Choice for FDI and Post-FDI Productivity : Comparison of Service and Manufacturing※

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July 17, 2007

Abstract

We highlight the difference between the service sector and the manufactur-ing sector in regard to the determinants for a firm to start FDI and the productivity growth it achieves. This paper analyzes two questions : (1) whether a productivity explains a Japanese firm's choice to be a multi-national firm (by starting FDI), and (2) how the productivity of such a multinational firm changes over time after FDI. Using the longitudinal panel data on Japanese firms from 1980 to 2005, We trace some firm-level decisions over several decades. This research contributes to the discussions where empirical evidence is not yet profoundly available: how the TFP of the service and manufacturing sectors presents difference for the choice of overseas activity, and how much productivity gain firms may achieve by intra-firm and cross-border reallocation of firm resources. We have found the following results: (1) compared by year and by industry, the TFP in manufacturing does not explain a firm's choice for starting FDI, but the TFP in the service sector does, then a low level of productivity deters a firm from pursuing FDI ; (2) in the manufacturing sector, the size and profitability of firms are positive factors for their future choice in FDI, but these do not matter in the service sector ; (3) after FDI, entrants in the service sector show 1.4 times higher annual productivity growth than those in the manufacturing sector. The productivity in service is also on average higher than that of selected domestic firms for counterfactuals.

Key words : FDI, productivity, service sector
JEL codes : F20, D21

* The DBJ and Toyo-Keizai Database, as well as the JIP-Database, integrated in this paper are prepared in cooperation with the Ministry of Economy, Trade and Industry (METI), and the Research Institute of Economy, Trade and Industry (RIETI). We also extract data of listed Japanese firms from (http://www.jcer.or.jp/eng/index.html). I would like to thank Young Gak Kim for his instruction on data and provision of related deflators. I also gratefully acknowledge Hidenori Nishita and Masayuki Iwamoto (Policy Plannning and Research Division, Trade Policy Bureau, METI) for their excellent support and valuable advice throughout this research project. Comments by Prof. Kyoji Fukao, Tomohiko Inui, and seminar participants at RIETI greatly improved this paper. The author is solely responsible for the views expressed herein and all remaining errors.

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1. Introduction

The World Investment Report (2006) by UNCTAD reports that the balance of the world FDI stock in 2004 in the service sector comprises 68.1 percent of the total investment of 10 trillion US dollars.[1] Compared to the composition in 1990, the share of the service sector increased from 46.5 percent, but that of the manufacturing sector decreased from 44.5 percent to 26.6 percent. These statistics suggest that we are undergoing a surge of internationally connected service activities in trade and in FDI. Although the service industries were traditionally treated as "non-tradables," it has now changed into the major driving force of globalization.

In spite of this trend in the world, the share of service sector regarding outward investment from Japan remains behind. The White Paper on International Economy and Trade (Tu-sho Hakusho, in Japanese; 2007) by METI reports that the balance of FDI stock in service as of 2005 has a share of only 35 percent, which is less than a half of those in the U.S. and EU15.[2]

Our primary concern is to figure out some firm-level factors to explain this relatively inactive service FDI in Japan. If firms in the service sectors show different responses in starting FDI, or different performances after FDI compared to the manufacturing, the findings help us to understand the gap in FDI amounts we observe between the sectors. They also provide the clues to investigate the small ratio of service investment in Japan compared to other developed countries.

For this goal, this paper analyzes two questions using the longitudinal panel data on Japanese listed firms from 1980 to 2005. The first one is whether a productivity (TFP) explains a firm's choice to be a multinational firm. We compare the performances when firms newly start FDI, with those when they stay at domestic operations. Then we see what motivates firms to "switch."

The second question is how the productivity of multinational firms change over time after FDI. We ask how the multinational firms change their performances. We also investigate whether the multinational firms perform better or not, compared to the domestic firms that would have entered into FDI with the similar propensities.

These analyses contribute to the discussions where empirical evidence is not yet profoundly available. These show how the TFP of service and manufacturing sectors presents difference in their choice of FDI, and how much productivity gain firms doing FDI in each

sector may achieve.

This paper is organized as follows. The next section summarizes the issues in the literature. The third section introduces the data used. The fourth section discusses the estimation methods and their results. The last section gives concluding remarks.

2. Literature Review

FDI is a form of overseas activity which involves stronger commitment by home firms than trade or foreign outsourcing does. It also requires a home firm to incur some sunk costs and additional fixed costs of operations. Given these features, there exist some causality analysis and association analysis to explain the relation between FDI and productivity of firms, both in theory and in empirical analysis.

Firstly, FDI can effectively increase productivity of home firms by com-positional changes within each firm. If a firm relocates its relatively inef-ficient parts of services or production processes to another country where these can be produced more efficiently and cheaply, it can expand its output in stages with comparative advantage and can enhance the average productivity. Given this argument, firms which choose FDI may become more and more productive over time.

Kimura and Kiyota (2007) show the association between FDI and/or ex-port activity and the TFP growth, using 1994-2000 observations of Japanese firms.[3] Using the initial TFP levels as controls, they state that firms with foreign presence become more productive than others. In addition, they show that, with foreign presence, a firm gains a longer survival rate in do-mestic markets.

Some recent studies go further to correct the endogeneity of the TFP and the operational modes, since they are simultaneously defined and causalities are ambiguous. Girma, Greenaway, and Kneller (2004) show the positive causality from exporting to the TFP growth in UK manufacturing firms in 1988-1999. Navaretti and Castellani (2004) also state the causal effect of the entry in FDI on the TFP and output for Italian manufacturing firms in 1993-1998. Hijzen, Inui, and Todo (2007) obtain significant causal effects of FDI on the growth of output and employment of home firms, but get subtle effects on the TFP, by using Japanese manufacturing firms from 1995 to 2002.[4]

The within-firm effect is also discussed in terms of employment and cap-ital investment of home firms, which are possibly substitutable for foreign affiliates.[5] Hanson, Mataloni, and Slaughter (2003) focus on the reallocation of labor power between home and abroad with-

in a firm, using US multina-tional firms from 1989 to 1999. They show that the foreign and parent labor may work complementarily. For example, an expanded scale at foreign af-filiates, or a higher sales in foreign affiliates, raises the parent employment. They state that the skill composition of foreign labor defines whether employed workers at two locations are substitutes or complements: the US labor powers are complements for skilled foreign labor, and are substitutes for low-skilled foreign labor.[6)]

Secondly, home firms that are not doing overseas activity may also achieve higher productivity by structural changes within-industry or across-industry. One possibility is when FDI causes an industry-wide competitive environment, accruing to active entry and exit. Another possibility is when there are positive externalities, such as technology diffusions or knowledge spillovers.

