The impact of foreign firms on industrial productivity : evidence from Japan

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journal or publication title	IDE Discussion Paper
volume	533
year	2015-08-01
URL	http://hdl.handle.net/2344/1467

INSTITUTE OF DEVELOPING ECONOMIES

IDE Discussion Papers are preliminary materials circulated
to stimulate discussions and critical comments

IDE DISCUSSION PAPER No. 533

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August 2015

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[ζ] This study is conducted as a part of the project "Competitiveness of Japanese Firms: Causes and Effects of the Productivity Dynamics" undertaken at the Research Institute of Economy, Trade, and Industry (RIETI). I would like to thank RIETI for research opportunities and the Ministry of Economy, Trade, and Industry (METI) for providing firm-level data. I wish to acknowledge the financial support of JSPS Grant-in-Aid for Scientific Research (B) Grant Number 26285058. For useful comments, I also thank Kozo Kiyota, Toshiyuki Matsuura, and the seminar participants at the RIETI workshop in 2014. The opinions expressed and arguments employed in this paper are the sole responsibility of the author and do not necessarily reflect those of RIETI, METI, or any institution with which the author is affiliated. All remaining errors are my own.
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1. Introduction

Governments in developed and developing economies have increasingly made efforts to attract foreign direct investment (FDI) through foreign-ownership liberalization and investment incentives for foreign investors. These policies are motivated by the expectation that foreign firms would bring in intangible assets such as superior technology and managerial know-how, leading to pro-competitive effects and positive externalities for domestic firms. Despite a concern over their crowding-out effects on domestic industries, the presence of foreign firms is expected to generate productivity gains for a host economy. Consequently, there exist a large number of empirical studies on the role of foreign firms in the host economy. While FDI spillovers to domestic firms attract a great deal of attention, the empirical magnitude of FDI spillovers varies widely in prior studies, suggesting that the empirical evidence is not conclusive about the precise effects of foreign firms (Crespo and Fontoura, 2007; Havránek and Iršová, 2011; Iršová and Havránek, 2013; Wooster and Diebel, 2010).

An empirical investigation of foreign firms in Japan is a crucial issue from both academic and policy perspectives. Inward FDI stocks in Japan increased from 3.5 trillion yen in 1996 to 17.8 trillion yen in 2012 (Bank of Japan). In the Japan Revitalization Strategy 2014, the Japanese government set a target to increase inward FDI stocks up to 35 trillion yen by the year 2020, with the expectation that FDI promotion policies would contribute to economic growth. However, as reviewed in Kiyota (2014), there is limited evidence on the impact of foreign firms in Japan, and the previous results are mixed. Todo (2006) uses a Japanese firm-level dataset – the Basic Survey of Japanese Business Structure and Activities (BSBSA) – and finds that the industry R&D stock of foreign firms has a positive impact on the productivity of domestic firms in similar manufacturing sectors.[1] By contrast, Ito (2013) uses the same data source to measure the foreign presence by employment, but finds a negative intra-industry spillover effect in both manufacturing and non-manufacturing industries. Finally, Iwasaki (2013) uses the firm-level data of listed companies on Japanese stock markets and finds a positive forward-linkage effect of foreign firms to domestic firms.

In this paper, I estimate the impact of foreign firms on industrial productivity at the regional-level by extending the literature in two ways. First, I employ a series of firm-level surveys to construct a unique dataset on foreign firms in Japan for the period 1995-2008. My main data source is the Survey of Trends in Business Activities of Foreign Affiliates (STBAFA) by the Japanese Ministry of Economy, Trade, and Industry (METI). This survey is designed to cover all the business enterprises in which more than one third of shares or holdings are owned by foreign investors. There is no threshold for the survey coverage in terms of the firm size. By

[1] The BSBSA survey covers all business firms with 50 employees or more and capital of 30 million yen or more.

contrast, there is a survey threshold in the BABSA data used in prior studies, implying that the STBAFA has more comprehensive coverage of foreign firms. Because the STBAFA covers foreign firms in real estate, finance, and insurance sector from only 2009 onward, I use another firm-level data source for these sectors: the Directory of Foreign Affiliates in Japan by Toyo Keizai Inc. By constructing firm-level panel data and carefully improving various variables on foreign firms' activities, I measure the presence of foreign firms as a share of foreign firms' employees in total employment across all sectors and all regions over time.[2] This measure is more appropriate than FDI stocks/flows in capturing actual production activity because FDI stocks/flows are seriously affected by financial transactions for non-production purposes such as the reduction of tax burdens (Lipsey, 2007).

I use a Bayesian-model averaging (BMA) approach to take into account both model uncertainty and parameter heterogeneity in a coherent framework. The firm-level surveys provide precise information on the nationality of foreign investors (Asia, North America, and Europe) and their mode of entry to the Japanese market (greenfield, joint venture, and M&A). By decomposing the foreign firms into various types of FDI activities, I can investigate whether foreign firms produce varying effects on industrial efficiency not only across sector linkages over space, but also across the nationalities of foreign investors and their entry modes. A standard approach is to adopt various empirical models in terms of the choice of explanatory variables and arrive at the selected models that are implicitly assumed to generate the data correctly for interpreting an effect of foreign firms. However, uncertainty issues in selection steps of appropriate models receive little attention, and model selection is a challenging task when we investigate a wide variety of channels through which foreign firms affect productivity. In this respect, the BMA is an appropriate approach for interpreting the magnitude and robustness of each variable.

Summarizing the main results, I find that the presence of foreign firms in similar sectors and in the same prefecture is positively associated with industrial productivity across prefectures. This result suggests that the presence of foreign firms may contribute to industrial efficiency directly through their above-average productivity and indirectly through their positive spillovers to other firms. The presence of foreign firms with strong backward linkages in the same prefecture is positively correlated with industrial productivity, implying that other firms in the same prefecture may benefit from positive spillovers through these backward linkages. However, the presence of foreign firms with strong forward linkages is negatively correlated with industrial productivity. Additionally, I find that the impacts of foreign firms on industrial

[2] My data coverage is more detailed than prior studies using aggregate data. Bitzer and Görg (2009) and Fillat and Woerz (2011) use panel data at the industry and country levels. While Zhao and Zhang (2010) use industry-level panel data in China, Bode et al. (2012) use state-level panel data in the U.S.

productivity depend not only on specific linkages with domestic industry but also on the nationality and entry mode of foreign investors. Taken together, my analysis highlights the complex linkages through which foreign firms affect industrial productivity. Because aggregating the foreign presence may mask the distinctive impacts of foreign firms, it is important to disentangle the various linkages of foreign firms with domestic industry and to take into account model uncertainty.

