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TANAKA Kiyoyasu
Institute of Developing Economies, JETRO

RIETI
Research Institute of Economy, Trade & Industry, IAA

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The Impact of Foreign Firms on Industrial Productivity: A Bayesian-model averaging approach[ζ]

TANAKA Kiyoyasu[§]
(Institute of Developing Economies, JETRO)

Abstract

Inward foreign direct investment affects industrial productivity in a host country through a wide range of channels as the presence of foreign firms is heterogeneous across industries, regions, and their characteristics such as entry mode and nationality. Because a wide variety of potential variables pose serious model uncertainty, I adopt a Bayesian-model averaging (BMA) approach to estimate the impact of foreign firms on industry- and prefecture-level productivity in Japan. I find that the foreign presence may contribute to industrial efficiency directly through their above-average productivity and indirectly through positive spillovers in intra-industry and local backward linkages. These positive impacts are likely to occur as a result of the foreign firms being owned by North American and European investors and the foreign firms making joint venture and merger and acquisition (M&A) investments to enter the Japanese market. By contrast, the foreign presence in distant downstream sectors and local upstream sectors may have negative impacts.

***Keywords*:** Bayes, FDI, Foreign firm, Industrial productivity, Japan
***JEL Classification*:** C11, F21, F23, F61

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[§] Institute of Developing Economies, JETRO; address: 3-2-2 Wakaba, Mihama-ku, Chiba-shi, Chiba 261-8545, Japan; e-mail: kiyoyasu_tanaka@ide.go.jp

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, which subsequently yield positive externalities to domestic firms. Despite a concern over crowding-out effects of FDI on domestic industries, the presence of foreign firms is expected to generate productivity gains for a host economy. Accordingly, there have been a large number of empirical studies on the role of foreign firms in the host economy. In particular, FDI spillovers to the domestic firms have attracted large attention and the prior evidence is widely reviewed (Crespo and Fontoura, 2007; Havránek and Iršová, 2011; Iršová and Havránek, 2013; Wooster and Diebel, 2010).

However, the empirical magnitude of FDI spillovers on domestic industries varies widely by prior studies, suggesting that the empirical evidence is not necessarily conclusive about the precise effects of foreign firms. A possible reason for the mixed evidence is that previous studies adopt a variety of empirical models in terms of the choice of explanatory variables; for instance, there is a wide difference in the measurement of foreign firms' activity, their linkages with domestic industry, and the choice of control variables. Then, researchers arrive at the selected models that are implicitly assumed to generate the data correctly and interpret an effect of foreign firms based on the results of the chosen models. Although prior works follow this approach as a standard practice, they do not systematically address uncertainty issues in selection steps of appropriate models. In other words, reported regressions include only a modest subset of different combinations of explanatory variables on foreign firms' activities.

In this paper, I adopt a Bayesian-model averaging (BMA) approach to estimate an impact of foreign firms on industrial productivity at the regional-level. This approach allows me to take into account both model uncertainty and parameter heterogeneity in a coherent framework. Motivated by the prior literature, I consider potentially varying effects of foreign firms on industrial efficiency across sectoral linkages and over space. Moreover, I decompose the presence of foreign firms by the nationality of foreign investors (Asia, North America, and Europe) and the mode of entry to a foreign market (greenfield, joint venture, and merger & acquisition). Although these measures enable me to examine a wide variety of channels through which foreign firms affect productivity, model selection becomes a challenging task for model uncertainty. In this respect, the BMA is an appropriate approach to interpret the magnitude and robustness of each variable.

Because the appropriate measurement of foreign firms' activity is important for an empirical

investigation, I exploit a series of firm-level surveys to construct a unique dataset on foreign firms in Japan. A main data source is the *Gaishikei Kigyou Doko Chosa* – the Survey of Trends in Business Activities of Foreign Affiliates (STBAFA) – by the Japanese Ministry of Economy, Trade, and Industry. 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.[1] This measure is more appropriate than FDI stocks/flows to capture actual production activity because FDI stocks/flows are seriously affected by financial transactions for non-production purposes such as reducing tax burdens (Lipsey, 2007). Additionally, the firm-level surveys provide precise information on the nationality of foreign investors and their entry mode to the Japanese market. Using such information, I can decompose the presence of foreign firms into various types of FDI activity.

To summarize the main results, I find that foreign firms in similar sectors and local downstream sectors are positively associated with industrial productivity across prefectures. This implies 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 domestic upstream industries in the same region. Moreover, industrial efficiency is positively correlated with the presence of foreign firms owned by North American and European investors in similar sectors and with the presence of foreign firms in similar sectors which enter the Japanese market through joint-venture and M&A investments. By contrast, the foreign presence in distant downstream sectors and local upstream sectors are negatively correlated with industry-level productivity across prefectures. In particular, I find the negative impacts of the foreign firms by North American investors in distant downstream sectors and local upstream sectors. This result points to potentially negative spillover effects of foreign firms on domestic industries through the other linkages. 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 for a regression model and a Bayesian-model averaging 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

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

different investors' nationalities and entry modes to the Japanese market. Section 5 concludes.