Bernard, Jensen, and Schott (2006) show, with the US manufacturing data of 1977-1997, that domestic firms adjust their product mix in response to import pressures, especially those from low-wage countries such as China and India. For example, they switch to less competitive industries, or to products with greater skill-intensity. These movements toward comparative advantage enhance the overall productivity level of the country. Matsuura, Motohashi, and Fujisawa (2007), by constructing a comprehensive data of Japanese machinery manufacturing firms, analyze the productivity of do-mestic industries.[7)] They separate the productivity into two parts: the contribution by multinational firms, and that by domestic firms. Then, the productivity growth achieved by each part is investigated. The productiv-ity growth is either driven by the within-firm improvement of productivity by incumbent firms, or by the reallocation effects: changes in sales shares (weights) of existing firms, or changes of firms by entry or exit. The pa-per concludes that multinational firms and domestic firms contribute to the industry-level productivity in different ways. The contribution of the former is largely explained by the within-firm effects, whereas the latter is derived from the entry and exit (reallocation) effects.

Keller and Yeaple (2004) consider positive externalities through trade and (incoming) FDI. With the data of manufacturing firms operating in the U.S. in 1987-1996, they show that the FDI leads to significant domestic productivity gain, accounting for 14 percent of productivity growth in the U.S.

Thirdly, in contrast to the first mechanism, there is also a view that choice of FDI is the result of a high level of productivity gained in advance of the entry. In other words, they are self-selected to become multinationals. Some other papers aim to validate the selection of more efficient firms into overseas activities.

Helpman, Melitz, and Yeaple (2004) present the theoretical model of firms who may serve foreign markets through export or through (horizontal) FDI, then argue that highly productive firms start FDI, intermediate firms start trade, and less productive firms stay within the domestic border. This implication has been tested in Japanese firm-level data. Head and Ries (2003), using listed manufacturing firms in 1992, associate the productivity with the modes of overseas activity (export and FDI). Kimura and Kiyota (2007) report the association for the said panel data. They also investigate the self-selection into export and FDI, by using the method of Clerides, Lach and Tybout (1998). Tomiura (2007) uses a multinomial response model for a cross-section data of manufacturing firms in 1998, and sorts the productivity level by the modes (combination) of foreign activities: FDI, export, and foreign outsourcing. These three papers overall confirm the outcome in line with Helpman, Melitz, and Yeaple (2004).[8)]

Although all of these three sets of explanations have certain levels of validity, these are subject to at least two important caveats. For one thing, only a few provide some legitimate corrections on the endogeneity issues, where productivity and the FDI status are simultaneously determined. Our research is, therefore, indebted to Hijzen, Inui, and Todo (2007) or Navaretti and Castellani (2004) for their application of the propensity score matching method, and difference-in-difference estimation in comparison with domestic firms. The other thing is that almost all of the papers focus only on manu-facturing industries. Despite the recent boost of FDI in the service sector, comparison between manufacturing and service FDI and productivity has scarcely been done. Although Kim, Kwon, and Fukao (2007) provide the latest and most comprehensive analysis by categorizing the sources of productivity,[9)] the link between the FDI and productivity of firms in the service sector has not yet been explained.[10)] Then this paper tries to provide evidence on these links.

3. Data

We integrated the database of listed firms reported by the Development Bank of Japan: The Data Bank of Corporate Finance (Kigyo Zaimu Data Bank, in Japanese), with the database of multinational firms and their affiliates by Toyo Keizai Incorporated: the Database of Foreign Affiliates of Japanese Firms (Kaigai Shinshutu Kigyo Souran, in Japanese). The former covers the listed firms in the first or second part of the Tokyo, Osaka, or Nagoya Stock Exchanges.[11)] The financial information therein has a high level of

accuracy, as those are taken from official and compulsory financial statements for disclosure. The database, recorded since 1956, include 3274 firms in manufacturing sector and 3276 firms in the service sector. The latter database is used to add the information on the former: whether these listed firms have entered in FDI (have owned foreign affiliates) or not. We define that a firm starts FDI in year t when it registers its first foreign affiliates in that year. In this manner, there are 2166 multinational firms in the manufacturing sector, and 742 multinational firms in the service sector. The remaining 1108 firms in the manufacturing and 2534 firms in the service are domestic firms. This means, among the listed firms in Japan, 66.1 percent of firms in the manufacturing sector, and 22.6 percent of firms in service sector are multinationals.[12)]

For our analysis on entry decision and TFP growth, we consistently use the observations from 1980 to 2005. Additional selections of the observations are performed for each analysis, which are described in the following section.

4. Estimation and Results

First, we discuss whether the productivity explains a Japanese firm's choice to be a multinational firm, and whether service and manufacturing sectors respond differently to their productivity upon the entry decision to FDI. We apply Logit estimation, by denoting 1 as the occasion when a domestic firm switches to a multinational firm the first time in its corporate history. In contrast, we denote 0 as the occasion when a domestic firm stays in domestic activity in year t.[13)]

Second, we analyze for each sector whether a multinational firm, com-pared to a "similar" domestic firm, can achieve a higher TFP growth after the startup of FDI. We apply difference-in-difference estimation by con-structing a control group of domestic firms, to be compared with a treatment (switching) groups of multinational firms. The control group is selected by the nearest-neighbor matching of the propensity score. The propensity score is the predicted conditional probability for each firm to switch into a multinational firm. An entrant at year t, under a certain predicted probability, and a domestic firm with the closest probability at year t are matched. We then compare the TFP of the two, to figure out whether an entry to FDI works as a significant turning-point in TFP growth.

Third, for each sector, we investigate explanations for a multinational firm's post-FDI productivity growth. We apply GLS random-effects estimation to see whether the experience of foreign operations after the entry influences TFP levels. In addition, we regress

TFP growth on firm-specific characteristics to see dynamic effects from the past TFP.

4.1　Logit Estimation for Entry into FDI

First, we investigate whether productivity and other firm-level characteris-tics can explain the odds（probability）to start FDI during 1980-2005. The logit of a probability number p ∈［0, 1］is

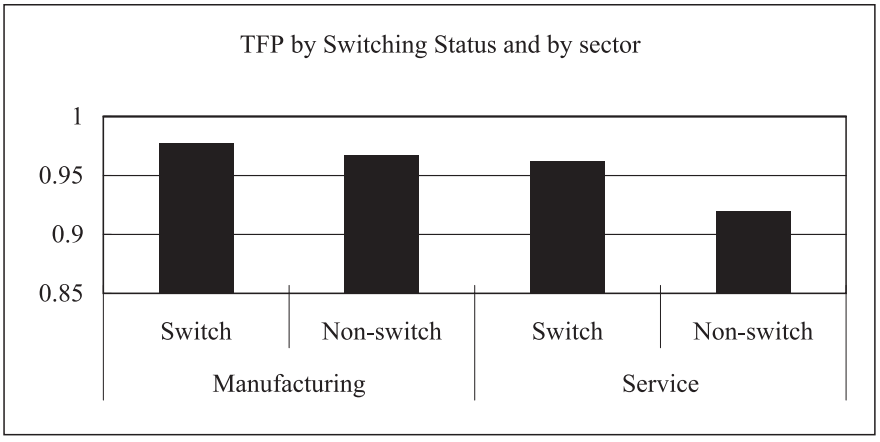
$$logit(p_i) = \log(\frac{p_i}{1-p_i}) = \log(p_i) - \log(1-p_i) = a + X_i'b \tag{1}$$

