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Productivity Spillovers and the Entry of Foreign-Owned Firms: The Case of Japanese Manufacturing Firms

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Productivity Spillovers and the Entry of Foreign-Owned Firms:

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and

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Abstract

This paper shows that in the short run an increase in foreign firms' industry share lowers the TFP growth of Japanese firms as a result of the decrease in market power. However, in the long run, the entry of foreign-owned firms has a positive effect on the productivity of local firms as a result of technology spillovers. In addition, the results suggest that foreign firms exert competitive pressure that forces Japanese firms with a high level of technological capabilities raise their productivity growth.

JEL Code: F11

Key Words: Technology Spillovers, Market Power, FDI, Productivity, Absorptive Capacity

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1 Introduction

During the 1990s, Japan's economy registered minimal growth. Studies suggest that this "lost decade" was partly caused by a stagnation in total factor productivity (TFP) growth. Two factors in particular appear to have contributed to this stagnation. The first is that the entry of productive firms and the expansion of production by high-TFP firms have been limited (see, e.g., Nishimura, Kiyota and Nakajima, 2003, and Fukao and Kwon, 2004). This situation stands in stark contrast with that in the U.S. where, as productivity analyses show, the entry of productive establishments and the expansion of existing high-productivity firms have substantially contributed to overall TFP growth (Baily, Hulten and Campbell, 1992; Foster, Haltiwanger and Krizan, 1998). Against this background, foreign direct investment (FDI) can potentially play an important role in lifting the TFP growth rate in Japan.

According to the standard theory of FDI (see, e.g., Caves, 1982, and Dunning, 1996), foreign investment can be understood in terms of the so-called OLI paradigm, where the "O" refers to ownership advantages, the "L" to location advantages, and the "I" to internalization advantages. Ownership advantages relate to the intangible assets that firms own and that help to compensate for the disadvantages firms face when operating in a foreign environment where they may lack consumer recognition and established networks of suppliers and are unfamiliar with the legal system and local customs. In this context, FDI is considered as a form of long-term international capital movement which is accompanied by investors' intangible assets. Furthermore, it is expected that the transfer of foreign-owned firms' business resources (such as technological knowledge, business know-how, etc.) helps to raise the productivity of domestic firms in the recipient country.

Whether this is indeed the case has been the subject of numerous studies which either use cross-country or firm-level data to examine the benefits of inward FDI for the host country. Blomstrom and Sjöholm (1998), for example, in an empirical study using micro data for Indonesia, found that the labor productivity of foreign-owned firms was higher than that of domestically-owned firms ("domestically-owned firms" will be referred to as "domestic firms" hereafter for brevity). Their findings, moreover, suggest that while the share of foreign-owned firms in a particular industry does not have any influence on the labor productivity of export-oriented domestic firms, it does have a positive influence on other, i.e. non-exporting, domestic firms. Okamoto (1999), using a plant-level data set on the U.S. automobile parts industry, compared various business performance indicators of Japanese plants in the U.S. and domestically-owned U.S. plants and investigated whether there have been technological knowledge spillovers from Japanese to U.S. plants. She found that the labor productivity and outsourcing ratio of Japanese plants were higher than those of U.S. plants, but TFP was lower. Moreover, she found that there were statistically significant spillovers of technological knowledge from Japanese plants to U.S. plants.

In an earlier study on foreign direct investment in Japan (Fukao and Murakami, 2005), we found that the TFP level and the TFP growth rate of foreign-owned firms in Japan were higher than those of domestic firms when controlling for firm fixed effects and other factors influencing firms' productivity. In addition, we found that out-in M&A target firms tended to score better in terms of R&D intensity, current profits per worker and wage levels to begin with when compared with other firms. Finally, our results suggested that target firms of out-in M&As saw an improvement in their business efficiency after the M&A, while target firms of in-in M&As did not. Taken together, the results suggested that the Japanese economy benefits from inward FDI. Since foreign-owned firms have a higher productivity than domestic firms and out-in M&As raise the productivity level of Japanese industry overall through the "share effect," FDI raises the productivity of the Japanese economy as a whole.