2. Empirical Framework

2.1. Empirical Specification

I start to discuss potential channels through which foreign firms affect industrial productivity. First, there is a direct compositional effect of foreign firms on industry-level efficiency, as is emphasized by Bitzer and Görg (2009). If foreign firms are more productive than domestic firms, the entry and expansion of above-average productive foreign firms should increase industrial productivity. On the other hand, if foreign firms are less productive than domestic firms for some reasons such as start-ups and inappropriate adoption of foreign technology/products, the exit and contraction of below-average productive foreign firms would increase industry-level productivity. However, industrial productivity should decrease from the entry and expansion of below-average productive foreign firms and the exit and contraction of above-average productive foreign firms.

There is an indirect effect of foreign firms on the productivity of domestic firms through various channels, which consequently affect industrial productivity. While a comprehensive review should be referred to prior work such as Görg and Greenaway (2004) and Smeets (2008), the literature has highlighted intra- and inter-industry spillovers. For instance, skilled workers receiving investment in their training at a foreign firm may move to work for a local firm, and bring it with a tacit form of superior management and production technology embodied in them. Labor mobility between foreign and domestic firms can improve the productivity of domestic firms. Moreover, 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. Domestic firms may also purchase intermediate inputs from foreign firms, which contribute to improve the quality of their products. Through buyer-supplier transactions, domestic firms may benefit from the presence of foreign firms. Finally, foreign firms affect market competition faced by domestic firms in similar sectors. Domestic firms can benefit from pro-competitive effects and/or suffer from crowding-out effects. In sum, there is a wide range of channels through which foreign firms affect industry-level efficiency.

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

$$\ln Y_{jrt} = \sum_k \beta_k FF^k_{jrt} + \beta_K \ln K_{jrt} + \beta_H \ln H_{jrt} + \beta_{HK} HK_{jrt} + \gamma Z_{jrt} + f_j + f_r + f_t + \varepsilon_{jrt} \quad (1)$$

where $\ln Y$, $\ln K$, and $\ln H$ are the natural logarithms of value added, capital stock, and working hours. HK is an index of labor quality. These variables vary by sector *j*, region *r* and year *t*.[2] Z is a set of control variables including the natural logarithms of intangible asset in

[2] As the assumption on homogeneous parameters for input variables across industries and/or

sector *j* for year *t* and per capita income in region *r* for year *t*. Additionally, f_j, f_r, and f_t are unobserved time-invariant fixed effects specific to sector *j*, region *r*, and year *t*, respectively.

A set of variables, FF^k, 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. As a benchmark, 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* for year *t*, denoted by FP_{jrt}. Second, a local backward-linkage effect is represented by:

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

where $M_{j\delta t}$ 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 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. $FPC_{f\delta t}$ and $FIM_{f\delta t}$, are the purchase and import of foreign firm *f* in sector δ for year *t*, respectively. The last term is the presence of foreign firms in sector δ and region *r* for year *t*. In sum, this measure increases with the 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 δ.

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

$$\text{Forward}_{jrt} \equiv \sum_{\delta \neq j} \frac{M_{\delta jt}}{\sum_{\delta} M_{\delta jt}} \left(\sum_f \frac{FSL_{f\delta t} - FEX_{f\delta t}}{FSL_{f\delta t}} \cdot \frac{FSL_{f\delta t}}{\sum_f FSL_{f\delta t}} \right) FP_{\delta rt}$$

where $M_{\delta jt}$ 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. $FSL_{f\delta t}$ and $FEX_{f\delta t}$ are the sales and export of foreign firm *f* in sector δ for year *t*, respectively. This measure increases with the 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 input-output (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

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prefectures may be strong, an alternative approach is to estimate the production function separately for each industry and/or prefectures. However, this approach suffers from an endogeneity issue, making it difficult to obtain unbiased estimates for these parameters. Additionally, an index approach avoids parameter estimation but assumes no measurement error of input variables, which should be violated in my industry-level dataset.

[3] See Barrios *et al.*, (2011) for measurement issues of vertical linkages.

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 locations than those in distant locations. While these studies point to regional spillover effects, foreign firms in nearby and distant locations 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 $\sum_{s\neq r} FP_{jst}/D_{rs}$, where *D* denotes the geographic distance between regions *r* and *s*. A spatial backward-linkage effect is $\sum_{s\neq r} Backward_{jst}/D_{rs}$. Finally, a spatial forward-linkage effect is represented by $\sum_{s\neq r} Forward_{jst}/D_{rs}$.