Applying the exponential on both sides of the equality in equation（1）and doing further calculations, we come to the following relation:

$$p(X) = \frac{e^{a+X_i'b}}{1+e^{a+X_i'b}} \tag{2}$$

Table 1-1　Summary Statistics for Logit Estimation

Number of Observations (Switching or Non-switching)	Service	Manufacture	Total
Switch into FDI from 1980-2005	158	419	577
Non-switch into FDI from 1980-2005	10255	11468	21723
	10413	11887	22300



: Arithmetic mean of cross-sectional TFP by switchers and non-switchers from 1980-2005
: In manufacturing, switchers are 419 firms（419 obs.）; non-switchers are 630 firms（10613 obs.）
: In service, switchers are 158 firms（158 obs.）; non-switchers are 799 firms（9060 obs.）

Table 1-2 Summary Statistics by Sector for Logit Estimation

	Service				Manufacturing			
	Mean	Std. Dev.			Mean	Std. Dev.		
ln_TFP	overall **-0.111**	0.202	Obs.	9214	overall **-0.058**	0.117	Obs.	11018
by time trend	between	0.194	Firm (i)	953	between	0.106	Firm (i)	1035
	within	0.107	Time (t)	9.67	within	0.077	Time (t)	10.65
lnTFP	overall **-0.098**	0.173	Obs.	9214	overall **-0.035**	0.069	Obs.	11018
by cross-section	between	0.171	Firm (i)	953	between	0.060	Firm (i)	1035
	within	0.087	Time (t)	9.67	within	0.049	Time (t)	10.65
lnTFP_(t)- lnTFP_(t-1)	overall **0.008**	0.070	Obs.	9214	overall **0.006**	0.048	Obs.	11018
	between	0.041	Firm (i)	953	between	0.028	Firm (i)	1035
	within	0.067	Time (t)	9.67	within	0.046	Time (t)	10.65
FDI Dummy_t	overall **0.015**	0.122	Obs.	10413	overall **0.035**	0.184	Obs.	11887
1=if a firm enters at t	between	0.369	Firm (i)	971	between	0.489	Firm (i)	1057
0=if otherwise	within	0.000	Time (t)	10.72	within	0.000	Time (t)	11.25
R&D intensity	overall **0.001**	0.007	Obs.	10412	overall **0.001**	0.009	Obs.	11887
(R&D spending/Sales)	between	0.003	Firm (i)	971	between	0.006	Firm (i)	1057
	within	0.006	Time (t)	10.72	within	0.007	Time (t)	11.25
Operational Profits/Sales	overall **0.068**	0.101	Obs.	10412	overall **0.043**	0.087	Obs.	11887
	between	0.094	Firm (i)	971	between	0.100	Firm (i)	1057
	within	0.062	Time (t)	10.72	within	0.061	Time (t)	11.25
ln_(Capital Stock/Employees)	overall **10.093**	1.293	Obs.	9120	overall **9.329**	1.170	Obs.	11124
	between	1.169	Firm (i)	929	between	1.019	Firm (i)	1028
	within	0.708	Time (t)	9.82	within	0.831	Time (t)	10.82
ln_(Number of Employees)	overall **6.218**	1.620	Obs.	10413	overall **6.171**	1.141	Obs.	11887
	between	1.533	Firm (i)	971	between	1.159	Firm (i)	1057
	within	0.896	Time (t)	10.72	within	0.546	Time (t)	11.25

where X_is are the firm-level independent variables on which the decision to switch into FDI may depend.

Having observed the values of X_is and whether there was a "switch" or a "stay (non-switch)" in each case, we estimate the values of the coefficients by the maximum likelihood methods. The result can then be used to assess the probability of "an entry into FDI" in year t in a case where the values of X_is in preceding years are known.

For each sector, we denote the observation of 0s (non-entrant into FDI at year t) from domestic firms as well as multinational firms before their entry during 1980-2005. We define the observation of 1s at year t when a firm starts FDI at that year, and any observation after the entry is not coded.

In the upper part of table 1-1, we count the observations of each category. Since an entry is a one-shot observation, the indicator 1 is far less frequently observed than 0, which is observed several times per firm. The figure in table 1-1 shows the arithmetic mean of TFP levels of 577 entrants, and 1429 stayers, by sector. The productivity gap between the two

Table 2　Logit Estimation for Entry to FDI

Entrants 1980-2005, Non-entrants 1980-2005	Service		Manufacturing	
1=Entry at t 0=Non-entry, or Pre-entry	(1)	(2)	(3)	(4)
lnTFP (t-1)	1.9128*** [0.5297]	1.4707*** [0.5098]	0.6483 [0.9271]	0.9908 [0.9036]
z-stat	(3.61)	(2.89)	(0.70)	(1.10)
Profit/Sales (t-1)	-1.8059 [1.1879]	-1.1808 [1.0233]	2.3128*** [0.8137]	2.2482*** [0.7628]
z-stat	(-1.52)	(-1.15)	(2.84)	(2.95)
ln_Size (t-1)	0.1581** [0.0705]	0.0384 [0.0533]	0.5039*** [0.0515]	0.4223*** [0.0487]
z-stat	(2.24)	(0.72)	(9.78)	(8.67)
ln_(Kstock/Labor) (t-1)	-0.1979*** [0.0759]		-0.0101 [0.0546]	
R+D Intensity (t-1)		-43.5872 [61.3448]		-1.824 [8.0759]
Constant	-2.9045*** [1.0543]	-4.0467*** [0.6931]	-7.9588*** [0.9216]	-7.6144*** [0.7993]
Year Dummy	Yes	Yes	Yes	Yes
Industry Dummy	No	No	No	No
Observations	8080	8326	10130	10497
LR Chi2	45.71	34.1	187.52	181.12
Prob>Chi2	0.0137	0.1631	0	0
Pseudo R^2	0.0337	0.0239	0.0603	0.057
Log Likelihood	-655.25	-697.80	-1461.15	-1497.36

Standard errors in brackets

*** p<0.01, ** p<0.05, * p<0.1, respectively

An entrant is included in the observation until her entry（switch from 0 to 1）at year t. The observations after t+1 are omitted

modes is greater in the service sector, as the gap is smaller in the manufacturing sector. This may imply that the productivity level in the service sector affects the likelihood of selecting an overseas operation, which we estimate in table 2.

