	16061		29696		16061		29696	
Wald chi2	350.48		361.12		585.91		1056.72	
Log pseudolikelihood	-2892.33		-6490.76		-6499.73		-17852.2	
Pseudo R2	0.05		0.02		0.06		0.02	

Notes: Year dummies are included in all regressions. Standard errors are clustered. Oic denotes overall industry concentration. ***, **, and * respectively denote significance at the 1, 5, and 10 per cent level.

Table 3: FDI in R&D from All Countries except Hong Kong, Macau and Taiwan – The Impact on Transportation Equipment Manufacturing

	Entry Likelihood				Exit Likelihood			
	Coef.	S.E.	Coef.	S.E.	Coef.	S.E.	Coef.	S.E.
firm size$_{t-1}$	-0.12***	0.02			-0.27***	0.02		
labour productivity$_{t-1}$	0.004	0.02			-0.11***	0.02		
capital intensity$_{t-1}$	0.05***	0.02			-0.03**	0.01		
average wage$_{t-1}$	-0.35***	0.05			-0.08**	0.03		
diversification$_{t-1}$	0.10	0.12			0.16*	0.08		
ownership$_{t-1}$	0.12***	0.04			-0.06**	0.03		
R&D intensity$_{t-1}$	-1.39	2.22			-0.12	0.77		
herfindahl$_{t-1}$	0.93**	0.37			1.00***	0.27		
oic$_{t-1}$	0.0001	0.0001			0.00001	0.0001		
FDI in R&D$_t$	-0.03	0.28	-0.27	0.18	1.67***	0.25	1.47***	0.14
forward linkage$_t$	18.80***	1.39	8.06	6.65	22.38***	1.23	73.10***	4.60
backward linkage$_t$	-19.91	18.91	-34.31***	5.32	99.64***	15.65	20.63***	3.72
constant	-2.10*	1.17	-0.36	1.02	-8.91***	0.98	-9.60***	0.71
Number of obs	16061		29696		16061		29696	
Wald chi2	349.73		362.4		581.78		1072.13	
Log pseudolikelihood	-2892.39		-6490.1		-6501.66		-17850.4	
Pseudo R-Square	0.05		0.02		0.06		0.02	

Notes: Year dummies are included in all regressions. Standard errors are clustered. Oic denotes overall industry concentration. ***, **, and * respectively denote significance at the 1, 5, and 10 per cent level.

Table 4: FDI in R&D from Hong Kong, Macau and Taiwan – The impact on Transportation Equipment Manufacturing

	Entry Likelihood				Exit Likelihood			
	Coef.	S.E.	Coef.	S.E.	Coef.	S.E.	Coef.	S.E.
firm size$_{t-1}$	-0.12***	0.02			-0.28***	0.02		
labour productivity$_{t-1}$	0.004	0.02			-0.12***	0.02		
capital intensity$_{t-1}$	0.05***	0.02			-0.03**	0.01		
average wage$_{t-1}$	-0.35***	0.05			-0.07**	0.03		
diversification$_{t-1}$	0.10	0.12			0.16*	0.08		
ownership$_{t-1}$	0.13***	0.04			-0.06	0.03		
R&D intensity$_{t-1}$	-1.39	2.23			-0.08	0.78		
herfindahl$_{t-1}$	0.90**	0.37			0.91***	0.27		
oic$_{t-1}$	0.0001	0.0001			0.00005	0.0001		
FDI in R&D$_t$	1.10	1.08	0.10	0.60	2.85***	0.91	1.44***	0.44
forward linkage$_t$	-1.26	29.11	34.84	66.16	-52.05**	23.33	-150.54***	47.96
backward linkage$_t$	86.10	112.84	-36.08	110.09	278.64***	90.77	270.65***	79.81
constant	-4.41*	2.32	-2.47***	0.38	-7.81***	1.87	-0.21	0.28
Number of obs	16061		29696		16061		29696	
Wald chi2	353.79		358.49		562.95		922.86	
Log pseudolikelihood	-2891.88		-6494.72		-6522.27		-17883.3	
Pseudo R2	0.05		0.02		0.06		0.02	

Notes: Year dummies are included in all regressions. Standard errors are clustered. Oic denotes overall industry concentration. ***, **, and * respectively denote significance at the 1, 5, and 10 per cent level.