The rest of this paper is organized as follows. Section 2 presents an empirical framework and a BMA method. Section 3 describes data sources and summarizes the main characteristics of foreign firms' activities in Japan. Section 4 presents the estimation results, followed by the results that decompose foreign presence into different investors' nationalities and entry modes to the Japanese market. Section 5 concludes.

2. Empirical Framework

2.1. Empirical Specification

To estimate the impact of foreign firms on industrial productivity, I use the log-linearized form of a Cobb-Douglas production function for sector *j*, region *r*, and time *t*:

$$\ln Y_{jrt} = \delta F'_{jr,t-1} + \beta_K \ln K_{jrt} + \beta_H \ln H_{jrt} + \beta_{HK} HK_{jrt} + f_j + f_r + f_{jt} + f_{rt} + f_t + \varepsilon_{jrt} \quad (1)$$

where $\ln Y$, $\ln K$, and $\ln H$ are the natural logarithms of value added, capital stock, and working hours, respectively. HK is an index of labor quality. These variables vary by sector *j*, region *r* and year *t*. f_j and f_r are unobserved time-invariant fixed effects specific to sector *j* and region *r*, respectively. f_{jt} and f_{rt} are time-varying effects specific to sector *j* and region *r*, respectively. f_t is an aggregate year effect. Finally, ε is an error term.

A vector of variables, $F_{jr,t-1}$, is intended to capture the various effects of foreign firms on value added in sector *j* and region *r* for year *t* after controlling for capital and labor inputs. For a benchmark specification, I consider the following variables to represent possible channels through which the presence of foreign firms would affect industrial productivity. First, a local intra-industry effect is captured by a share of foreign firms' employment in total employment in sector *j* and region *r*, denoted by $FP_{jr,t-1}$. Second, a local backward-linkage effect is represented by:

$$\text{Backward}_{jr,t-1} \equiv \sum_{\delta \neq j} \frac{M_{j\delta,t-1}}{\sum_\delta M_{j\delta,t-1}} \left(\sum_f \frac{FPC_{f\delta,t-1} - FIM_{f\delta,t-1}}{FPC_{f\delta,t-1}} \cdot \frac{FPC_{f\delta,t-1}}{\sum_f FPC_{f\delta,t-1}} \right) FP_{\delta r,t-1}$$

where $M_{j\delta,t-1}$ is an intermediate input of sector δ from sector *j*, which excludes imported inputs and products for final consumption. These data are taken from input-output (IO) tables in the host economy. The second term is an industry-level average of local purchase ratios of foreign firms, which are weighted by the volume of their purchases. $FPC_{f\delta,t-1}$ and $FIM_{f\delta,t-1}$, are the purchase and import of foreign firm *f* in sector δ, respectively. The last term is the presence of foreign firms in sector δ and region *r*. This measure increases with a greater proportion of intermediate input supplied from sector j to sector δ and the larger local purchases and presence of foreign firms in downstream sector.

Third, a local forward-linkage effect is denoted by:

$$\text{Forward}_{jr,t-1} \equiv \sum_{\delta \neq j} \frac{M_{\delta j,t-1}}{\sum_{\delta} M_{\delta j,t-1}} \left(\sum_{f} \frac{FSL_{f\delta,t-1} - FEX_{f\delta,t-1}}{FSL_{f\delta,t-1}} \cdot \frac{FSL_{f\delta,t-1}}{\sum_{f} FSL_{f\delta,t-1}} \right) FP_{\delta r,t-1}$$

where $M_{\delta j,t-1}$ is an intermediate input of sector *j* from sector δ, which also excludes imported inputs and products for final consumption. The second term is an industry-level average of local sales ratios of foreign firms, with a weight of firm-level sales. $FSL_{f\delta,t-1}$ and $FEX_{f\delta,t-1}$ are the sales and export of foreign firm *f* in sector δ, respectively. This measure increases with a greater proportion of intermediate input supplied from sector δ to sector *j* and the larger local sales and presence of foreign firms in upstream sector. It should be emphasized that previous studies tend to measure backward and forward linkages by IO coefficients in IO tables and do not necessarily exclude imported inputs and foreign firms' trade.[3] By contrast, I explicitly address these measurement issues to calculate vertical linkages.

In addition to the above measures of local within- and between-industry linkages, I also consider spatial measures of these linkages. Prior studies such as Barrios *et al.* (2006), Girma and Wakelin (2007), and Halpern and Muraközy (2007) examine whether local firms tend to benefit more from foreign firms in nearby regions than in distant regions. While these studies point to localized spillover effects, foreign firms in nearby and distant regions may have different influences. To distinguish the spatial impacts, I construct the distance-weighted measures for region j and s. Specifically, a spatial intra-industry effect is captured by $\sum_{s \neq r} FP_{js,t-1}/D_{rs}$, where *D* denotes the geographic distance between regions *r* and *s*. A spatial backward-linkage effect is represented by $\sum_{s \neq r} Backward_{js,t-1}/D_{rs}$. A spatial forward-linkage effect is represented by $\sum_{s \neq r} Forward_{js,t-1}/D_{rs}$. In total, I construct six proxy variables in the benchmark specification to estimate the impact of foreign firms on industrial productivity. More intuitively, local and spatial within-industry linkages are measured by a share of foreign firms' employment in the same region and in all other regions, respectively. Local and spatial between-industry linkages are measured by the economy-wide linkages of sectors that are weighted with foreign firms' employment in the same region and in all other regions, respectively.