In sum, I construct 6 indicators to estimate the impact of foreign firms on industrial productivity. While these indicators serve as a benchmark set of key variables, prior research on FDI effects further suggests additional channels on the impact of foreign firms. First, the impact of foreign firms may depend 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 various home countries with different characteristics including technological level, transport costs, and wage costs. As 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_{jrt}, mask differences across foreign firms' nationalities, I decompose the variable FP_{jrt} by major investor regions: Asia, North America, and Europe. Thus, FP_{jrt}^{AS}, FP_{jrt}^{NA}, and FP_{jrt}^{EU} are defined as a share of employees by foreign firms from Asia, North America, and Europe, respectively in total employment in sector *j* and region *r* for year *t*. Constructing 6 indicators for each variable, I obtain 18 variables to estimate the impact of foreign firms by the origin of investors.

Second, the effect of foreign presence on industrial productivity may depend 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 yielding varying impacts of foreign firms. Therefore, I decompose the variable FP_{jrt} by the entry mode of foreign firms; FP_{jrt}^{GR}, FP_{jrt}^{JV}, and FP_{jrt}^{MA} are defined as a share of employees by foreign firms making greenfield, joint venture, and M&A investments, respectively in total employment in sector *j* and region *r* for year *t*. Constructing 6 indicators for each variable, I obtain 18 variables to estimate the impact of foreign firms by their entry mode.

2.2. Bayesian Model Averaging

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 uncertain selection processes of appropriate models. While the prior literature has not addressed explicitly the issue of model uncertainty, this paper adopts a Bayesian-model averaging (BMA) approach to deal with model selection issues. Because the BMA is widely known, I provide a brief summary in my specification.[4]

Following Magnus et al. (2010), I can re-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, $\boldsymbol{X}_2$ is an $n\times k_2$ matrix of observations on explanatory variables to represent various linkages between foreign firms and industrial value added. $\boldsymbol{\beta}_1$ and $\boldsymbol{\beta}_2$ are the corresponding vectors of unknown parameters and $\boldsymbol{u}$ is an $n\times 1$ vector of error terms. 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. Therefore, equation (2) can be expressed for each model $i = 1, \ldots, I$:

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

where $\boldsymbol{X}_{2i}$ is an $n\times k_{2i}$ matrix of observations on the included explanatory variables and $\boldsymbol{\beta}_{2i}$ 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 the 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 the better fit of corresponding models with the data. To judge the robustness of explanatory variables under consideration, posterior inclusion probability is computed for each variable: the sum of the posterior model probabilities of all models that include a corresponding variable. Under the conventional prior distributions as adopted by Magnus et al. (2010), the posterior distributions of coefficients of all models are computed to obtain their posterior mean and posterior standard deviation. To interpret the significance of

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

explanatory variables, I follow the suggestions in 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). Finally, this paper uses the BMA package in STATA provided by De Luca and Magnus (2011).

It should be emphasized that the above BMA method enables me to address model uncertainty of the regression model with exogenous explanatory variables after accounting for a wide variety of unobserved fixed effects across industries, regions, and years. However, an exogenous restriction of foreign-presence variables is a strong assumption because economic decisions of foreign firms may be influenced by domestic industrial activities. Estimation results should be interpreted carefully as not suggesting causal effects of foreign presence. It is preferred to take into account both model uncertainty and exogenous restrictions in the Bayesian framework, as is recently proposed in the instrumental variable regression model by Koop et al. (2012). Nevertheless, an application of this approach also causes a challenging task to construct a set of ideal instrumental variables for a large number of endogenous variables on foreign firms' activities, which is beyond the scope of this paper.

3. Data Description

3.1. Data on Foreign Firms

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 Industry (METI). The survey covers the foreign-owned firms as defined by (1) a company in which more than one third of shares or holdings are owned by foreign investors, (2) a company in which more than one third of shares or holdings are owned directly/indirectly by the domestic company in which more than one third of shares or holdings are owned by foreign investors, and (3) the companies defined in (1) or (2) above, in which a direct investment ratio of a principal foreign investor is more than 10%. Given this definition of foreign firms, this paper looks at the business enterprises in Japan that are substantially managed by the foreign investor. The survey provides information on economic activity of foreign firms including employment, sales, export, purchase, and import. Moreover, the survey asks an entry mode of foreign firms to the Japanese market after year 2002.

I obtain a confidential firm-level dataset of the STBAFA during the period 1995-2011 from the Research Institute of Economy, Trade, and Industry (RIETI).[5] As pointed out by Ito and

[5] For data availability of other variables, I focus on the period 1995-2008.