Table 5: FDI in R&D from All Countries – The impact on Electrical Machinery and Equipment Manufacturing

	Entry Likelihood				Exit Likelihood			
	Coef.	S.E.	Coef.	S.E.	Coef.	S.E.	Coef.	S.E.
firm size$_{t-1}$	-0.14***	0.02			-0.24***	0.01		
labour productivity$_{t-1}$	-0.05**	0.02			-0.14***	0.01		
capital intensity$_{t-1}$	0.003	0.02			-0.04***	0.01		
average wage$_{t-1}$	-0.30***	0.05			-0.11***	0.03		
diversification$_{t-1}$	0.17*	0.10			0.10	0.06		
ownership$_{t-1}$	0.20***	0.04			0.07***	0.02		
R&D intensity$_{t-1}$	-3.51*	2.10			-0.86	0.85		
herfindahl$_{t-1}$	0.99	0.66			0.68*	0.41		
oic$_{t-1}$	0.0003	0.0004			0.0003	0.0003		
FDI in R&D$_t$	0.03	0.18	-0.07	0.14	0.09	0.15	0.22**	0.09
forward linkage$_t$	5.10	23.59	-5.70	15.19	26.58	19.24	25.25**	10.08
backward linkage$_t$	-3.83***	1.36	-4.21***	0.30	-5.89***	1.12	-5.23***	0.19
constant	-1.73	4.66	0.19	3.09	-5.15	3.80	-4.82**	2.05
Number of obs	20650		38272		20650		38272	
Wald chi2	328.65		329.63		776.56		1357.22	
Log pseudolikelihood	-3367.96		-7538.22		-8285.5		-22958.9	
Pseudo R2	0.05		0.02		0.06		0.02	

Notes: Year dummies are included in all regressions. Standard errors are clustered. Oic denotes overall industry concentration. ***, **, and * respectively denote significance at the 1, 5, and 10 per cent level.

Table 6: FDI in R&D from All Countries except Hong Kong, Macau and Taiwan – The Impact on Electrical Machinery and Equipment Manufacturing

	Entry Likelihood				Exit Likelihood			
	Coef.	S.E.	Coef.	S.E.	Coef.	S.E.	Coef.	S.E.
firm size$_{t-1}$	-0.14***	0.02			-0.24***	0.01		
labour productivity$_{t-1}$	-0.05**	0.02			-0.14***	0.01		
capital intensity$_{t-1}$	0.003	0.02			-0.04***	0.01		
average wage$_{t-1}$	-0.30***	0.05			-0.11***	0.03		
diversification$_{t-1}$	0.17*	0.10			0.10*	0.06		
ownership$_{t-1}$	0.20***	0.04			0.06***	0.02		
R&D intensity$_{t-1}$	-3.50*	2.09			-0.82	0.85		
herfindahl$_{t-1}$	1.10*	0.62			0.60	0.40		
oic$_{t-1}$	0.0003	0.0004			0.0003	0.0003		
FDI in R&D$_t$	0.01	0.24	-0.02	0.19	-0.23	0.19	0.03	0.12
forward linkage$_t$	23.62	35.69	19.88	23.60	-4.86	27.40	21.02	14.98
backward linkage$_t$	-8.95*	5.54	-8.78**	3.46	-5.84	4.27	-9.87***	2.19
constant	-3.39	4.10	-3.27	2.73	0.68	3.14	-2.12	1.73
Number of obs	20650		38272		20650		38272	
Wald chi2	329.55		332.14		777.17		1353.41	
Log pseudolikelihood	-3367.44		-7536.35		-8284.34		-22959.1	
Pseudo R2	0.05		0.02		0.06		0.02	

Notes: Year dummies are included in all regressions. Standard errors are clustered. Oic denotes overall industry concentration. ***, **, and * respectively denote significance at the 1, 5, and 10 per cent level.

Table 7: FDI in R&D from Hong Kong, Macau and Taiwan – The Impact on Electrical Machinery and Equipment Manufacturing

	Entry Likelihood				Exit Likelihood			
	Coef.	S.E.	Coef.	S.E.	Coef.	S.E.	Coef.	S.E.
firm size$_{t-1}$	-0.14***	0.02			-0.24***	0.01		
labour productivity$_{t-1}$	-0.05**	0.02			-0.14***	0.01		
capital intensity$_{t-1}$	0.00	0.02			-0.04***	0.01		
average wage$_{t-1}$	-0.30***	0.05			-0.11***	0.03		
diversification$_{t-1}$	0.17*	0.10			0.10	0.06		
ownership$_{t-1}$	0.20***	0.04			0.06**	0.02		
R&D intensity$_{t-1}$	-3.49*	2.09			-0.82	0.85		
herfindahl$_{t-1}$	0.82	0.66			0.25	0.42		
oic$_{t-1}$	0.0003	0.0004			0.0004	0.0003		
FDI in R&D$_t$	0.15	0.27	-0.10	0.21	0.54**	0.22	0.46***	0.14
forward linkage$_t$	12.55	29.66	-12.91	20.03	62.64***	24.14	36.13***	13.92
backward linkage$_t$	-8.01***	2.58	-12.19***	1.49	-6.00***	2.09	-10.63***	1.00
constant	-1.86	2.54	0.08	1.71	-5.38***	2.08	-2.83**	1.19
Number of obs	20650		38272		20650		38272	
Wald chi2	329.13		329.88		780.34		1370.41	
Log pseudolikelihood	-3367.48		-7536.61		-8283.95		-22947.1	
Pseudo R2	0.05		0.02		0.06		0.02	

Notes: Year dummies are included in all regressions. Standard errors are clustered. Oic denotes overall industry concentration. ***, **, and * respectively denote significance at the 1, 5, and 10 per cent level.