Table 1-2 gives the summary statistics to be used for the Logit estimation, and comparison of sectors. The manufacturing sector includes 419 entrants and 630 stayers, implying that, every year, 3.5 percent of the listed firms becomes multinational firms on an average. The service sector pools 158 entrants and 799 stayers, implying that 1.5 percent of the firms be-come multinational firms on an average. The manufacturing sector presents less

variant TFP levels between firms, and a higher TFP level on average than the service sector. Profitability, capital-labor ratio, and the number of employees are higher on average, but more variant in the service sector.

Table 2 shows the results of the Logit estimation. We regress the bi-nary variable indicating the switch to FDI on the explanatory variables of a preceding year. Specifically, we investigate how the TFP of a previous year, size of a firm, profitability, capital-labor ratio, and research intensity explain the propensity to start FDI.[14)]

In the service sector, the pre-entry TFP is positively significant for a firm to enter. In contrast, the scale and profitability of a firm matter more for the entry in the manufacturing sector. It may imply that FDI in the service sector could be possibly promoted relatively independently of the firm size, if they can achieve a high level of efficiency.

4.2 Propensity Score Matching and Difference-in-Difference Estimation on Productivity

Although we cannot impose experimental controls on firms, we may obtain data from a set of potential comparison units and regard those as the coun-terfactuals. In our case, for every firm, there is a positive probability of starting FDI given some firm characteristics, and we use these conditional probabilities as comparison units.

The propensity score, the conditional probability of receiving treatment (=doing FDI) given Xs, denoted as $p(X)$, is suggested by Rosenbaum and Rubin (1983) as a matching measure.[15)]

In implementing matching based on $p(X_i)$, three issues are relevant : (1) whether to match with or without replacement, (2) the number of units to use in the comparison set, and (3) the choice of matching method. We treat these issues as follows. First, we apply matching with replacement where not all the non-treated observations are matched with the treated, as non-treated observations are abundantly available. Second, we use a single closest match to a treated case. In this way, we are left with a relatively large variance but we can reduce the bias. Third, through propensity score matching, the matching is simply based on a scalar-valued metric. This method can avoid the unsuccessful match which will arise if we set some high dimensional factors to compare.

We calculate the conditional probability by Logit estimation described in the previous subsection. Then, we apply one-to-one, nearest neighbor matching, where a treated (entry into FDI) unit i, is matched to a non-treated (without FDI) unit j, such that:

$$|p_i - p_j| = \min_{k \in \{D=0\}} \{|p_i - p_k|\} \tag{3}$$

Here we denote $D = 1$ as the treated group, with the entry record of FDI, and $D = 0$ as non-treated group. Then, for a treated firm i, the resulting TFP change before and after FDI（denoted as b and a, respectively）is measured by［$y_{ia} - y_{ib} \mid D_i = 1$］, and［$y_{ia} - y_{ib} \mid D_i = 0$］for untreated. Hence the treatment effect is estimated by［$y_{ia} - y_{ib} \mid D_i = 1$］−［$y_{ia} - y_{ib} \mid D_i = 0$］.

Consider a model with a fixed effect ϕ_i and a drift term δ_t, where the TFP of pre-treatment（b）and post treatment（a）are given by,

$$\begin{aligned} y_{it}^0 &= \phi_i + \delta_t + \epsilon_{it} \\ y_{it}^1 &= y_{it}^0 + \alpha \end{aligned}$$

where $t = a, b$ applies. The first equation is for untreated, and the second one is for treated. These can be summarized these by:

$$\begin{aligned} y_{it} &= (1 - D_i) y_{it}^0 + D_i y_{it}^1 \\ &= \phi_i + \delta_t + \alpha D_i + \epsilon_{it} \end{aligned} \tag{4}$$

The difference-in-difference estimator for the treatment effect, α, is ob-tained by,

$$\begin{aligned} \alpha &= E[y_{ia} - y_{ib} | D_i = 1] - E[y_{ia} - y_{ib} | D_i = 0] \\ &= \{E[y_{ia} | D_i = 1] - E[y_{ia} | D_i = 0]\} - \{E[y_{ib} | D_i = 1] - E[y_{ib} | D_i = 0]\} \end{aligned}$$

where the subtracting step eliminates the fixed effects ϕ_i and the drift δ_t.

Table 3 indicates the statistics of the propensity score matching, where the target propensity score is the conditional probability for starting FDI, calculated regardless of the actual FDI record. The upper table is for the service sector, and the lower table is for the manufacturing sector.

By the simple（unmatched）observations, entrants attain higher levels in TFP and firm size, and lower levels in capital-labor ratio in the service sector. In manufacturing, entrants and non-entrants show comparable TFP levels, but entrants achieve higher profitability and larger firm sizes. Compared to the unmatched observations, the average values of the matched pairs（treated and control）are balanced, mitigating differences. The third column computes the difference between the mean of pairs（in percentage）, and the fourth column shows the reduction of the mean differences from the original statistics. The last

Table 3 Balancing of the Variable in Propensity Score Matching

PSM in Service Sector (entrants and nonentrants from 1980-2005)		(A)	(B)	(A-B)/B x 100	Achieved % reduction in |bias|	t-test for mean equivalence of (A) and (B)	
Variable		Entrants Treated	Non-entrants Control	%bias		t-value	p>|t|
ln_TFP	Unmatched	-.08034	-0.10965	14.1		1.69	0.092
by time trend	Matched	-.08034	-0.09406	6.6	53.2	-1.66	0.097
lnTFP	Unmatched	-.06496	-0.10211	20.7		2.48	0.013
by cross-section	Matched	-.06496	-0.07765	7.1	65.8	-2.39	0.017
lnTFP_(t)- lnTFP_(t-1)	Unmatched	0.0101	0.0068	4.4		0.55	0.582
	Matched	0.0101	0.0066	4.7	-6.1	1.07	0.284
Operational Profits/Sales	Unmatched	0.0611	0.0646	-4		-0.38	0.703
	Matched	0.0611	0.0593	2.2	46.8	-0.78	0.433
ln_(Number of Employees)	Unmatched	6.6758	6.3632	23.9		2.76	0.006
	Matched	6.6758	6.6222	4.1	82.9	-4.33	0
ln_(Capital Stock/Employees)	Unmatched	9.9542	10.2260	-22.7		-2.38	0.017
	Matched	9.9542	9.8892	5.4	76.1	3.12	0.002
Propensity Score=Predicted	Unmatched	0.0310	0.0169	62.9		10.79	0
Pr(Entry into FDI at t | Xt-1)	Matched	0.0310	0.0310	0.2	99.7	-10.34	0