On the other hand, however, the industrial organization literature suggests that the market structure in a particular industry has an important impact on firms' performance. We would therefore expect that if foreign-owned firms undermine the market share and market power of domestic firms, this would lower the profitability and productivity of the latter.[1] For example, if domestic firms enjoy economies of scale that help to lower average costs and raise productivity, then the entry of foreign-owned firms potentially erodes such cost advantages. Such negative effects are described by the market power hypothesis, which suggests that the greater a firm's market share in an industry, the higher its profitability will be (Kwoka, 1985; Martin, 1993; Sleuwaegen and Dehandschutter, 1986) If market power helps to significantly lift domestic firms' profitability, then the entry of foreign firms, by drawing demand from domestic rivals, lowers their profitability.

The aim of this paper is firstly to examine whether the entry of foreign firms generates positive technology spillovers or indeed lowers domestic firms' productivity by taking demand away from them. Secondly, we investigate whether the long-run effects of the entry of foreign firms are different from the

[1] Another avenue through which foreign competition may undermine the market share and market power of domestic firms is imports. Keller and Yeaple (2003) argued that imports bring about competitive pressure. This paper does not consider imports.

short–run effects. Thirdly, we investigate the extent to which Japanese firms of different absorptive capabilities have benefited from spillovers from foreign-owned firms. The remainder of this paper is organized as follows. Section 2 provides a description of the data set, while Section 3 presents our estimation model and results. Section 4 concludes.

2 Data Sources and the Calculation of TFP

In order to examine empirically how the entry of foreign firms affects the productivity of domestic firms, we examine the relationship between the share of employment accounted for by foreign firms in a particular industry and the TFP growth of domestic firms.

The analysis in this paper is based on the firm-level data of the *Basic Survey of Business Activity*[2] conducted annually by the Ministry of Economy, Trade and Industry. Our panel consists of data for the period from 1994 to 1998 covering all manufacturing firms with more than 50 workers and 30 million yen in capital. We define foreign-owned firms as those in which more than 33.4 percent of capital is foreign-owned. The reason for this cut-off ratio of 33.4 percent is that this is the minimum share that grants investors veto rights on important matters such as changes in the articles of incorporation, the dismissal of COEs, and organizational changes.

Let us have a brief look at the extent of foreign ownership in Japan's manufacturing sector. We measure the share of foreign ownership in terms of the employment accounted for by foreign-owned

[2] The compilation of the micro data of the Basic Survey of Business Activity was conducted as a part of the RIETI project "Study on Industry- and Firm-Level Productivity in Japan.".

firms. Doing so, we find that the share of foreign ownership in the manufacturing sector as a whole increased from 2.7 percent in 1994 to 4.3 percent in 1998. Moreover, we find that the share of foreign-owned firms is particularly high in the petroleum products industry (27.0 percent), in the transportation machinery industry (10.6 percent), and in the chemical industry (7.1 percent).

Table 1: Foreign-owned Firms' Employment Share by Industry (in %)

	1994	1995	1996	1997	1998
Food and Beverages	0.79	0.74	0.62	0.77	0.97
Textiles and Clothes	0.50	0.30	0.32	0.04	0.43
Wood and Paper Products	1.15	0.09	0.00	0.00	0.13
Chemicals	6.58	6.67	6.08	7.49	7.06
Steel	0.12	0.00	0.00	0.00	0.00
Nonferrous Metal	4.24	4.53	3.51	3.77	0.91
Machinery	4.65	4.56	4.66	5.05	4.59
Electrical Machinery	2.80	3.01	2.99	2.88	4.17
Transportation Machinery	1.99	2.39	2.05	4.83	10.64
Precision Machinery	1.38	0.93	0.94	1.52	2.95
Petroleum Products	23.21	25.07	26.48	20.67	26.96
Other	0.62	0.51	0.51	0.47	0.73
Total	2.68	2.72	2.56	3.18	4.33

Source: *Basic Survey of Business Activity*

We now turn to the measurement of TFP that we will use in our analysis. We base our approach on the work by Caves, Christensen, and Diewert (1982) and Good, Nadiri, and Sickles (1997). Caves, Christensen, and Diewert (1982) introduce the concept of a multilateral productivity index, which compares the productivity of the individual firm with that of the representative firm. We substitute the manufacturing sector average output and input for the output and input of the representative firm.This index is very useful when the object is to compare the productivity of more than two firms at a particular point in time. However, it is inappropriate in a dynamic context, i.e., when allowing for the passage of time and the entry and exit of firms, which lead to changes in the number of observations, in average productivity, and in the productivity of individual firms. Good, Nadiri and Sickles (1997) overcome this problem by using a Divisia index, which reflects changes in the distribution of productivity and changes in the productivity of the representative firm as time passes. Because this paper deals with a longitudinal panel data set, we measure TFP following Good, Nadiri and Sickles's approach.