We turn to discuss how these benchmark variables affect industrial productivity.[4] First, a local within-industry linkage captures a direct compositional effect of foreign firms on industry-level efficiency, as is emphasized by Bitzer and Görg (2009). If foreign firms are more

[3] See Barrios *et al.* (2011) for measurement issues of vertical linkages.
[4] Refer to a comprehensive review such as Görg and Greenaway (2004) and Smeets (2008).

productive than domestic firms, the entry and expansion of foreign firms with above-average productivity should increase industrial productivity. On the other hand, if foreign firms are less productive than domestic firms for reasons such as start-ups and/or inappropriate adoption of foreign technology/products, the exit and contraction of foreign firms with below-average productivity would increase industry-level productivity. However, industrial productivity should decrease from the entry and expansion of foreign firms with below-average productivity and the exit and contraction of foreign firms with above-average productivity. In addition to the direct effect, domestic firms may benefit from foreign firms in similar industries through demonstration and imitation effects of their superior production technology and management know-how. Local and spatial within-industry linkages also capture these spillover effects of foreign presence in the same and other regions, respectively. Finally, foreign firms have an indirect effect on the productivity of domestic firms through inter-industry spillovers. In the case of local and spatial backward linkages, domestic firms supply intermediate inputs for foreign firms, which in turn provide technical and managerial advice for local suppliers to improve the quality of the purchased inputs. On the other hand, local and spatial forward linkages suggest that domestic firms may purchase intermediate inputs from foreign firms, which contribute to improve the quality of their products. Through buyer-supplier transactions, domestic firms benefit from the presence of foreign firms in the same and other regions.

Prior research on FDI effects suggests that the impact of foreign firms may also depend on their characteristics. First, the impact of foreign firms depends on the nationality of foreign investors, as shown in previous studies such as Javorcik and Spatareanu (2011), Lin et al. (2009), and Xu and Sheng (2012). Foreign investors come from home countries with different characteristics including technological level, transport costs, and wage costs. As the investment motives of foreign firms differ by parent country, their economic activity may have varying impacts on the host economy across different nationalities. Because the measure of foreign firms, $FP_{jr,t-1}$, masks differences across foreign firms' nationalities, I decompose the variable $FP_{jr,t-1}$ by major investor regions: Asia, North America, and Europe. Thus, $FP_{jr,t-1}^{AS}$, $FP_{jr,t-1}^{NA}$, and $FP_{jr,t-1}^{EU}$ are defined as the shares of employees by foreign firms from Asia, North America, and Europe, respectively, in total employment in sector j and region r. Constructing six benchmark variables of foreign firms' linkages for Asia, North America, and Europe, I have 18 proxy variables to be used as a set of explanatory variables for estimating the impact of foreign firms by the origin of investors.

Second, the effect of foreign firms on industrial productivity depends on the entry mode of foreign firms. Foreign firms face at least three modes of entry to a foreign market through direct investment: greenfield, joint venture, and merger & acquisition (M&A). Greenfield and joint-venture investments are made to establish new production/distribution facilities, which differ by the degree of foreign ownership. On the other hand, M&A investment changes corporate ownership and control over existing facilities by domestic firms. As shown in previous research such as Balsvik and Haller (2010), Javorcik and Spatareanu (2008), and Wang and Wong (2009), the entry mode is likely to yield different implications for the market structure, thereby possibly leading to varying impacts of foreign firms. Therefore, I decompose the variable $FP_{jr,t-1}$ by the entry mode of foreign firms; $FP^{GR}_{jr,t-1}$, $FP^{JV}_{jr,t-1}$, and $FP^{MA}_{jr,t-1}$ are defined as the shares of employees by foreign firms making greenfield, joint venture, and M&A investments, respectively, in total employment in sector *j* and region *r*. Constructing six benchmark variables of foreign firms' linkages for greenfield, joint venture, and M&A, I have 18 proxy variables to be used for estimating the impact of foreign firms by entry mode.

2.2. Estimation Method

The discussions up to this point suggest a wide range of potential channels through which the presence of foreign firms influences industrial productivity. A challenging task is to select which explanatory variables are included in the model and to interpret the statistically important variables based on the uncertain selection processes of appropriate models. This paper adopts a BMA approach to deal with model selection issues. Because the BMA is widely known, I briefly discuss its application to my empirical model.[5]

Following Magnus et al. (2010), I express equation (1) in the following form:

$$\mathbf{y} = \boldsymbol{X}_1\boldsymbol{\beta}_1 + \boldsymbol{X}_2\boldsymbol{\beta}_2 + \boldsymbol{u} \tag{2}$$

where $\mathbf{y}$ is an $n \times 1$ vector of observations on industrial value added. $\boldsymbol{X}_1$ is an $n \times k_1$ matrix of observations on explanatory variables that must belong to the productivity function model, which are called 'focus' regressors. These include production factors and a variety of unobserved effects: $\ln K$, $\ln H$, HK, f_j, f_r, f_{jt}, f_{rt}, and f_t. $\boldsymbol{X}_2$ is an $n \times k_2$ matrix of observations on additional explanatory variables that may or may not belong to the model, which are called 'auxiliary' regressors. In my specification, these correspond to a wide range of potential linkages between foreign firms and industrial value added: $F_{jr,t-1}$. $\boldsymbol{\beta}_1$ and $\boldsymbol{\beta}_2$ are the corresponding vectors of unknown parameters and $\boldsymbol{u}$ is an $n \times 1$ vector of error terms: $\boldsymbol{u} \sim N(0, \sigma^2)$. Because it is not clear *ex ante* whether and how foreign firms influence industrial productivity, model uncertainty arises regarding the choice of explanatory variables k_{2i} in $\boldsymbol{X}_2$ for *i*th model denoted by M_i. Thus, equation (2) is expressed for each model *i* = 1 ,…, *I* :

$$\mathbf{y} = \boldsymbol{X}_1\boldsymbol{\beta}_1 + \boldsymbol{X}_{2i}\boldsymbol{\beta}_{2i} + \boldsymbol{e}_i \tag{3}$$

where $\boldsymbol{X}_{2i}$ is an $n \times k_{2i}$ matrix of observations on the included explanatory variables and $\boldsymbol{\beta}_{2i}$

[5] For introductory explanations of the BMA method, see Hoeting et al. (1999), Koop (2003, chap. 11), and Raftery (1995). Moral-Benito (2013) provides a literature review of model averaging in economics.

is the corresponding vector of unknown parameters. $\boldsymbol{e}_i$ is an $n \times 1$ vector of corresponding error terms. The number of alternative models under consideration is $I = 2^{k_2}$.