Fukao (2005), the STBAFA data suffer from 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 make substantial efforts to correct various dimensions of the dataset including the firm identification number, industrial classification codes, headquarters' address, nationality of a principal foreign investor, and so on. Constructing firm-level panel data, I further estimate missing observations on the number of regular employees by linear interpolation and extrapolation.[6]

Another statistical problem in the STBAFA is that the survey covers foreign firms in real estate, finance, and insurance sectors only from 2009. 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 past years. To complement these sectors, I exploit the *Gaishikei Kigyou Soran* – the Directory of Foreign Affiliates in Japan – by Toyo Keizai Inc. The survey covers the 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, (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.

3.2. Characteristics of Foreign Firms in Japan

I turn to describe the main characteristics of foreign firms in Japan.[7] 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 the number of their employees also increased from 254 thousands to 629 thousands. However, the global financial crisis occurred in 2008, leading to discontinue the growing trend in foreign firms' activity.

---Table 1---

As is described in Tanaka (2014) based on the same dataset, the presence of foreign firms differs remarkably by the industry, nationality of foreign investors, and headquarters location. In

[6] See Tanaka (2014) for details of the methodology and consistency with other statistics on foreign firms in Japan.

[7] See Paprzycki and Fukao (2008) for a detailed examination of inward FDI in Japan.

terms of employment size, foreign firms were large 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 share of wholesale and retail sectors imply that market-seeking motives are crucial for foreign investors in Japan. Next, 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. shows the prominent presence; their employment increased from 156 thousands to 311 thousands between 1995 and 2007. In recent years, there has been 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.[9] The number of foreign firms headquartered in Tokyo increased from 1,176 to 2,711 between 1995 and 2007.

While these patterns are generally consistent with the description of inward FDI in Japan in prior work such as Ito and Fukao (2005) and Paprzycki and Fukao (2008), there has been little description on the entry modes of foreign firms. To fill this gap, I use the STBAFA to describe the number and employment of foreign firms across entry modes for the period 2002-2008 in Table 2.[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. However, the greenfield entry explained only one third of foreign firms' employment. Although the share of employment by M&A mode declined over time, around 30% of employment belonged to the foreign firms making the M&A investment. These results suggest that a large number of foreign firms enter the Japanese market by establishing their own local subsidiary. The number of foreign firms choosing M&A entry is relatively small in number, but they tend to be larger in employment size than the foreign firms by other entry modes.

---Table 2---

3.3. Other Data Sources

Data on value added, capital stock, and working hours are taken from the Regional-level Japan Industrial Productivity Database provided by the RIETI. The database includes a variety of economic indicators used to estimate productivity across 23 sectors and 47 prefectures for the period 1970-2008. The value added and capital stock are measured in million yen at a 2000 constant price. Working hours are calculated by the number of workers multiplied by annual

[8] Appendix Table A shows the industry classification employed in this paper.
[9] Note that the employment share of Tokyo is lower in terms of the establishment location of foreign firms.
[10] The foreign firms entering the market before 2002 are assigned to each entry mode based on their survey after 2002. Note that the sample does not include foreign firms in financial sectors.

working hours per worker divided by 1000. Also, data on per capita income in thousand yen come from this database. Data on intangible asset in million yen at a 2000 constant price are taken from the Japan Industrial Productivity Database provided by the RIETI.[11] This database also provides data on annual input-output tables. Finally, data on the geographic distance come from the Japanese Geographical Survey Institute.

4. Estimation Results

4.1. Main Results

Table 3 provides summary statistics of the sample used. To gauge a relative importance of foreign firms, 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 industry on average, but exhibit a nontrivial share of their activities in some sectors and/or regions. I present the benchmark results by Bayesian model averaging approach in Table 4. In estimating equation (1) over model space, I always include the main explanatory variables and a variety of fixed effects in sector, region, and year. The key variables on foreign firms are defined contemporaneous in column (1) and one-year lagged in column (2).

---Tables 3, 4---

The results show that the posterior means of local and spatial intra-industry variables have the one-standard error bands outside zero, respectively. Also, their posterior inclusion probabilities are close to one, implying that these variables are strongly effective in the specification according to the criteria in Raftery (1995). Robust to the lagged specification, intra-industry foreign presence in both local and spatial areas has a significantly positive correlation with industrial value added across prefectures. Additionally, the magnitude of their effects is economically meaningful. To gauge the economic magnitude in column (1), a one-standard-deviation increase in the local presence of foreign firms within similar industries leads to a 1.59% increase in industrial value added at the prefecture level whereas the corresponding increase in the spatial within-industry presence leads to a 1.64% increase.