Consequently, the TFP level (in logarithmic form) of firm *f* at time *t* is calculated as follows:

$$
\begin{aligned}
\ln TFP_{ft} &= \left(\ln Y_{ft} - \overline{\ln Y_{jt}}\right) + \sum_{s=2}^{t}\left(\overline{\ln Y_{js}} - \overline{\ln Y_{js-1}}\right) \\
&- \left[\sum_{i=1}^{3} 1/2\left(S_{ift} + \overline{S_{ijt}}\right)\left(\ln X_{ift} - \overline{\ln X_{ijt}}\right)\right. \\
&+ \left.\sum_{s=2}^{T}\sum_{i=1}^{3} 1/2\left(\overline{S_{ijs}} + \overline{S_{ijs-1}}\right)\left(\overline{\ln X_{ijs}} - \overline{\ln X_{ijs-1}}\right)\right]
\end{aligned} \tag{1}
$$

where Y_{ft} is the output of firm *f* at time *t*, X_{ift} represents the factor inputs of firm *f* in year *t*, and S_{if} is the cost share of factor *i* in total costs. Variables with an upper bar denote the manufacturing industry average of that variable and thus stand for the representative firm. For Y_{ft}, we use sales from our dataset, and we consider three types of factor inputs: capital stock, labor, and materials.

The data sources for the variables used to calculate TFP are as follows. Output is obtained from the *Basic Survey of Business Activity*, while deflators by industry are obtained by dividing nominal output by real output using the IO Tables of the Management and Coordination Agency. We use the 3-digit industry classifications of the *Basic Survey of Business Activity*.

Capital stock is estimated as follows. First, plant and equipment investment (excluding expenses for land and buildings) at the 3-digit-level, obtained from the *Census of Manufactures* published by the

Ministry of Economy, Trade and Industry, is divided by the SNA deflator and is accumulated by the perpetual inventory method. Next, we calculate the real market price/nominal book value ratio which is the real capital stock divided by nominal tangible fixed assets (book value, end of year) obtained from the *Census of Manufactures*.

We use tangible fixed assets from the *Basic Survey of Business Activity* as the real capital stock of each firm, which is multiplied by this preceding real market price/nominal book value ratio. To adjust the utilization rate, we use the utilization ratio from Fukao and Murakami (2000). Cost shares are calculated using capital service price data by industry from the JIP database of Fukao et al. (2003).

Costs for materials are calculated as total operating costs minus other expenses such as rent, wages, depreciation and taxes, while material costs at constant prices are obtained in the same way as in the calculation for output above. In order to calculate productivity accurately, we exclude raw material, energy and other costs from output. The amount of raw materials and energy reflects firms' utilization ratio which is determined by the demand conditions firms face.

Constant labor input is calculated by multiplying the number of employees by the labor hour index of the SNA divided by 100. Both 0.1% tails of the distribution of output, capital stock, employee, payment, and material are omitted as outliers.

3 Regression Analysis

We use the growth rate of TFP as the dependent variable. The estimation model looks as follows:

$$TFPG_{ft}^{d} = \beta_0 + \beta_1 TFP_{ft-1}^{d} + \beta_2 FFshare_{j,t-1} * FFTFP_{j,t-1} + \beta_3 \frac{R\&D_{f,t-1}^{d}}{SALES_{f,t-1}^{d}}$$

$$+ \sum_j \gamma_j INDYDUM_j + \sum_t \delta_t YEARDUM_t \qquad (2)$$

where *d* represents domestic firms and *j* stands for the industry to which a firm belongs, while *t* represents the year. The following independent variables are used: To measure firms' catch-up to more productive firms, we use the TFP level (measured as the deviation from the manufacturing average) of domestic firms in the preceding year (TFP_{t-1}). To capture the effect of the entry of foreign firms, we include the product of two variables: $FFTFP_{t-1}$, which represents the deviation of foreign firms' productivity from the industry average in year *t-1*, weighted by $FFshare_{t-1}$, which is foreign firms' share in the industry (calculated as their share in the total workforce in the industry) in year *t-1*. Moreover, we include R&D intensity (calculated as R&D costs divided by sales) as a proxy for the effect of innovation on firms' productivity growth. Finally, industry and year dummies are also included.