Model-averaging estimation proceeds by first estimating parameters conditional upon a selected model M_i over model space and then computing the unconditional estimate from a weighted average of conditional estimates in each selected model. In the BMA estimator, the weights are measured by posterior model probabilities, with the larger posterior model probabilities indicating that the corresponding models fit better with the data. To judge the robustness of the explanatory variables under consideration, posterior inclusion probability is computed for each variable, which is the sum of the posterior model probabilities of all models that include a corresponding variable. Also, the posterior distributions of coefficients of all models are computed to obtain their posterior mean and posterior standard deviation. To interpret the significance of explanatory variables, I follow the suggestion of Raftery (1995) that the variable should be effective if it has the posterior inclusion probability of more than 50%. Alternatively, the variable is considered to be effective if the coefficient has a t ratio of more than one in absolute value, implying that one standard-error band of the corresponding coefficient does not contain zero (Masanjala and Papageorgiou, 2008).[6]

It should be emphasized that the BMA method enables me to address the model uncertainty of the regression model with exogenous explanatory variables after accounting for a wide variety of unobserved effects across industries, regions, and years. However, an exogenous restriction of foreign-presence variables is a strong assumption because the economic decisions of foreign firms may be influenced by domestic industrial activities. For instance, foreign firms may select to enter better performing regions and sectors. In this sense, estimation results should not be interpreted as strictly suggesting causal effects of foreign presence. It is preferred to take into account both model uncertainty and exogenous restrictions in the Bayesian framework for identification, as is proposed in the instrumental variable regression model by Koop et al. (2012). Nevertheless, an application of this approach requires a set of ideal instrumental variables to be constructed for a large number of variables on foreign firms' activities, which is beyond the scope of this paper. Therefore, I mitigate the endogeneity bias by taking a one-year lag of the variables on foreign firms.

3. Data Description

3.1. Data on Foreign Firms in Japan

This paper uses two data sources at the firm-level to construct various measures of foreign firms in Japan. First, I use the *Gaishikei Kigyou Doko Chosa* – the Survey of Trends in Business Activities of Foreign Affiliates (STBAFA) – by the Japanese Ministry of Economy, Trade, and

6 I use the STATA code provided by De Luca and Magnus (2011).

Industry (METI). The survey covers foreign-owned firms as defined by (1) a company in which more than one third of shares or holdings are owned by foreign investors, and (2) a company in which more than one third of shares or holdings are owned directly/indirectly by a domestic company in which more than one third of shares or holdings are owned by foreign investors. Moreover, a principal foreign investor has more than 10% of shares or holdings in the companies defined in (1) or (2). Given this definition of foreign firms, this paper examines the business enterprises in Japan that are substantially managed by a foreign investor. The survey provides information on the nationality of principal foreign investors and their economic activity including employment, sales, export, purchase, and import. Moreover, the survey begins to ask the entry mode of foreign firms to the Japanese market in 2002. Although I obtain a confidential firm-level dataset of the STBAFA for the period 1995-2011, I focus on the period 1995-2008 for data availability of other variables.

As pointed out by Ito and Fukao (2005), the STBAFA data have statistical problems such as a low response rate, implying that the raw dataset may underestimate the aggregate economic activity of foreign firms. To mitigate these issues, I made substantial efforts to correct various dimensions of the dataset including the firm identification number, industrial classification codes, headquarters' address, and nationality of a principal foreign investor. When constructing firm-level panel data, I further estimated missing observations on the number of regular employees by linear interpolation and extrapolation at the firm-level.[7]

Another statistical problem in the STBAFA is that the survey covers foreign firms in real estate, finance, and insurance sectors from only 2009 onward. Because these sectors are considered to attract large foreign investment, the STBAFA data are not sufficient to capture the aggregate measure of foreign firms in the years before 2009. To complement these sectors, I exploit the *Gaishikei Kigyou Soran* – the Directory of Foreign Affiliates in Japan – by Toyo Keizai Inc. The survey covers foreign-owned firms as defined by (1) a major company with capital of 50 million yen or more in which more than 49% of shares or holdings are owned by foreign investors, (2) a non-major company in which more than 20% of shares or holdings are owned by foreign investors, or (3) branches of major foreign multinational firms and financial institutions. From this dataset, I use the sample firms in real estate, finance, and insurance sectors, which include only the business enterprises in which more than one third of shares or holdings are owned by foreign investors. Missing observations on employment are estimated by linear interpolation and extrapolation. While the information on headquarters location and nationality of a principal foreign investor is available, this dataset does not include entry mode.

[7] See Tanaka (2014) for a more detailed description of the methodology and consistency with other statistics on foreign firms in Japan.

3.2. Characteristics of Foreign Firms

I proceed to describe the main characteristics of foreign firms in Japan. Table 1 shows the aggregate figures of foreign firms for the periods 1995-2008. The number of foreign firms increased rapidly from 1,617 to 3,816 between 1995 and 2007, and their employees also increased from 254 thousands to 629 thousands. However, the global financial crisis occurred in 2008, halting the growing trend in foreign firms' activity. Furthermore, as described in Tanaka (2014) based on the same dataset, the presence of foreign firms differs remarkably by industry, nationality, and headquarters location. In terms of employment size, foreign firms were largest in wholesale/retail, chemical, and electric machinery sectors for 1995.[8] In the 2000s, foreign firms increased in service sectors such as financial and insurance services. The large shares in the wholesale and retail sectors imply that market-seeking motives are crucial for foreign investors in Japan. The major nationalities of foreign investors include the OECD countries such as the U.S., Germany, France, and the U.K. In particular, the U.S. is the most prominent; the employment of firms with U.S. investors increased from 156 thousand to 311 thousand between 1995 and 2007. In recent years, there was an increase in foreign investment from East Asian economies such as Korea, Taiwan, China, and Hong Kong. Finally, Tokyo is the major location for headquarters of foreign firms. The number of foreign firms headquartered in Tokyo increased from 1,176 to 2,711 between 1995 and 2007.

---Table 1---

These patterns are generally consistent with the description of inward FDI in Japan from prior works such as Ito and Fukao (2005) and Paprzycki and Fukao (2008). However, there has been little investigation of the entry modes of foreign firms in prior work. To fill this gap, I use the STBAFA to describe the employment of foreign firms across entry modes for the period 2002-2008 in Table 2.[9] In this period, greenfield entry explained around one third of foreign firms' employment whereas the share of employment by joint-venture mode accounted for around 20%. Although the share of employment by M&A mode declined over time, around 30% of employment belonged to the foreign firms making M&A investment.[10] These results suggest that the presence of foreign firms differs significantly according to their entry modes. Among others, there has been relatively large employment by the foreign firms establishing their own local subsidiary and choosing M&A investment to enter the Japanese market. Taken together, there is a growing presence of foreign firms with various characteristics in their location,

[8] Appendix Table A shows the industry classification employed in this paper.