The foreign presence in downstream sectors exhibits the significant correlation with industrial value added, with the positive sign in local backward linkage and the negative sign in spatial backward linkage. These significant associations are robust to the lagged specification. To assess their economic impacts in column (1), a one-standard-deviation increase in the local backward linkage leads to a 1.56% increase in the industrial value added. The corresponding increase in the spatial backward linkage leads to a 2.17% decrease. Additionally, the foreign

[11] See Miyagawa and Hisa (2013) for measurement of intangible investment in Japan.

presence in upstream sectors also show the significantly negative association with the industrial value added although the spatial presence is not significant in the lagged specification. According to the result in column (1), a one-standard-deviation increase in the local and spatial forward linkages leads to a 2.45% and 1.36% decrease in the industrial value added, respectively. These negative forward linkages are also found in Javorcik (2004) for the case of Lithuanian manufacturing sectors.[12]

Summarizing the main results, I find that foreign firms in similar sectors and local downstream sectors are positively associated with industrial productivity across prefectures. To interpret these results, the presence of foreign firms may contribute to industrial efficiency directly through their above-average productivity and indirectly through their positive spillovers to other domestic upstream industries. By contrast, the foreign presence in distant downstream sectors and local upstream sectors are negatively correlated with industry-level productivity across prefectures. This finding suggests that foreign firms may also have negative spillover effects on the domestic industries through the other linkages.

By way of comparison, prior studies provided conflicting evidence of FDI spillovers in Japan. Based on the similar Japanese firm-level data, Todo (2006) presents the positive spillover effects of intra-industry FDI activity, whereas Ito (2013) finds the negative spillover impacts. Using the other firm-level data, Iwasaki (2013) examines inter-industry spillovers of FDI to manufacturing firms in Japan. His analysis shows that forward spillovers are positive, but backward spillovers are insignificant. Compared to this paper, these studies have not explicitly addressed the measurement issue of foreign firms' activities in Japan, and thus there is little discussion whether their measures are sufficiently representative of the entire FDI activity in Japan. Additionally, my results highlight that it is important to disentangle the linkages of foreign presence carefully across industries and over space. Aggregating the foreign presence across industries and regions may mask the distinctive impact of foreign firms on productivity.

Although this paper does not aim to identify the sources of negative spillover effects, it is in order here to discuss possible channels. First, foreign firms may offer higher wages for workers, thereby attracting more competent workers who are previously employed by domestic firms in different industries and regions. As domestic firms make substantial investment in the human capital of their workers, and their leave may lead to additional investment in other employees for production activity and a decline in productivity during an adjustment period. Thus, labor mobility from domestic to foreign firms could generate negative impacts on the domestic industries. In my analysis, such negative effects could occur through the spatial

[12] Her results 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.

backward and local forward linkages with the foreign firms. An empirical investigation of such a hypothesis needs employer-employee linked data to track labor mobility between foreign and domestic firms. Second, it is often argued that foreign firms provide technical assistance for their suppliers, which works as a positive spillover channel. On the other hand, it is also possible that foreign firms reduce transactions with domestic suppliers in distant regions for restructuring and concentrate on transactions with other suppliers in proximity. In this case, the foreign presence leads to afflict upstream domestic industries in distant. Moreover, an entry of foreign firms may lead to crowding-out of domestic firms in similar industries and gain greater market power. Taking advantage of their increased bargaining power, they could provide products and services of lower quality to local customers at a higher market price. Thus, the presence of foreign firms may yield a negative influence on downstream domestic industries in proximity. An examination of such a hypothesis requires firm-level transaction data between foreign and domestic firms.

4.2. Results of the Nationality of Foreign Investors

I proceed to examine whether nationality of foreign firms matters. Table 5 shows the estimation results in which the foreign presence is decomposed by the nationality of principal foreign investors.[13] As is the case in Table 4, I include the main explanatory variables and a variety of fixed effects in sector, region, and year over model space, with the key variables on foreign firms defined contemporaneous in column (1) and one-year lagged in column (2).

---Table 5---

The local intra-industry share of Asian investors' employment has the significantly positive posterior mean in column (1). However, the one-year lagged specification leads to the insignificant posterior mean in this variable. The other variables of Asian investors do not have the significant posterior means across alternative specifications. These results suggest that foreign firms owned by Asian investors do not have a significant impact on industrial productivity. By contrast, I find that foreign firms owned by North American investors have the significantly positive impact through spatial intra-industry linkage, but the significantly negative impact through spatial backward and local forward linkages. These variables have the posterior means whose one-standard error band does not include zero. Their posterior inclusion probabilities take on one, implying that these variables are strongly effective over model space. Compared with the benchmark results, the North American investors appear to explain the negative impacts of the foreign presence in distant downstream sectors and local upstream

[13] The summary statistics on the foreign-presence variables are provided in Appendix Table B.

sectors. Additionally, I find the significant posterior mean for the local intra-industry share of European firms' employment. Robust to the lagged specification, the posterior inclusion probabilities take on one.

These results highlight that the impacts of foreign firms on industrial productivity depend crucially not only on specific linkages with domestic industry but also on the nationality of foreign investors. My findings are consistent with the evidence from Romania by Javorcik and Spatareanu (2011) in terms of the nationality heterogeneity. In particular, I find the same result that Asian investors do not exhibit significant spillovers. However, my results are not necessarily consistent with their hypothesis that foreign investors from more distant home markets should present larger positive vertical spillovers for their greater incentive to source inputs from a host market. That is, North American investors present the negative impact through spatial backward linkages in my analysis.