We begin our empirical investigation by using equation (2), with the results shown in Table 2(a), but also estimate an alternative specification in which $FFshare_{t-1}$ and $FFTFP_{t-1}$ are used separately in order to capture their individual effects; those results are shown in Table 2(b). Looking first at the results in Table 2(a), we find that the coefficient on the TFP level of the previous year are negative in all columns. This means that firms tend to catch-up to more productive firms. The coefficient on *FFshare *FFTFP* in columns (1) and (2) using observations for all manufacturing firms are negative and are not statistically significant, suggesting that there is no clear effect of the entry of foreign firms on domestic firms. As expected, the coefficients on

R&D intensity are positive, indicating that firms' R&D activity raises their TFP growth.

We also tried estimations using observations of firms in the chemical industry and electrical machinery industry only, as these are relatively R&D-intensive industries and the share of foreign firms is comparatively high. The results are shown in columns (3) and (4) and suggest that the entry of foreign firms had a negative influence on the TFP growth rate of Japanese firms, indicating that the entry of foreign firms undermines domestic firms' market power and reduces their cost advantages.

Next, we estimate an alternative specification in which $FFshare_{t-1}$ and $FFTFP_{t-1}$ are used separately in order to capture their individual effects. This results are shown in Table 2(b).

In the estimation shown in column (5), which is for the manufacturing sector as a whole and includes industry dummies, the coefficient on *FFshare* is not statistically significant. However, in the estimation shown in column (6), which includes firm dummies, the coefficient on $FFshare_{t-1}$ is negative and statistically significant. This result is confirmed in the estimation for the chemical industry only: Here, too, *FFshare* has a negative effect on the productivity growth of domestic firms.

On the other hand, the coefficient on *FFTFP* is not statistically significant in the estimations for all manufacturing firms and firms from the electrical machinery industry shown in columns (5), (6) and (8). However, *FFTFP* does have a significant negative effect on the productivity growth of domestic firms in the case of the chemical industry, as shown in column (7). Overall, the results obtained here suggest that the entry of productive foreign firms has a negative effect on domestic firms as a result of the decrease in market share.

Table 2(a): Foreign-Owned Firms' Industry Share and Spillover Effects

Dependent variable = Domestic firms' TFP growth rate from *t-1* to *t*

	Manufacturing Industry		Chemical Industry	Electrical Machinery Industry
	(1)	(2)	(3)	(4)
FFshare t−1 X FFTFP t−1	−0.0013	0.0007	−0.0174 ***	−0.0091 *
	(−0.76)	(0.47)	(−2.85)	(−1.89)
TFP t−1	−0.3131 ***	−1.0531 ***	−0.2796 ***	−0.2820 ***
	(−104.88)	(−217.63)	(−21.12)	(−35.97)
R&D intensity t−1	0.1052 ***	−0.0294 ***	0.0753 ***	0.0949 ***
	(17.59)	(−2.98)	(4.39)	(8.04)
Constant	−0.0549 ***	−0.0243 ***	−0.0614 ***	−0.0590 ***
	(−12.93)	(−27.96)	(−4.80)	(−11.25)
No. of observations	49410	49410	2477	7423
adj.R2	0.2221	0.6018	0.1736	0.1724
Industry Dummies	yes	no	no	no
Year Dummies	yes	yes	yes	yes
Firm Dummies	no	yes	yes	yes

Note: The figures in parentheses show t-values. *, **, *** indicate the value is significant at the 10% , 5% and 1% level, respectively.

Table 2(b): Foreign-Owned Firms' Industry Share and Spillover Effects

Estimations using FFshare and FFTFP separately

	Manufacturing Industry		Chemical Industry	Electrical Machinery Industry
	(5)	(6)	(7)	(8)
FFshare t-1	0.0001	-0.0005 *	-0.0030 ***	-0.0001
	(0.40)	(-1.76)	(-2.96)	(-0.14)
FFTFP t-1	-0.0056	-0.0026	-0.0703 *	-0.0194
	(-0.99)	(-0.52)	(-1.69)	(-1.02)
TFP t-1	-0.3132 ***	-1.0530 ***	-0.2796 ***	-0.2826 ***
	(-104.91)	(-217.64)	(-21.14)	(-36.04)
R&D intensity t-1	0.1051 ***	-0.0293 ***	0.0752 ***	0.0949 ***
	(17.57)	(-2.98)	(4.39)	(8.04)
Constant	-0.0547 ***	-0.0228 ***	-0.0613 ***	-0.0586 ***
	(-12.76)	(-21.02)	(-4.81)	(-10.50)
No. of observations	49410	49410	2477	7423
adj.R2	0.2221	0.6018	0.1752	0.172
Industry Dummies	yes	no	no	no
Year Dummies	yes	yes	yes	yes
Firm Dummies	no	yes	yes	yes

Note:The figures in parentheses show t-values. *, **, *** indicates the value is significant at the 10% , 5% and 1% level, respectively.