[9] Foreign firms entering the market before 2002 are assigned to each entry mode based on their survey response after 2002. Note that the sample does not include foreign firms in financial sectors.

[10] In terms of the number of firms, greenfield investment accounted for around 60% of foreign firms while joint-venture investment explained around 20% of foreign firms. Thus, only around 10% of foreign firms made M&A investment.

industry, nationality, and entry mode. These features provide a motivation for investigating their impacts on industrial productivity.

---Table 2---

3.3. Other Data Sources

Data on value added, capital stock, working hours, and quality of labor are taken from the Regional-level Japan Industrial Productivity Database provided by the Research Institute of Economy, Trade, and Industry (RIETI), Japan (Tokui et al., 2013). The database includes a variety of economic indicators used to estimate productivity across 23 sectors and 47 prefectures for the period 1970-2008. Value added and capital stock are measured in millions of yen at a year 2000 constant price. Working hours are calculated by the number of workers multiplied by annual working hours per worker divided by 1000. The index of labor quality is defined to take on unity in the year 2000 for all prefectures and industries. Additionally, the Japan Industrial Productivity Database by the RIETI provides data on annual IO tables at the country level. Finally, data on the geographic distance come from the Japanese Geographical Survey Institute.

4. Estimation Results

4.1. Main Results

Table 3 provides the summary statistics of the sample used. To gauge the relative importance of foreign firms in domestic industries, the local intra-industry share of foreign firms' employment is on average 0.52%, with the standard deviation of 4.4%. These figures imply that foreign firms do not have substantial presence in the Japanese economy on average, but there is a large degree of variation in the presence of foreign firms across sectors and regions. A variation in foreign firms across sectors and regions is exploited to examine whether industrial productivity increases with the presence of foreign firms.

---Table 3---

Table 4 presents the estimation results of equation (1) by the ordinary least squares (OLS) and BMA methods. I discuss the OLS result in column (1) as a benchmark in which model uncertainty is not explicitly considered. The OLS result shows the statistically significant coefficients for the foreign-firm variables except for the spatial intra-industry variable. Consistent with the standard production function, capital stock and working hours have significantly positive coefficients whereas labor quality has an insignificant coefficient. The BMA result in column (2) shows that the local intra-industry variable has the posterior mean of 0.25, with the one standard-error band located outside zero. As its posterior inclusion probability (PIP) is 0.90, it is strongly effective in the specification according to the criteria in

Raftery (1995). To gauge the economic magnitude, a one-standard-deviation increase in the local intra-industry linkage leads to a 1.10% increase in industrial value added at the prefecture level.[11] By contrast, the spatial intra-industry linkage shows that its one standard-error band includes zero, with PIP of 0.12. Consistent with the OLS result, the intra-industry linkage of foreign firms in other regions has little effect on industrial value added.

---Table 4---

The local backward linkage variable has the posterior mean of 2.69, with the one standard-error band outside zero and PIP of 1.00. Consistent with the OLS result, this variable is strongly effective. In terms of the economic magnitude, a one-standard-deviation increase in the local backward linkage is associated with a 2.45% increase in industrial value added. On the other hand, the one standard-error band includes zero for the spatial backward linkage variable, with a PIP of 0.36. While the OLS result shows a significantly negative coefficient, the BMA result indicates that the spatial backward linkage has little effect. Such a difference in the estimation results highlights that model uncertainty should be explicitly addressed when making a judgment on the statistically important variables. It also suggests that the linkages of foreign presence should be disentangled across industries over space. Aggregating the foreign presence across industries or across regions may mask the distinctive impacts of foreign firms. Additionally, I find that the one standard-error bands do not include zero for both local and spatial forward linkage variables. Their PIPs are 1.00, implying that these variables are strongly effective. The BMA result suggests that a one-standard-deviation increase in the local and spatial forward linkages leads to a 3.85% and 5.36% decrease in the industrial value added, respectively. Thus, the backward linkage effect is positive, but the forward linkage effect is negative. These results are consistent with the findings in Javorcik (2004) for the case of Lithuanian manufacturing sectors.[12]

Summarizing the main results, I find that the presence of foreign firms in similar sectors and the same prefecture is positively associated with industrial productivity at the prefecture-level. This result suggests that the presence of foreign firms may contribute to industrial efficiency directly through their above-average productivity and indirectly through their positive intra-industry spillovers to other firms in the same prefecture. Also, the presence of foreign firms with strong backward linkages in the same prefecture is positively correlated with industrial productivity, implying that other firms in the same prefecture may benefit from positive spillovers through the backward linkages. This result is consistent with the prior

[11] The predicted percentage change in value added is $100[exp(0.25 \times 0.044) - 1]$. The following computation is based on an estimated coefficient and standard deviation of corresponding variables.

[12] Negative forward linkage effects are interpreted as suggesting that foreign investors start to manufacture more sophisticated products in a host market and domestic firms are forced to incur the higher cost of inappropriate products in terms of their absorptive capacity.

findings on significant positive spillovers to suppliers in developed and developing economies (Havránek and Iršová, 2011). However, the backward linkages with foreign firms in distant prefectures are not correlated with industrial productivity, implying that distinguishing between local and spatial backward linkages is crucial. The presence of foreign firms with strong forward linkages negatively correlates with industrial productivity, regardless of their location in the same or other prefectures. Finally, a model-averaging method produces a result similar to that from an OLS method in terms of estimated coefficients and statistical significance. However, significant variables such as spatial backward linkages in the OLS method become ineffective in the BMA method, implying that model uncertainty should be carefully addressed when estimating the channels through which foreign firms affect productivity.

4.2. Results of the Nationality of Foreign Investors

I next examine whether foreign investors' nationality matters. Table 5 shows the estimation results in which the foreign presence is decomposed by the nationality of principal foreign investors.[13] I report the OLS result in column (1) as a benchmark and the BMA result in column (2). While the local backward and spatial forward linkages have significant coefficients in the OLS result, they are not effective in the BMA result in terms of the one standard-error bands and PIPs, suggesting that model uncertainty problem may drive the significant coefficients in the former result. Because all the variables on Asian investors show that their one standard-error bands include zero, Asian-owned foreign firms are not likely to have a significant impact on industrial productivity. In the case of North American investors, I find that the local backward linkage has the posterior mean of 4.76, with its one standard-error band located outside zero. It is strongly effective in the specification, and a one-standard-deviation increase in the local backward linkage is predicted to increase industrial value added by 2.70%. By contrast, the local and spatial forward linkages with North American investors have negative posterior means and their one standard-error bands do not include zero. Consistent with the main results, the forward linkage with North American investors is negatively associated with industrial productivity.