PSM in Manufacturing Sector (entrants and nonentrants from 1980-2005)		(A)	(B)	(A-B)/B x 100	Achieved % reduction in |bias|	t-test for mean equivalence of (A) and (B)	
Variable		Entrants Treated	Non-entrants Control	%bias		t-value	p>|t|
ln_TFP	Unmatched	-.05628	-0.05843	1.9		0.35	0.724
by time trend	Matched	-.05628	-0.06155	4.7	-144.8	2.07	0.038
lnTFP	Unmatched	-.02811	-0.03623	12.5		2.22	0.027
by cross-section	Matched	-.02811	-0.03392	9	28.4	0.57	0.572
lnTFP_(t)- lnTFP_(t-1)	Unmatched	0.0091	0.00507	9.3		1.62	0.105
	Matched	0.0091	0.00264	14.9	-60.4	2.11	0.035
Operational Profits/Sales	Unmatched	0.054	0.03847	22.9		3.75	0
	Matched	0.054	0.05296	1.5	93.3	-0.84	0.404
ln_(Number of Employees)	Unmatched	6.7561	6.1828	55.2		10.21	0
	Matched	6.7561	6.7569	-0.1	99.8	-6.95	0
ln_(Capital Stock/Employees)	Unmatched	9.3873	9.3796	0.7		0.13	0.9
	Matched	9.3873	9.3019	8.1	-1000.8	2.6	0.009
Propensity Score=Predicted	Unmatched	0.06597	0.03496	75.6		17.25	0
Pr(Entry into FDI at t | Xt-1)	Matched	0.06597	0.06596	0	100	-16.24	0

two columns show the t-test results（t-values and significance level）for the mean equivalence between matched treatment and controls.

Table 4 is the difference-in-difference estimation for the treatment effect. Like a first-dif-

Table 4　Difference-in-Difference Estimation for TFP Growth by Sector

	Service		Manufacturing	
	⊿lnTFP_t+1 (t+1)-(t) 1 year after entry	⊿lnTFP_t+2 (t+2)-(t) 2 years after entry	⊿lnTFP_t+1 (t+1)-(t) 1 year after entry	⊿lnTFP_t+2 (t+2)-(t) 2 years after entry
FDI Dummy 1=Treatment 0=Control	0.0019 [0.0058]	0.0152 [0.0061]***	0.0018 [0.0024]	0.0016 [0.0024]
Constant	-0.0024 [0.0066]	-0.0021 [0.0054]	0.02 [0.0025]***	0.028 [0.003]***
Year Dummies 1980-2005	Yes	Yes	Yes	Yes
Number of Firms	876	876	970	970
Number of Obs.	7268	6751	9849	8998
R^2	0.036	0.036	0.057	0.058

ference estimator in linear panel data, the difference-in-difference aims at eliminating unobserved heterogeneity, which might not be captured by the matching, but can affect post-FDI performance. We consider the TFP changes after 1 and 2 years after FDI as explained vari-ables. The regressors are the indicator variable for starting FDI, a constant term, and time dummies. We select these two years to illustrate the direct effects of the treatment, not including possible indirect effects influencing the TFP in the long run.

From table 4, in the service sector, we obtain the result that FDI treatment increase the TFP by 1.5 percent in 2 years after FDI. On the other hand, in the manufacturing sector, FDI treatment does not have a strong effect on TFP growth in 1 or 2 years.[16)]

4.3　Productivity Growth after FDI

Lastly, we investigate how the entrants achieve their productivity after FDI. We are aware that there may exist an omitted variable bias, in which TFP includes the effect of other events as influential as the start of FDI（e.g., the start of new international trading channels）. Although we have such limitations, we suggest that the estimation of long-run effects of post-FDI, with the comparison of the two sectors is viable and informative.

For this analysis, we select the FDI entrants from 1980 to 2005. Then we select the observation from the year of entry and the following years. For this panel data, we choose GLS（Generalized Least Squares）estimation with the assumption of random fixed effects, after implementing the F-test and Lagrange Multiplier test over Pooled-OLS, and the Hausman test over fixed-effects GLS. The TFP level of the entrants at a post-FDI year of t

is shown as follows.

$$\begin{aligned} y_{it} &= \psi + X_{it}'\gamma + \upsilon_{it} \\ \text{where } \upsilon_{it} &= \mu_i + u_{it} \end{aligned} \tag{5}$$

In the random-effects model, $\mu_i \sim IID\ (0, \sigma^2_\mu)$, which will keep the degree of freedom high enough, and $u_{it} \sim IID\ (0, \sigma^2_u)$, where u_{it} is independent with μ_i.

Table 5-1 gives the summary statistics of the entrants, with those of non-entrants for comparison. Table 5-2 is the correlation matrices. Observation for entrants are from their initial investment years in FDI and any years after, if those are keep listed in the stock exchanges during 1980 to 2005. Observation of non-entrants are taken for their years listed in the stock exchanges during 1980-2005.[17)]

In the service sector, the entrants show higher TFP levels and growth rates, as well as larger sizes of firms. In the manufacturing sector, there are fewer distinctions between entrants and non-entrants, compared to that in the service sector. But entrants show slightly higher levels of TFP levels, profitability, size, and capital-labor ratio.

In Table 6, the upper table takes the TFP level compared to that of the representative firm at the initial year as the dependent variable.[18)] The lower table takes the cross-sectional TFP, the level of deviation from the industry average of each reporting year, as the dependent variable. For regressors, we select the following: the firm's years of operation after the entry to FDI (the firm's experience in FDI), profitability, size, research intensity, and capital-labor ratio (in logarithm of real values).

The experience in FDI turns out as a positive and significant factor of enhancing TFP levels in both sectors. With an additional year of experience, a firm in the service sector may be about 1.4 times more productive in TFP growth than that in the manufacturing sector. The effect of the experience on the cross-sectional TFP is also stronger in the service sector. TFP in both sectors receives the positive significant effects from profitability, but the negative significant effects from the firm size, indicating that a firm's growth rate declines as its size becomes larger.

To further investigate whether the significance in Table 6 is consistently observable or not, we partition the sample by their years of entry into FDI. We conjecture that, if the features above are consistent, the results may hold significance for partitioned groups. Table 7 indicates the results for service in the upper part, and for manufacturing in the lower part. In both sectors, the significance is kept for the FDI experiences and profitability of firms. The effects of experience on TFP in both sectors becomes greater for the firm group of