The above estimations examined the effect of the entry of foreign firms on domestic firms after a period of one year and came to the conclusion that the effect was negative. However, we are curious whether this result also holds in the long run. The entry of foreign competitors may lead local firms to reexamine and reconstruct the efficiency of their organization and production processes, their products and business strategies. Naturally, such efforts take time to implement and bear fruit. Firms' core competences are path-dependent, and whatever core competences a firm has, such as its technology, marketing know-how, supplier networks, or workers' skills, these cannot be reconfigured and new business resources cannot be developed over night. For example, as highlighted by Furukawa and Goto (2006), in the pharmaceutical industry, the development and commercialization of new products and technologies can take as much as ten years. Therefore, it makes sense to assume that it takes several years for the entry of foreign firms to have a positive effect on the productivity growth of domestic firms.

Taking these considerations into account, we try to estimate the long–run effect of the entry of foreign firms by looking at a four-year period. The results are shown in Table 3 and indicate that four years after the entry of foreign firms, they indeed had a positive effect on productivity growth in manufacturing industries. In the estimation using industry dummies (column (2)), the coefficient on $FFshare_{t-4}*FFTFP_{t-4}$ is significant and positive, indicating that the presence of foreign firms is associated with higher productivity growth. On the other hand, in the estimations for the chemical and the electrical machinery industry, the coefficient is not significant, although it is also positive. The estimation results thus provide some support to the hypothesis that in the longer run, the presence of foreign firms does raise the productivity growth of domestic firms.

Table 3: Foreign Firms' Industry Share and Spillovers in the Long Run

Dependent variable = Domestic firms' TFP growth rate from *t-4* to *t*

	Manufacturing Industry		Chemical Industry	Electrical Machinery Industry
	(1)	(2)	(3)	(4)
FFshare t−4 x FFTFP t−4	0.0019278 ***	0.0022374 **	0.0023618 *	−0.0003792
	3.73	2.31	1.81	−0.2
Constant	−0.00537 ***	0.0059796	−0.015665	−0.0024344
	−2.78	0.44	−0.58	−0.4
No. of observations	8732	8732	492	1295
Adjusted R2	0.0014	0.098	0.0228	0.047
Industry Dummies	yes	yes	yes	yes

Note: The figures in parentheses show t-values. *, **, *** indicate the value is significant at the 10% , 5% and 1% level, respectively.

It is conceivable that the results obtained so far mask considerable differences between different firms' ability to absorb potential technological spillovers generated by the presence of foreign firms. The literature suggests that knowledge does not spill over or flow naturally from highly productive to less productive firms. Rather, in order to be able to benefit from knowledge spillovers, firms need to have a certain absorptive capacity. This is particularly so in the case of spillovers from R&D, where recipient firms typically need to engage in R&D themselves in order to benefit. We therefore also investigate the extent to which Japanese firms of different absorptive capabilities have benefited from spillovers from foreign-owned firms.

In order to do so, we assume that firms' absorptive capacity is determined by their size (proxied by the number of workers), TFP level, skilled-labor ratio (the ratio of workers at the head office to the total number of workers), and R&D intensity. We then rank firms in each industry and year in terms of their absorptive capacity as measured by these indicators The bottom group consists of firms with the lowest absorptive capacity, i.e., those whose scale (or TFP level, skilled-labor ratio, or R&D intensity) falls into the bottom quantile, the next group comprises firms who fall into the two median quantiles, while the top group consists of firms with the highest absorptive capacity, i.e., those who fall into the top quantile of the distribution. The regressions are run using equation (2).

The estimation using the observations for the manufacturing sector as a whole did not yield any clear results. This is probably because it includes several industries, such as the wood, furniture, food, and textile industries, where both the number of firms which conduct R&D and the number of foreign firms are small. We therefore concentrate our analysis on the electrical machinery industry and our estimation results are shown in Table 4.