---Table 5---

In the case of European investors, the OLS result shows that the local intra-industry linkage has the significantly positive coefficient. The BMA result shows the posterior mean of 0.50, and its one standard-error band does not include zero. The PIP of 1.00 implies that the local intra-industry linkage is strongly effective in the specification. A one-standard-deviation increase in the local intra-industry linkage with European investors is predicted to increase industrial value added by 1.50%. On the other hand, the spatial backward linkage has a

[13] The summary statistics on foreign firms are provided in Appendix Table B.

significantly negative coefficient in the OLS result. The BMA result suggests that the posterior mean is -41.2, and its one standard-error band does not include zero, with the PIP of 0.94. Thus, the spatial backward linkage with European investors is strongly effective and negatively associated with industrial productivity. Finally, I find that the spatial forward linkage has a significantly positive coefficient in the OLS result. However, the BMA result indicates that the posterior mean is 0.40 and its PIP is 0.02, implying that this variable is not effective.

Taken together, the results in Table 5 highlight that the impact of foreign firms depends not only on specific linkages with domestic industry but also on the nationality of foreign investors. Asian investors exhibit little impact on industrial productivity whereas North American investors have an impact through backward and forward linkages. European investors show a positive impact through local intra-industry linkage, but a negative impact through spatial backward linkages. Consistent with the evidence from Romania reported by Javorcik and Spatareanu (2011), my analysis highlights that nationality heterogeneity matters. In particular, I find the same result that Asian investors do not exhibit significant spillovers. Finally, the OLS result shows significant coefficients for local backward linkage with Asian investors, spatial backward linkage with North American investors, and spatial forward linkage with European investors. However, the BMA result indicates that these variables are not effective in terms of one standard-error bands and PIPs. Compared with the main specification in Table 4, a larger number of auxiliary regressors in Table 5 appear to cause a larger influence of model uncertainty.

4.3. Results of Entry Mode

In this section, I examine whether the entry mode of foreign firms matters. Table 6 shows the estimation results in which foreign presence is decomposed by the mode of entry to the Japanese market: greenfield, joint venture, and M&A entry.[14] Note that the STBAFA began to survey the entry mode of foreign firms in 2002, and the sample used in estimation does not include the real estate, finance, and insurance sectors. As a result, the sample size is largely reduced compared to the previous estimation results.

---Table 6---

The OLS result shows a significantly positive coefficient for a spatial backward linkage with foreign firms making greenfield entry. The BMA result indicates that the posterior mean is 179.6 and one standard-error band does not include zero. The PIP of 0.63 implies that this variable is effective. A one-standard-deviation increase in the spatial backward linkage is associated with an increase in industrial value added by 1.81%. By contrast, a spatial forward linkage of greenfield entry has the posterior mean of -174.3 in the BMA result. This variable is

[14] See Appendix Table B for the summary statistics.

effective in terms of its one standard-error band and PIP. Consistent with the OLS result, industrial productivity is negatively associated with the spatial forward linkage with foreign firms entering the Japanese market by greenfield investment. Additionally, a spatial intra-industry linkage of joint-venture entry has the posterior mean of 29.3, and its one standard-error band and PIP indicate that it is effective. A one-standard-deviation increase in this variable is predicted to increase industrial value added by 2.07%. The OLS result also shows a significantly positive coefficient.

In the case of M&A entry, a local intra-industry variable has the posterior mean of 0.48 and is effective because its one standard-error band does not include zero and its PIP is 0.89. Industrial efficiency is positively correlated with the presence of foreign firms acquiring domestic firms in similar industries. While this result suggests positive direct and indirect effects of foreign firms on industrial productivity, an alternative explanation is that foreign firms may self-select to acquire superior domestic firms in rapidly growing industries and regions. Additionally, the BMA result shows an effectively positive posterior mean of local backward linkage, but an effectively negative posterior mean of spatial backward linkage. This contrasting result may imply that foreign firms making M&A investment may restructure a transaction relationship in sourcing intermediate inputs and shift their transactions to local suppliers away from distant suppliers for cost reduction.

These results highlight that the impact of foreign firms depends also on the entry mode of foreign investors, as is discussed in a prior study of Norwegian manufacturing firms by Balsvik and Haller (2011). Their findings suggest that M&A entry is more likely than greenfield entry to generate positive spillovers to domestic firms because M&A entry involves stronger linkages between domestic and foreign firms. My analysis extends their results by taking into account joint-venture entry together with greenfield and M&A investment. I also demonstrate that foreign firms may yield varying spillovers across sectors over space within each entry mode.

5. Conclusion

The rapid growth of foreign production by multinational firms has made it increasingly important to investigate their impact on host economies. To estimate the impact of foreign firms on industrial productivity across Japanese regions, a BMA approach was used to take into account a wide variety of channels through which foreign firms affect productivity. Exploiting detailed firm-level information, I constructed a comprehensive dataset on foreign firms across all sectors and regions in Japan, which were also broken down by the nationality of foreign investors and their mode of entry to the Japanese market. I found that foreign firms in similar sectors are positively associated with industrial productivity across prefectures, suggesting that their presence may contribute to industrial efficiency directly through their above-average productivity and indirectly through their intra-industry positive spillovers to other firms. Industrial productivity is positively associated with backward linkages with foreign firms, but negatively correlated with forward linkages with foreign firms. Furthermore, I found that the impact of foreign firms also depends on the nationality and entry mode of foreign investors.

Finally, I conclude to mention some remaining issues for future research. The impact on domestic employment is another consequence of inward FDI activity. As the employment effects attract wide policy interests, it is important to investigate whether and how foreign firms affect domestic employment. The newly constructed dataset on foreign firms in Japan can be exploited to shed light on this important issue. Additionally, there are various sources of FDI spillovers such as labor mobility, buyer-supplier transactions, and technology transfers. It is crucial to empirically investigate specific sources of FDI spillovers. Empirical evidence on foreign firms should form a basis for an objective assessment of policy instruments to attract foreign firms and thus provide reliable guidance for future policy making.

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Table 1. The Trend in Foreign Firms in Japan.