4.3. Results of Entry Mode

Table 6 shows the estimation results in which foreign presence is decomposed by the mode of entry to the Japanese market.[14] The main explanatory variables and a variety of fixed effects in sector, region, and year are always included over model space, with the key variables on foreign firms defined contemporaneous in column (1) and one-year lagged in column (2). As is mentioned previously, the information on entry mode is available only from the year 2002, and the sample used in estimation does not include foreign firms in real estate, finance, and insurance sectors. As the sample size is largely reduced, the analysis should be carefully interpreted in comparison with the results in previous sections.

---Table 6---

Across alternative specifications, I find that the spatial forward linkage of greenfield entry has the significantly negative posterior mean. This implies that industrial productivity is negatively correlated with the presence of foreign firms making greenfield investment in upstream sectors. On the other hand, I find the significantly positive posterior mean for the spatial intra-industry share of joint-venture entry. This finding suggests that industry-level productivity is positively associated with the presence of foreign firms choosing joint-venture entry in similar industries. Finally, the local intra-industry variable of M&A entry has the significantly positive posterior mean, implying that industrial efficiency is positively correlated with the presence of foreign firms acquiring domestic firms in similar industries.

These results highlight the varying impacts of foreign firms by entry mode. Greenfield

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

entry in upstream sectors may generate negative vertical spillovers whereas joint-venture and M&A entry could produce positive horizontal spillovers. The former entry involves only foreign investors, and the latter entry involves domestic firms in foreign entry. These patterns are consistent with the prior evidence of Norwegian manufacturing firms by Balsvik and Haller (2011). My finding is different from their study in that joint-venture entry is also considered. As is argued in their work, the positive impacts may be in part due to domestic linkages with foreign investors, which tend to be stronger in the case of the joint venture and M&A modes.

5. Conclusion

The growing role of foreign firms has made it increasingly important to investigate their impact on the host economies. Focusing on the consequences of foreign firms in Japanese industrial productivity across regions, this paper adopts a Bayesian-model averaging approach to estimate a wide variety of channels through which foreign firms affect productivity across sectors and over space. Exploiting the detailed firm-level information, foreign firms are decomposed by the nationality of foreign investors and the mode of entry to the Japanese market. I find that foreign firms in similar sectors and local downstream sectors are positively associated with industrial productivity across prefectures. Their presence may contribute to industrial efficiency directly through their above-average productivity and indirectly through their positive spillovers to other domestic upstream industries. On the other hand, the foreign presence in distant downstream sectors and local upstream sectors are negatively correlated with industry-level productivity, which point to potentially negative spillover effects through other linkages. Therefore, it is crucial to disentangle the various linkages of foreign firms with domestic industry and to take into account model uncertainty in estimation.

Finally, there are some remaining issues for future research. The newly constructed dataset on foreign firms in Japan can be used to investigate firm dynamics such as entry, exit, and productivity improvement at the firm level. The detailed impacts on individual Japanese firms improve our understanding of the role of foreign firms. 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. Finally, there remains to identify distinctive sources of FDI spillovers such as labor mobility, buyer-supplier transactions, and competition effects in Japan.

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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 and employment is the total number of their employees in thousand persons.

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. A Share of Foreign Firms by Entry Mode

Panel A: Number of Foreign Firms				
Year	Greenfield	Joint Venture	M&A	Other
2002	60.2	21.3	7.9	10.6
2003	61.3	21.9	9.5	7.3
2004	61.6	21.8	10.2	6.3
2005	62.1	21.6	10.2	6.1
2006	63.7	20.3	10.1	5.9
2007	62.7	20.5	10.2	6.6
2008	63.5	20.1	10.5	5.8
Panel B: Employment of Foreign Firms				
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 considered.

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)	14,401	11.58	1.79
Log of real capital stock at year 2000 price (mil. yen)	14,401	12.44	1.85
Log of total hours of working	14,401	10.12	1.88
Labor quality index: year 2000=100	14,401	1.01	0.03
Log of real intangible asset stock at year 2000 price (mil. yen)	14,401	14.85	1.29
Log of per capita income (thou. yen)	14,401	7.93	0.14
Local intra-industry share of foreign firms' employment	14,401	0.0052	0.0440
Spatial intra-industry share of foreign firms' employment	14,401	0.0012	0.0032
Local downstream industry share of foreign firms' employment	14,401	0.0018	0.0089
Spatial downstream industry share of foreign firms' employment	14,401	0.0004	0.0006
Local upstream industry share of foreign firms' employment	14,401	0.0020	0.0097
Spatial upstream industry share of foreign firms' employment	14,401	0.0005	0.0007

Note: Spatial indicates a distance-weighted measure of the corresponding variable in other regions.