Table 4: Firms' Absorptive Capacity and Spillovers in the Electrical Machinery Industry

Dependent Variable ＝Growth Rate of TFP of domestic firm from *t-4* to *t*

Electrical Machinery Industry

	Scale economies (no. of workers)			TFP level		
	Bottom 25%	25-75%	Top 25%	Bottom 25%	25-75%	Top 25%
	(1)	(2)	(3)	(4)	(5)	(6)
FFshare t-4 x FFTFP t-4	0.0041	0.0071	0.0155	-0.0131	0.0153	-0.0070
	(0.12)	(0.51)	(1.06)	(-0.30)	(1.45)	(-0.30)
Constant	-0.0096	-0.0010	-0.0178 *	-0.1109 ***	-0.0083	0.0766 ***
	(-0.71)	(-0.13)	(-1.80)	(-3.89)	(-1.50)	(3.14)
No. of observations	197	763	335	173	937	185
adj.R2	-0.0088	0.0615	0.0784	-0.0086	0.01	0.0423
Year Dummies	yes	yes	yes	yes	yes	yes
	Skilled-labor ratio			R&D intensity		
	Bottom 25%	25-75%	Top 25%	Bottom 25%	25-75%	Top 25%
	(7)	(8)	(9)	(10)	(11)	(12)
FFshare t-4 x FFTFP t-4	0.0197	0.0146	0.0009	0.0108	-0.0047	0.0433 **
	(1.19)	(1.03)	(0.04)	(0.66)	(-0.28)	(2.32)
Constant	0.0114	-0.0056	-0.0087	-0.0053	0.0067	-0.0219 **
	(1.13)	(-0.87)	(-0.85)	(-0.53)	(0.82)	(-2.15)
No. of observations	271	550	474	326	580	389
adj.R2	0.0916	0.0488	-0.000	0.0424	0.0541	0.0424
Year Dummies	yes	yes	yes	yes	yes	yes

Note: T-values in parenthesis *, **, *** indicate the value is significant at the 10% , 5% and 1% level, respectively.

The results of our estimation when using firms' scale, TFP level, or skilled-labor as our measure of absorptive capacity are shown in columns (1) to (9). However, none of the coefficients on our variables are statistically significant when using these measures. On the other hand, when R&D intensity is used as our measure of absorptive capacity, we find clear differences in spillovers (columns (10) to (12)). In the case of the group with the highest absorptive capacity, which in shown in column (12), a positive spillover effect is observed. In contrast, no statistically significant effect is observed in the groups with low or intermediate absorptive capacity. This result may suggest that firms with a R&D intensity in the electrical machinery industry have accumulated sufficient technological knowledge to achieve a rise in productivity growth when the foreign firms enter.

A more thorough examination of spillovers from foreign firms would require a more detailed data set containing, for example, information on supplier relationships between foreign and domestic firms in Japan.[3] Although unfortunately not available at present, such data could help to examine whether domestic firms acting as subcontractors to foreign firms show increases in their productivity and whether indicators of domestic firms' R&D output such as patents show improvements after the entry of foreign firms.[4]

4 Conclusion

Using firm-level data for the Japanese manufacturing sector, this paper investigated whether the entry of foreign-owned firms has a positive effect on domestic firms' productivity growth. The results indicate that an increase in foreign firms' share in an industry lowers the TFP growth rate of domestic firms in the short run, suggesting that the entry of foreign firms has an adverse effect on domestic firms' market share, costs, and profitability.

However, as it takes time for firms to reconfigure their business and for this to bear results, we also examined the long-run effects and found evidence suggesting that the presence of foreign firms raises the

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[3] Smarzynska (2002) shows that inward FDI in Lithuania also exerts competitive pressure and negatively affects local firms' productivity. However, she found positive spillovers from foreign to local firms in the materials industry through supplier relationships.

[4] An example of an empirical analysis of technological spillovers using a patent index is Branstetter's (2000) study on Japanese affiliates in the U.S. He showed that the number of patents applied to U.S. Patent Office by Japanese affiliates increased and the number of patents applied by local firms also increased as a result of technology spillover.

productivity growth of domestic firms through spillovers.

Finally, we examined the role of domestic firms' capacity to absorb technological spillovers. Concentrating on the electrical machinery industry, we found that when using firms' R&D intensity as our measure of absorptive capacity, firms with a high R&D intensity experienced a positive effect on their productivity growth from the presence of foreign firms. This result suggests that the entry of foreign firms exerts competitive pressure that forces Japanese firms in the electrical machinery industry with a high level of technological capabilities to accelerate business restructuring and further enhance their technological capabilities. Overall, the results of this study suggest that the effects of inward FDI are not always immediately clear and may differ in the short and in the long term.

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