Table 5-1　Summary Statistics by Sector and Entry Status

Variables		Service							
		Non-Entrants				Entrants into FDI			
ln_TFP	overall	**-0.111**	0.202	Obs.	9060	**-0.080**	0.199	Obs.	3595
by time trend	between		0.188	Firm (i)	799		0.172	Firm (i)	283
	within		0.108	Time (t)	11.34		0.114	Time (t)	12.70
lnTFP	overall	**-0.099**	0.173	Obs.	9060	**-0.069**	0.170	Obs.	3595
by cross-section	between		0.166	Firm (i)	799		0.157	Firm (i)	283
	within		0.087	Time (t)	11.34		0.088	Time (t)	12.70
lnTFP_(t)- lnTFP_(t-1)	overall	**0.008**	0.070	Obs.	9060	**0.012**	0.073	Obs.	3595
	between		0.030	Firm (i)	799		0.022	Firm (i)	283
	within		0.067	Time (t)	11.34		0.070	Time (t)	12.70
R&D intensity	overall	**0.001**	0.007	Obs.	10254	**0.000**	0.002	Obs.	4062
(R&D spending/Sales)	between		0.003	Firm (i)	813		0.001	Firm (i)	285
	within		0.006	Time (t)	12.61		0.002	Time (t)	14.25
Operational Profits/Sales	overall	**0.068**	0.102	Obs.	10254	**0.061**	0.083	Obs.	4061
	between		0.097	Firm (i)	813		0.083	Firm (i)	285
	within		0.062	Time (t)	12.61		0.046	Time (t)	14.25
ln_(Number of Employees)	overall	**6.216**	1.619	Obs.	10255	**6.626**	1.632	Obs.	4068
	between		1.473	Firm (i)	813		1.379	Firm (i)	285
	within		0.903	Time (t)	12.61		0.931	Time (t)	14.27
ln_(Capital Stock/Employees)	overall	**10.095**	1.295	Obs.	8976	**10.08**	1.250	Obs.	3490
	between		1.165	Firm (i)	785		1.155	Firm (i)	279
	within		0.714	Time (t)	11.43		0.656	Time (t)	12.51

Variables		Manufacturing							
		Non-Entrants				Entrants into FDI			
ln_TFP	overall	**-0.058**	0.117	Obs.	10613	**-0.053**	0.119	Obs.	11192
by time trend	between		0.099	Firm (i)	630		0.085	Firm (i)	611
	within		0.079	Time (t)	16.85		0.090	Time (t)	18.32
lnTFP	overall	**-0.036**	0.070	Obs.	10613	**-0.026**	0.064	Obs.	11192
by cross-section	between		0.056	Firm (i)	630		0.049	Firm (i)	611
	within		0.050	Time (t)	16.85		0.046	Time (t)	18.32
lnTFP_(t)- lnTFP_(t-1)	overall	**0.006**	0.048	Obs.	10613	**0.010**	0.043	Obs.	11192
	between		0.014	Firm (i)	630		0.015	Firm (i)	611
	within		0.046	Time (t)	16.85		0.041	Time (t)	18.318
R&D intensity	overall	**0.001**	0.009	Obs.	11468	**0.001**	0.003	Obs.	12182
(R&D spending/Sales)	between		0.006	Firm (i)	638		0.002	Firm (i)	616
	within		0.007	Time (t)	17.97		0.003	Time (t)	19.78
Operational Profits/Sales	overall	**0.042**	0.088	Obs.	11468	**0.051**	0.069	Obs.	12182
	between		0.117	Firm (i)	638		0.059	Firm (i)	616
	within		0.062	Time (t)	17.97		0.050	Time (t)	19.78
ln_(Number of Employees)	overall	**6.150**	1.139	Obs.	11468	**6.706**	1.093	Obs.	12182
	between		1.129	Firm (i)	638		1.089	Firm (i)	616
	within		0.556	Time (t)	17.97		0.545	Time (t)	19.78
ln_(Capital Stock/Employees)	overall	**9.329**	1.176	Obs.	10720	**9.466**	1.075	Obs.	11041
	between		1.028	Firm (i)	624		0.791	Firm (i)	608
	within		0.846	Time (t)	17.18		0.794	Time (t)	18.16

Table 5-2 Correlation Matrices

Service Sector, Non-entrants into FDI

Obs. =8352	timelnTFP	crosslnTFP	dlnTFP	R&D/Sales	Profits/Sale	# Employee	ln(K/L)
timelnTFP	1						
crosslnTFP	0.8847	1					
dlnTFP	0.1977	0.2317	1				
R&D/Sales	0.0273	0.0131	-0.0197	1			
Profits/Sales	0.3055	0.2766	0.0681	-0.0135	1		
# Employees	-0.1642	-0.1101	0.0273	0.0077	-0.0763	1	
ln(K/L)	0.307	0.2081	0.0014	0.0695	0.2074	-0.2143	1

Service Sector, Entrants into FDI

Obs. =3284	timelnTFP	crosslnTFP	dlnTFP	R&D/Sales	Profits/Sale	# Employee	ln(K/L)
timelnTFP	1						
crosslnTFP	0.8853	1					
dlnTFP	0.212	0.2277	1				
R&D/Sales	-0.0609	-0.059	-0.0247	1			
Profits/Sales	-0.0267	-0.0103	0.0065	-0.001	1		
# Employees	-0.1007	-0.1027	-0.0579	0.0004	0.0042	1	
ln(K/L)	0.3031	0.2013	-0.0217	-0.0208	-0.0063	-0.0723	1

Manufacturing Sector, Non-entrants into FDI

Obs. =10240	timelnTFP	crosslnTFP	dlnTFP	R&D/Sales	Profits/Sale	# Employee	ln(K/L)
timelnTFP	1						
crosslnTFP	0.5637	1					
dlnTFP	0.1084	0.2828	1				
R&D/Sales	-0.0792	-0.0524	0.002	1			
Profits/Sales	0.2353	0.4479	0.1765	-0.0309	1		
# Employees	-0.1118	0.052	0.0113	-0.026	0.0519	1	
ln(K/L)	0.2653	0.0267	-0.0366	-0.0258	0.0348	-0.176	1

Manufacturing Sector, Entrants into FDI

Obs. =10627	timelnTFP	crosslnTFP	dlnTFP	R&D/Sales	Profits/Sale	# Employee	ln(K/L)
timelnTFP	1						
crosslnTFP	0.5366	1					
dlnTFP	0.125	0.2534	1				
R&D/Sales	-0.1279	-0.0887	-0.0092	1			
Profits/Sales	0.2406	0.5445	0.198	-0.0348	1		
# Employees	-0.0949	-0.0051	-0.0433	0.0169	0.0568	1	
ln(K/L)	0.3575	0.0133	-0.0141	-0.0405	-0.0626	-0.1208	1

Table 6　Post-FDI Productivity of Entrants by Sector
（Productivity from　1980 − 2005; Entrants from 1980-2005）

GLS	Service			Manufacturing		
ln_TFP (t) by time trend from the initial year	(1)	(2)	(3)	(4)	(5)	(6)
Years of Operation after Entry to FDI	0.0132*** [0.0006]	0.0132*** [0.0006]	0.0120*** [0.0007]	0.0093*** [0.0002]	0.0093*** [0.0002]	0.0086*** [0.0003]
Profit/Sales (t-1)	0.5837*** [0.0476]	0.5839*** [0.0479]	0.6176*** [0.0470]	0.4037*** [0.0187]	0.3994*** [0.0188]	0.4231*** [0.0188]
ln_Size (t-1)	-0.0090*** [0.0024]	-0.0090*** [0.0024]	-0.0476*** [0.0060]	-0.0014 [0.0013]	-0.0014 [0.0013]	-0.0074*** [0.0023]
R+D Intensity (t-1)		-0.2787 [5.6507]			-0.6125** [0.2773]	
ln_(Kstock/L) (t-1)			0.0076 [0.0051]			0.0064*** [0.0018]
Constant	-0.1872 [0.1231]	-0.1872 [0.1232]	0.6233*** [0.1894]	-0.1649*** [0.0190]	-0.1632*** [0.0190]	-0.1747*** [0.0291]
Fixed Effects						
industry dummies	Yes	Yes	Yes	Yes	Yes	Yes
year dummies	Yes	Yes	Yes	Yes	Yes	Yes
Observations	2090	2090	2044	6233	6233	6176
Number of Firms	259	259	255	573	573	570
R-squared Overall	0.4114	0.4114	0.4239	0.3651	0.3664	0.3665
R-squared Between	0.5038	0.5039	0.4946	0.4612	0.4618	0.489
R-squared Within	0.2353	0.2353	0.2733	0.3054	0.3058	0.3665