Table 8: FDI in R&D from All Countries except Hong Kong, Macau and Taiwan - The Impact on Transport Equipment Manufacturing by Firm Size

	Entry Likelihood				Exit Likelihood			
	Large Firms		Small Firms		Large Firms		Small Firms	
	Coef.	S.E.	Coef.	S.E.	Coef.	S.E.	Coef.	S.E.
firm size$_{t-1}$	-0.22***	0.05	-0.11**	0.05	-0.07***	0.03	-0.45***	0.03
labour productivity$_{t-}$	-0.05	0.04	0.04	0.03	-0.06**	0.03	-0.16***	0.02
capital intensity$_{t-1}$	0.01	0.03	0.08***	0.03	-0.03	0.02	-0.04**	0.01
average wage$_{t-1}$	-0.23***	0.08	-0.43***	0.07	-0.09*	0.05	-0.09**	0.04
diversification$_{t-1}$	0.10	0.17	0.17	0.18	0.12	0.11	0.01	0.13
ownership$_{t-1}$	0.07	0.07	0.17***	0.06	-0.02	0.04	-0.06*	0.04
R&D intensity$_{t-1}$	-2.33	3.76	-0.28	1.94	-2.19	1.65	0.60	0.84
herfindahl$_{t-1}$	0.93	0.70	1.15**	0.48	1.40**	0.55	0.75**	0.31
oic$_{t-1}$	0.0001	0.0001	-0.0006	0.0005	-0.0001	0.0001	0.00	0.00
FDI in R&D$_t$	0.16	0.43	-0.06	0.41	0.27	0.42	2.48***	0.32
forward linkage$_t$	21.51***	2.45	17.42***	1.80	14.06***	1.90	28.22***	1.60
backward linkage$_t$	13.42	29.43	-34.80	27.21	0.95	26.00	151.43***	19.59
constant	-4.25**	1.89	-1.23	1.66	-2.29	1.61	-12.72***	1.23
Number of obs	7609		8452		7609		8452	
Wald chi2	131.88		228.39		88.98		482.14	
Log	-1183.11		-1689.01		-2416.65		-4003.54	
Pseudo R2	0.05		0.06		0.02		0.07	

Notes: Firms with number of employees greater than the industry average are categorised as large firms. Year dummies are included in all regressions. Standard errors are clustered. Oic denotes overall industry concentration. ***, **, and * respectively denote significance at the 1, 5, and 10 per cent level.

Table 9: FDI in R&D from All Countries except Hong Kong, Macau and Taiwan - The Impact on Electrical Machinery and Equipment Manufacturing by Firm Size

	Entry Likelihood				Exit Likelihood			
	Large Firms		Small Firms		Large Firms		Small Firms	
	Coef.	S.E.	Coef.	S.E.	Coef.	S.E.	Coef.	S.E.
firm size$_{t-1}$	-0.18***	0.04	-0.17***	0.05	-0.14***	0.03	-0.32***	0.03
labour productivity$_{t-1}$	-0.08***	0.03	-0.02	0.03	-0.11***	0.02	-0.17***	0.02
capital intensity$_{t-1}$	-0.01	0.03	0.02	0.02	-0.05***	0.02	-0.04***	0.01
average wage$_{t-1}$	-0.31***	0.07	-0.29***	0.06	-0.07**	0.04	-0.14***	0.04
diversification$_{t-1}$	-0.04	0.15	0.37***	0.13	0.02	0.09	0.15*	0.09
ownership$_{t-1}$	0.21***	0.06	0.19***	0.06	0.07*	0.04	0.07**	0.03
R&D intensity$_{t-1}$	-1.41	2.11	-5.21	3.66	-0.84	1.31	-0.87	1.13
herfindahl$_{t-1}$	1.26	0.87	0.97	0.88	0.71	0.54	0.62	0.57
oic$_{t-1}$	0.0002	0.0005	0.0004	0.0007	0.00022	0.0003	0.00	0.00
FDI in R&D$_t$	-0.15	0.34	0.16	0.35	-0.02	0.28	-0.30	0.26
forward linkage$_t$	0.64	50.28	47.29	52.63	33.69	40.74	-25.94	37.44
backward linkage$_t$	-4.87	7.79	-13.09	8.19	-10.48*	6.34	-3.60	5.84
constant	-0.65	5.77	-6.36	6.04	-3.89	4.67	3.12	4.29
Number of obs	10068		10582		10068		10582	
Wald chi2	126.05		196.57		207.22		506.48	
Log pseudolikelihood	-1418.87		-1939.23		-3399.39		-4858.88	
Pseudo R2	0.05		0.04		0.04		0.06	

Notes: Firms with number of employees greater than the industry average are categorised as large firms. Year dummies are included in all regressions. Standard errors are clustered. Oic denotes overall industry concentration. ***, **, and * respectively denote significance at the 1, 5, and 10 per cent level.