Year	Number	Employment
1995	1,617	254.4
1996	1,842	310.0
1997	2,049	336.6
1998	2,089	357.8
1999	2,313	431.8
2000	2,355	465.2
2001	2,466	484.8
2002	2,857	465.7
2003	2,978	572.6
2004	3,158	588.1
2005	3,310	580.5
2006	3,483	623.4
2007	3,816	629.9
2008	3,736	575.3

Notes: Number shows the total number of foreign firms; Employment is the total number of their employees in thousands.

Source: Author's calculation based on the Survey of Trends in Business Activities of Foreign Affiliates by METI and the Directory of Foreign Affiliates in Japan by Toyo Keizai.

Table 2. Share of Foreign Firms' Employment by Entry Mode

Year	Greenfield	Joint Venture	M&A	Other
2002	35.1	19.2	37.0	8.8
2003	36.6	18.2	35.8	9.4
2004	36.1	21.2	33.5	9.1
2005	35.7	22.2	31.4	10.7
2006	35.7	21.4	31.6	11.3
2007	36.2	24.0	28.8	11.1
2008	38.9	25.1	25.3	10.7

Notes: Figures are a percentage share of foreign firms classified by the initial mode of entry to the Japanese market; Other includes the sample firms with no information on their entry mode; foreign firms in financial sectors are not included.

Source: Author's calculation based on the Survey of Trends in Business Activities of Foreign Affiliates by METI.

Table 3. Summary Statistics

Variable	No. of Obs.	Mean	Std. Dev.
Log of real value added at year 2000 price (mil. yen)	13,382	11.579	1.791
Log of real capital stock at year 2000 price (mil. yen)	13,382	12.449	1.852
Log of total hours of working	13,382	10.115	1.883
Labor quality index: year 2000=1	13,382	1.014	0.031
Local intra-industry linkage	13,382	0.0052	0.0442
Spatial intra-industry linkage	13,382	0.0012	0.0033
Local backward linkage	13,382	0.0018	0.0091
Spatial backward linkage	13,382	0.0004	0.0007
Local forward linkage	13,382	0.0020	0.0095
Spatial forward linkage	13,382	0.0005	0.0007

Notes: The variables of linkages with foreign firms are defined as one-year lagged variables; spatial indicates a distance-weighted measure of the corresponding variable in other regions.

Table 4. Benchmark Results

Dependent: Log of Real Value Added

	(1)		(2)		
Estimation	OLS		BMA		
Variable	Coef.	Std. Err.	Posterior Mean	Posterior Std. Err.	Posterior Inclusion Probability
Local intra-industry linkage (t-1)	0.28**	(0.083)	**0.25**	(0.11)	0.90
Spatial intra-industry linkage (t-1)	2.78	(1.88)	0.38	(1.11)	0.12
Local backward linkage (t-1)	2.70**	(0.60)	**2.69**	(0.52)	1.00
Spatial backward linkage (t-1)	-21.8**	(8.02)	-8.65	(12.5)	0.36
Local forward linkage (t-1)	-3.87**	(0.68)	**-3.93**	(0.62)	1.00
Spatial forward linkage (t-1)	-41.8**	(8.96)	**-55.11**	(11.4)	1.00
Capital stock	0.50**	(0.012)	**0.51**	(0.0061)	1.00
Working hours	0.57**	(0.014)	**0.57**	(0.0085)	1.00
Labor quality	-0.31	(0.33)	-0.29	(0.37)	1.00
Sector dummy	Yes		Yes		
Sector × Year dummy	Yes		Yes		
Region dummy	Yes		Yes		
Region × Year dummy	Yes		Yes		
Year dummy	Yes		Yes		
R-squared	0.972				
No. of observations	13,382		13,382		

Notes: OLS reports robust standard errors; the posterior mean in bold indicates that the corresponding one standard-error band does not include zero.

** Significant at the 1 percent level

* Significant at the 5 percent level

+ Significant at the 10 percent level

Table 5. Results for Foreign Investors' Nationality

Dependent: Log of Real Value Added

Estimation	(1) OLS		(2) BMA		
Variable	Coef.	Std. Err.	Posterior Mean	Posterior Std. Err.	Posterior Inclusion Probability
Asian investors					
Local intra-industry linkage (t-1)	2.46	(1.62)	0.55	(1.17)	0.21
Spatial intra-industry linkage (t-1)	-5.88	(24.5)	-0.095	(2.11)	0.01
Local backward linkage (t-1)	-72.9**	(24.5)	-60.9	(38.6)	0.77
Spatial backward linkage (t-1)	-295.7	(415.6)	-1.81	(44.2)	0.01
Local forward linkage (t-1)	-5.05	(9.66)	-0.087	(1.38)	0.01
Spatial forward linkage (t-1)	204.5+	(106.2)	4.98	(38.5)	0.02
North American investors					
Local intra-industry linkage (t-1)	-0.17	(0.18)	-0.0063	(0.041)	0.03
Spatial intra-industry linkage (t-1)	6.95	(4.29)	1.04	(2.44)	0.18
Local backward linkage (t-1)	4.88**	(0.94)	**4.76**	(0.74)	1.00
Spatial backward linkage (t-1)	45.5**	(15.2)	8.84	(18.9)	0.21
Local forward linkage (t-1)	-8.44**	(1.09)	**-7.41**	(0.89)	1.00
Spatial forward linkage (t-1)	-107.0**	(17.5)	**-82.2**	(17.2)	1.00
European investors					
Local intra-industry linkage (t-1)	0.61**	(0.097)	**0.50**	(0.10)	1.00
Spatial intra-industry linkage (t-1)	-2.03	(2.51)	0.0020	(0.22)	0.01
Local backward linkage (t-1)	0.11	(0.84)	0.0032	(0.082)	0.01
Spatial backward linkage (t-1)	-64.0**	(10.2)	**-41.2**	(16.1)	0.94
Local forward linkage (t-1)	1.71	(1.32)	0.044	(0.34)	0.02
Spatial forward linkage (t-1)	33.4+	(17.2)	0.40	(4.21)	0.02
Capital stock	0.50**	(0.012)	**0.50**	(0.0061)	1.00
Working hours	0.57**	(0.014)	**0.57**	(0.0085)	1.00
Labor quality	-0.11	(0.34)	-0.14	(0.37)	1.00
Sector dummy	Yes		Yes		
Sector × Year dummy	Yes		Yes		
Region dummy	Yes		Yes		
Region × Year dummy	Yes		Yes		
Year dummy	Yes		Yes		
R-squared	0.972				
No. of observations	13,439		13,439		

Notes: OLS reports robust standard errors; the posterior mean in bold indicates that the corresponding one standard-error band does not include zero.