Standard errors in brackets

*** p<0.01, ** p<0.05, * p<0.1

GLS	Service			Manufacturing		
ln_TFP (t) by cross-section deviation from the industry average at year t	(1)	(2)	(3)	(4)	(5)	(6)
Years of Operation after Entry to FDI	0.0020*** [0.0005]	0.0020*** [0.0005]	0.0007 [0.0006]	0.0003** [0.0001]	0.0002* [0.0001]	0.0001 [0.0002]
z-stat	(3.87)	(3.90)	(1.15)	(2.02)	(1.79)	(0.50)
Profit/Sales (t-1)	0.5458*** [0.0429]	0.5432*** [0.0432]	0.5847*** [0.0424]	0.4245*** [0.0128]	0.4216*** [0.0129]	0.4345*** [0.0130]
ln_Size (t-1)	-0.0100*** [0.0021]	-0.0101*** [0.0021]	-0.0393*** [0.0055]	-0.0039*** [0.0009]	-0.0038*** [0.0009]	-0.0049*** [0.0016]
R+D Intensity (t-1)		2.5063 [5.0279]			-0.4084** [0.1886]	
ln_(Kstock/L) (t-1)			0.0101** [0.0046]			0.0017 [0.0012]
Constant	-0.0389 [0.1216]	-0.039 [0.1217]	0.7379*** [0.1817]	-0.0101 [0.0140]	-0.009 [0.0140]	-0.0172 [0.0210]
Fixed Effects						
industry dummies	No	No	No	No	No	No
year dummies	Yes	Yes	Yes	Yes	Yes	Yes
Observations	2090	2090	2044	6233	6233	6176
Number of Firms	259	259	255	573	573	570
R-squared Overall	0.3632	0.3626	0.3796	0.3045	0.3059	0.3054
R-squared Between	0.4534	0.452	0.4608	0.4297	0.4309	0.4672
R-squared Within	0.0687	0.069	0.1031	0.1276	0.1283	0.1268

Standard errors in brackets

*** p<0.01, ** p<0.05, * p<0.1

Table 7 Post-FDI Productivity of Entrants by Sector and by Years of Entry
(Productivity from 1980 − 2005; Entrants from 1980-2005)

	Service					
ln_TFP (t) by time trend from year=0 in 1980		(1)	(2)	(3)	(4)	(5)
	Entrants between 1980-2005	Entrants 1980-1985	Entrants 1986-1990	Entrants 1991-1995	Entrants 1996-2000	Entrants 2001-2005
Years of Operation after Entry to FDI	0.0120*** [0.0007]	0.0093*** [0.0011]	0.0123*** [0.0012]	0.0197*** [0.0018]	0.0191*** [0.0026]	0.0190** [0.0090]
Profit/Sales (t-1)	0.6176*** [0.0470]	0.4764*** [0.1420]	0.6770*** [0.0669]	0.3846*** [0.1410]	0.7035*** [0.1079]	0.5886*** [0.1984]
ln_Size (t-1)	-0.0476*** [0.0060]	-0.0582*** [0.0104]	-0.0411*** [0.0105]	-0.0622*** [0.0150]	-0.0196 [0.0151]	0.0035 [0.0312]
ln_(Kstock/L) (t-1)	0.0076 [0.0051]	-0.0145 [0.0100]	0.0224*** [0.0078]	-0.0200* [0.0118]	0.0028 [0.0159]	0.0838*** [0.0309]
Fixed Effects						
industry dummies	Yes	Yes	Yes	Yes	Yes	Yes
year dummies	Yes	Yes	Yes	Yes	Yes	Yes
Observations	2044	432	718	465	303	168
Number of Firms	255	33	66	51	52	64
R-squared Overall	0.4239	0.4445	0.5947	0.2759	0.4456	0.4297
R-squared Between	0.4946	0.5975	0.7169	0.3565	0.461	0.4899
R-squared Within	0.2733	0.2523	0.3462	0.3171	0.3173	0.4297

Standard errors in brackets

*** p<0.01, ** p<0.05, * p<0.1

	Manufacturing					
ln_TFP (t) by time trend from year=0 in 1980		(1)	(2)	(3)	(4)	(5)
	Entrants between 1980-2005	Entrants 1980-1985	Entrants 1986-1990	Entrants 1991-1995	Entrants 1996-2000	Entrants 2001-2005
Years of Operation after Entry to FDI	0.0086*** [0.0003]	0.0068*** [0.0004]	0.0089*** [0.0004]	0.0125*** [0.0007]	0.0102*** [0.0012]	0.0234*** [0.0044]
Profit/Sales (t-1)	0.4231*** [0.0188]	0.3964*** [0.0349]	0.4883*** [0.0306]	0.5283*** [0.0429]	0.2800*** [0.0475]	0.7095*** [0.1210]
ln_Size (t-1)	-0.0074*** [0.0023]	-0.026*** [0.0058]	-0.0107*** [0.0034]	0.0063* [0.0035]	-0.0021 [0.0056]	0.0063 [0.0081]
ln_(Kstock/L) (t-1)	0.0064*** [0.0018]	0.020** [0.0038]	0.0065** [0.0026]	-0.0118*** [0.0033]	0.0254*** [0.0077]	0.0043 [0.0095]
Fixed Effects						
industry dummies	Yes	Yes	Yes	Yes	Yes	Yes
year dummies	Yes	Yes	Yes	Yes	Yes	Yes
Observations	6176	1763	2453	1148	702	173
Number of Firms	570	105	190	115	97	76
R-squared Overall	0.3665	0.4464	0.421	0.4353	0.3735	0.6196
R-squared Between	0.489	0.555	0.5344	0.7006	0.5522	0.7385
R-squared Within	0.3665	0.3451	0.3425	0.2769	0.3735	0.2168