Table 4. Benchmark Results by Bayesian Model Averaging Method

Variable	(1) Posterior mean	(1) Posterior standard error	(1) Posterior inclusion probability	(2) Posterior mean	(2) Posterior standard error	(2) Posterior inclusion probability
Local intra-industry	**0.36**	0.08	1.00			
Spatial intra-industry	**5.10**	1.57	0.97			
Local backward linkage	**1.75**	0.74	0.91			
Spatial backward linkage	**-36.73**	8.66	1.00			
Local forward linkage	**-2.56**	0.69	0.98			
Spatial forward linkage	**-27.40**	15.07	0.83			
Local intra-industry (t-1)				**0.39**	0.08	1.00
Spatial intra-industry (t-1)				**7.91**	1.32	1.00
Local backward linkage (t-1)				**2.23**	0.57	0.99
Spatial backward linkage (t-1)				**-39.63**	8.63	1.00
Local forward linkage (t-1)				**-3.01**	0.63	1.00
Spatial forward linkage (t-1)				-6.04	12.13	0.23
Capital stock	**0.51**	0.01	1.00	**0.52**	0.01	1.00
Working hours	**0.55**	0.01	1.00	**0.55**	0.01	1.00
Labor quality	**1.17**	0.18	1.00	**1.07**	0.19	1.00
Intangible asset	**0.31**	0.02	1.00	**0.34**	0.03	1.00
Per capita income	**0.75**	0.11	1.00	**0.79**	0.12	1.00
Sector fixed effect		Yes			Yes	
Region fixed effect		Yes			Yes	
Year fixed effect		Yes			Yes	
No. of observations		14,401			13,382	

Notes: The posterior mean in bold indicates that the corresponding one-standard error band does not include zero.

Table 5. Results of Different Nationalities by Bayesian Model Averaging Method

	(1) No Lag			(2) One Year Lag		
Variable	Posterior mean	Posterior standard error	Posterior inclusion probability	Posterior mean	Posterior standard error	Posterior inclusion probability
Asian investors						
Local intra-industry	**2.13**	1.75	0.65	1.23	1.66	0.40
Spatial intra-industry	-1.08	6.55	0.04	-0.10	2.16	0.01
Local backward linkage	-4.28	14.30	0.10	-3.03	12.20	0.07
Spatial backward linkage	-60.70	216.04	0.09	-0.24	30.78	0.01
Local forward linkage	0.03	0.93	0.01	0.04	1.12	0.01
Spatial forward linkage	1.08	16.91	0.01	13.12	64.52	0.05
North American investors						
Local intra-industry	0.0001	0.01	0.01	0.0001	0.01	0.01
Spatial intra-industry	**11.65**	2.08	1.00	**15.98**	2.12	1.00
Local backward linkage	0.32	0.77	0.17	**1.40**	1.32	0.58
Spatial backward linkage	**-108.3**	11.21	1.00	**-93.21**	11.08	1.00
Local forward linkage	**-4.26**	0.83	1.00	**-4.51**	1.02	1.00
Spatial forward linkage	-0.12	1.85	0.01	-0.03	1.40	0.01
European investors						
Local intra-industry	**0.51**	0.11	1.00	**0.59**	0.11	1.00
Spatial intra-industry	0.0004	0.16	0.01	-0.02	0.26	0.01
Local backward linkage	0.38	0.77	0.22	0.22	0.62	0.13
Spatial backward linkage	1.00	4.95	0.05	0.06	1.20	0.01
Local forward linkage	0.02	0.20	0.01	0.01	0.15	0.01
Spatial forward linkage	-0.08	1.82	0.01	-0.15	2.27	0.01
Main and control variables		Yes			Yes	
Sector fixed effect		Yes			Yes	
Region fixed effect		Yes			Yes	
Year fixed effect		Yes			Yes	
No. of observations		14,473			13,439	

Notes: The posterior mean in bold indicates that the corresponding one-standard error band does not include zero.