** Significant at the 1 percent level

* Significant at the 5 percent level

+ Significant at the 10 percent level

Table 6. Results for Entry Modes

Dependent: Log of Real Value Added

Estimation	(1) OLS		(2) BMA		
Variable	Coef.	Std. Err.	Posterior Mean	Posterior Std. Err.	Posterior Inclusion Probability
Greenfield Entry					
Local intra-industry linkage (t-1)	-0.85**	(0.32)	-0.018	(0.12)	0.03
Spatial intra-industry linkage (t-1)	10.6	(9.48)	0.41	(2.61)	0.04
Local backward linkage (t-1)	8.89	(9.84)	0.20	(1.43)	0.03
Spatial backward linkage (t-1)	391.0**	(140.0)	**179.6**	(156.0)	0.63
Local forward linkage (t-1)	-4.45+	(2.54)	-0.021	(0.30)	0.02
Spatial forward linkage (t-1)	-186.4**	(35.0)	**-174.3**	(33.3)	1.00
Joint Venture Entry					
Local intra-industry linkage (t-1)	2.05**	(0.68)	0.10	(0.37)	0.09
Spatial intra-industry linkage (t-1)	36.8**	(12.3)	**29.3**	(17.0)	0.82
Local backward linkage (t-1)	-7.13+	(4.07)	-0.073	(0.81)	0.02
Spatial backward linkage (t-1)	-266.3+	(140.5)	-11.2	(59.1)	0.05
Local forward linkage (t-1)	10.6*	(4.22)	0.088	(0.78)	0.02
Spatial forward linkage (t-1)	66.4	(92.7)	0.43	(12.1)	0.01
M&A Entry					
Local intra-industry linkage (t-1)	0.48**	(0.16)	**0.48**	(0.22)	0.89
Spatial intra-industry linkage (t-1)	-2.30	(3.23)	-0.016	(0.38)	0.02
Local backward linkage (t-1)	4.46**	(1.30)	**1.76**	(1.70)	0.57
Spatial backward linkage (t-1)	-47.4**	(14.9)	**-47.9**	(26.5)	0.83
Local forward linkage (t-1)	-5.99*	(2.75)	-0.13	(0.81)	0.04
Spatial forward linkage (t-1)	5.14	(39.2)	0.75	(7.78)	0.02
Capital stock	0.51**	(0.019)	**0.51**	(0.0091)	1.00
Working hours	0.56**	(0.022)	**0.56**	(0.013)	1.00
Labor quality	-0.57	(0.36)	-0.40	(0.42)	1.00
Sector dummy	Yes		Yes		
Sector × Year dummy	Yes		Yes		
Region dummy	Yes		Yes		
Region × Year dummy	Yes		Yes		
Year dummy	Yes		Yes		
R-squared	0.971				
No. of observations	6,161		6,161		

Notes: OLS reports robust standard errors; the posterior mean in bold indicates that the corresponding one standard-error band does not include zero.

** Significant at the 1 percent level
* Significant at the 5 percent level
+ Significant at the 10 percent level

Appendix Table A. Industry Classification

Agriculture, forestry and fisheries	Electric machinery
Mining	Transportation equipment
Food products and beverages	Precision machinery
Textiles	Other manufacturing
Pulp, paper, and paper products	Construction, civil engineering
Chemicals and chemical products	Electricity, gas and water
Petroleum and coal products	Wholesale and retail trade
Ceramic, stone and clay products	Finance and insurance
Primary metals	Real estate
Metal products	Transportation and telecommunication
General machinery	Services in private and non-profit sectors

Appendix Table B. Summary Statistics

Variable	No. of Obs.	Mean	Std. Dev.
Local intra-industry linkage: Asian investors	13,439	0.0002	0.0028
Spatial intra-industry linkage: Asian investors	13,439	0.00004	0.0002
Local backward linkage: Asian investors	13,439	0.00004	0.0002
Spatial backward linkage: Asian investors	13,439	0.00001	0.00001
Local forward linkage: Asian investors	13,439	0.0001	0.0003
Spatial forward linkage: Asian investors	13,439	0.00001	0.00003
Local intra-industry linkage: North American investors	13,439	0.0027	0.0272
Spatial intra-industry linkage: North American investors	13,439	0.0006	0.0017
Local backward linkage: North American investors	13,439	0.0010	0.0056
Spatial backward linkage: North American investors	13,439	0.0002	0.0004
Local forward linkage: North American investors	13,439	0.0011	0.0060
Spatial forward linkage: North American investors	13,439	0.0003	0.0004
Local intra-industry linkage: European investors	13,439	0.0024	0.0298
Spatial intra-industry linkage: European investors	13,439	0.0006	0.0023
Local backward linkage: European investors	13,439	0.0009	0.0063
Spatial backward linkage: European investors	13,439	0.0002	0.0005
Local forward linkage: European investors	13,439	0.0008	0.0046
Spatial forward linkage: European investors	13,439	0.0002	0.0003
Local intra-industry linkage: Greenfield entry	6,161	0.0015	0.0138
Spatial intra-industry linkage: Greenfield entry	6,161	0.0003	0.0011
Local backward linkage: Greenfield entry	6,161	0.0004	0.0017
Spatial backward linkage: Greenfield entry	6,161	0.0001	0.0001
Local forward linkage: Greenfield entry	6,161	0.0007	0.0034
Spatial forward linkage: Greenfield entry	6,161	0.0002	0.0002
Local intra-industry linkage: Joint-venture entry	6,161	0.0012	0.0095
Spatial intra-industry linkage: Joint-venture entry	6,161	0.0003	0.0007
Local backward linkage: Joint-venture entry	6,161	0.0004	0.0016
Spatial backward linkage: Joint-venture entry	6,161	0.0001	0.0001
Local forward linkage: Joint-venture entry	6,161	0.0004	0.0018
Spatial forward linkage: Joint-venture entry	6,161	0.0001	0.0001
Local intra-industry linkage: M&A entry	6,161	0.0024	0.0332
Spatial intra-industry linkage: M&A entry	6,161	0.0005	0.0024
Local backward linkage: M&A entry	6,161	0.0012	0.0068
Spatial backward linkage: M&A entry	6,161	0.0003	0.0005
Local forward linkage: M&A entry	6,161	0.0005	0.0031
Spatial forward linkage: M&A entry	6,161	0.0001	0.0002