Table 6. Results of Different Entry Modes by Bayesian Model Averaging Method

	(1) No Lag			(2) One Year Lag		
Variable	Posterior mean	Posterior standard error	Posterior inclusion probability	Posterior mean	Posterior standard error	Posterior inclusion probability
Greenfield Entry						
Local intra-industry	-0.001	0.04	0.01	-0.01	0.08	0.02
Spatial intra-industry	1.47	5.02	0.10	3.37	7.85	0.18
Local backward linkage	0.22	1.42	0.03	0.17	1.30	0.03
Spatial backward linkage	41.97	93.24	0.20	**291.9**	131.3	0.90
Local forward linkage	-0.01	0.22	0.01	-0.01	0.24	0.01
Spatial forward linkage	**-119.8**	40.50	0.97	**-130.4**	45.08	0.96
Joint Venture Entry						
Local intra-industry	0.016	0.13	0.03	0.08	0.32	0.08
Spatial intra-industry	**24.33**	15.84	0.77	**23.93**	18.16	0.69
Local backward linkage	-0.09	0.88	0.02	-0.05	0.67	0.02
Spatial backward linkage	-41.13	106.88	0.15	-13.98	60.11	0.07
Local forward linkage	0.13	0.92	0.03	0.25	1.37	0.04
Spatial forward linkage	13.69	50.39	0.09	6.74	36.07	0.05
M&A Entry						
Local intra-industry	**0.29**	0.24	0.65	**0.31**	0.24	0.68
Spatial intra-industry	-0.61	1.94	0.11	-0.07	0.63	0.02
Local backward linkage	1.19	1.53	0.42	0.25	0.78	0.11
Spatial backward linkage	-22.77	25.45	0.49	**-78.43**	16.87	1.00
Local forward linkage	-0.02	0.28	0.01	-0.05	0.45	0.02
Spatial forward linkage	0.15	3.95	0.01	0.96	8.48	0.02
Main and control variables		Yes			Yes	
Sector fixed effect		Yes			Yes	
Region fixed effect		Yes			Yes	
Year fixed effect		Yes			Yes	
No. of observations		7,165			6,161	

Notes: The posterior mean in bold indicates that the corresponding one-standard error band does not include zero.

Appendix

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 share of Asian foreign firms' employment	14,473	0.0002	0.0029
Spatial intra-industry share of Asian foreign firms' employment	14,473	0.00004	0.0002
Local downstream industry share of Asian foreign firms' employment	14,473	0.00004	0.0002
Spatial downstream industry share of Asian foreign firms' employment	14,473	0.00001	0.00001
Local upstream industry share of Asian foreign firms' employment	14,473	0.0001	0.0003
Spatial upstream industry share of Asian foreign firms' employment	14,473	0.00001	0.00003
Local intra-industry share of North American foreign firms' employment	14,473	0.0026	0.0265
Spatial intra-industry share of North American foreign firms' employment	14,473	0.0006	0.0017
Local downstream industry share of North American foreign firms' employment	14,473	0.0011	0.0060
Spatial downstream industry share of North American foreign firms' employment	14,473	0.0003	0.0004
Local upstream industry share of North American foreign firms' employment	14,473	0.0009	0.0054
Spatial upstream industry share of North American foreign firms' employment	14,473	0.0002	0.0003
Local intra-industry share of European foreign firms' employment	14,473	0.0025	0.0293
Spatial intra-industry share of European foreign firms' employment	14,473	0.0006	0.0022
Local downstream industry share of European foreign firms' employment	14,473	0.0009	0.0061
Spatial downstream industry share of European foreign firms' employment	14,473	0.0002	0.0004
Local upstream industry share of European foreign firms' employment	14,473	0.0008	0.0046
Spatial upstream industry share of European foreign firms' employment	14,473	0.0002	0.0003
Local intra-industry share of greenfield foreign firms' employment	7,165	0.0014	0.0136
Spatial intra-industry share of greenfield foreign firms' employment	7,165	0.0003	0.0011
Local downstream industry share of greenfield foreign firms' employment	7,165	0.0004	0.0018
Spatial downstream industry share of greenfield foreign firms' employment	7,165	0.0001	0.0001
Local upstream industry share of greenfield foreign firms' employment	7,165	0.0007	0.0035
Spatial upstream industry share of greenfield foreign firms' employment	7,165	0.0002	0.0003
Local intra-industry share of joint-venture foreign firms' employment	7,165	0.0012	0.0095
Spatial intra-industry share of joint-venture foreign firms' employment	7,165	0.0003	0.0007
Local downstream industry share of joint-venture foreign firms' employment	7,165	0.0004	0.0015
Spatial downstream industry share of joint-venture foreign firms' employment	7,165	0.0001	0.0001
Local upstream industry share of joint-venture foreign firms' employment	7,165	0.0004	0.0018
Spatial upstream industry share of joint-venture foreign firms' employment	7,165	0.0001	0.0001
Local intra-industry share of M&A foreign firms' employment	7,165	0.0023	0.0324
Spatial intra-industry share of M&A foreign firms' employment	7,165	0.0005	0.0023
Local downstream industry share of M&A foreign firms' employment	7,165	0.0010	0.0063
Spatial downstream industry share of M&A foreign firms' employment	7,165	0.0002	0.0004
Local upstream industry share of M&A foreign firms' employment	7,165	0.0005	0.0033
Spatial upstream industry share of M&A foreign firms' employment	7,165	0.0001	0.0002

Note: Spatial indicates a distance-weighted measure of the corresponding variable in other regions.