Standard errors in brackets

Table 8　TFP Growth of Entrants after FDI

	Service							
	⊿lnTFP_t+1 (t+1)-(t)		⊿lnTFP_t+1 (t+1)-(t)		⊿lnTFP_t+1 (t+1)-(t)		⊿lnTFP_t+1 (t+1)-(t)	
Years of Entry	**All (1980-2005)**		(1980-1985)		(1986-1995)		(1996-2005)	
⊿lnTFP_t (t)-(t-1)		-0.0188 [0.0282]		-0.0019 [0.0582]		-0.0022 [0.0354]		-0.108 [0.0855]
⊿Profit/Sales (t)-(t-1)	0.6157*** [0.0322]	0.6051*** [0.0357]	0.5209*** [0.0615]	0.5193*** [0.0670]	0.6955*** [0.0441]	0.6935*** [0.0486]	0.5827*** [0.0840]	0.5205*** [0.0972]
⊿ln_(Kstock/Labor) (t)-(t-1)	0.0095** [0.0039]	0.0094** [0.0039]	0.0054 [0.0058]	0.0055 [0.0058]	0.0152*** [0.0052]	0.0153*** [0.0052]	-0.0535** [0.0206]	-0.0569*** [0.0207]
⊿ln_Size (t)-(t-1)	-0.0366*** [0.0087]	-0.0355*** [0.0088]	-0.0107 [0.0175]	-0.0107 [0.0175]	-0.0401*** [0.0106]	-0.0396*** [0.0108]	-0.0922** [0.0375]	-0.0900** [0.0375]
Year Dummies	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Constant	-0.0059 [0.0297]	-0.0057 [0.0297]	-0.0189 [0.0334]	-0.0188 [0.0335]	0.0546 [0.0343]	0.0541 [0.0343]	0.0078 [0.0276]	0.003 [0.0278]
Observations	1468	1466	355	354	919	918	194	194
Number of Firms	209	209	31	31	116	116	62	62
R-squared	0.29	0.29	0.32	0.32	0.3	0.3	0.33	0.34

	Manufacturing							
	⊿lnTFP_t+1 (t+1)-(t)		⊿lnTFP_t+1 (t+1)-(t)		⊿lnTFP_t+1 (t+1)-(t)		⊿lnTFP_t+1 (t+1)-(t)	
Years of Entry	**All (1980-2005)**		(1980-1985)		(1986-1995)		(1996-2005)	
⊿lnTFP_t (t)-(t-1)		0.1527*** [0.0161]		0.1590*** [0.0284]		0.1667*** [0.0210]		0.3004*** [0.0542]
⊿Profit/Sales (t)-(t-1)	0.2822*** [0.0085]	0.3274*** [0.0095]	0.2266*** [0.0154]	0.2653*** [0.0164]	0.2678*** [0.0114]	0.3164*** [0.0125]	0.4500*** [0.0237]	0.5735*** [0.0318]
⊿ln_(Kstock/Labor) (t)-(t-1)	0.0075*** [0.0012]	0.0085*** [0.0012]	0.0084*** [0.0022]	0.0102*** [0.0022]	0.0049*** [0.0015]	0.0053*** [0.0015]	0.0122* [0.0065]	0.0156** [0.0062]
⊿ln_Size (t)-(t-1)	-0.0257*** [0.0032]	-0.0291*** [0.0032]	-0.0165*** [0.0060]	-0.0197*** [0.0060]	-0.0351*** [0.0041]	-0.0396*** [0.0041]	-0.0290* [0.0161]	-0.0471*** [0.0157]
Year Dummies	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Constant	-0.0023 [0.0098]	-0.0025 [0.0096]	-0.0133 [0.0135]	-0.0126 [0.0133]	0.0189** [0.0090]	0.0173* [0.0092]	-0.0131 [0.0085]	-0.0137* [0.0081]
Observations	4789	4778	1478	1474	2878	2871	433	433
Number of Firms	505	505	103	103	302	302	100	100
R-squared	0.33	0.35	0.31	0.33	0.32	0.34	0.57	0.61

more recent entrants, with fewer years of experience. This result is reasonable, by accounting the trade-off of size（or years）and growth empirically shown in several studies by the test of Gibrat's Law.

For the panel data analysis in general, keep in mind the dynamic effects of regressors. With the effects considered, regressors may need to in-clude the lagged dependent vari-

ables. Table 8 then shows the regression on TFP growth by incorporating a lagged TFP growth. In the table, the positive significant effects of profitability on TFP growth still hold. However, two sectors show different responses on the lagged TFP growth term. In the service sector, the lagged TFP term is not significant, but in manufacturing, it is. This means that TFP in manufacturing firms may have an autoregres-sive nature, and we have to discount the result of the manufacturing sector in Table 6 and 7 in terms of their unbiasedness.

5. Conclusions

This paper delivers new empirical comparison of the service and manufacturing sectors, in terms of their choice to be multinational firms, and these multinational firms' productivity after FDI. By comparing the motivation as well as outcome of FDI, the paper gives empirical implication to explain the relatively inactive FDI activity in the service sector observed in Japan. Even in our data set of listed firms, on average, only 1.5 percent of firms newly launch FDI in the service sector. This frequency is less than half the level of the manufacturing industry average. But in the world accelerated by liberalization in trade policy or development of information technology, we observe an increase in service FDI both in volume and in presence. Therefore, analyzing causes and outcomes of service FDI is important in planning a promotion of service FDI.

We find the following results. First, compared by year and by industry, the TFP in manufacturing does not explain a firm's choice for beginning FDI, but TFP in the service sector works as a strong determinant for starting FDI. This implies that if a firm is stagnant in low productivity level, this will prevent a firm from launching FDI in the service sector.

Second, in the manufacturing sector, the current scale and profitability of firms are positive factors for their future choice in FDI, but these do not matter in the service sector. This implies that if a firm is small in scale, and low in profitability, these will become the limiting factors for FDI.

Third, after the start of FDI, entrants in service show a 1.4 times higher annual productivity growth than those in the manufacturing sector. This may suggest that, once entered, a firm in the service sector can possibly benefit from FDI to improve its efficiency. Through our propensity matching methods, which eliminate firm-level fixed effects, we confirm that there exist positive treatment effects of FDI on the service sector. But the effects in the manufacturing sector are subtle, due to the autocorrelation features from the

preceding TFP growth.

Our research will likely continue in the following directions. First, TFP comparison in service and manufacturing with its relation to overseas activities is to be done by combining more detailed FDI and trade information. In this paper, we focus on the event of the initial launch into FDI in a history of a firm, which fits most of the theoretical models to explain the startup of FDI. But in reality, some firms continue to establish multiple affiliates in multiple countries, with several timings of entry, and even with a couple of different modes. Therefore, we are interested in fixing this complexity in order to estimate post-FDI productivity growth more properly.

Secondly, we are also interested in analyzing the TFP growth by sources of contribution, such as entry and exit of firms in a industry, or productivity growth within existing firms. In the data of listed firms, a firm in general has a long life and a constant presence in the statistics. In this special case, the entry and exit from the stock exchanges are far less frequent than a small firm's entry and exit from census-coverage statistics. Although we have such observational limitations, we could still separate the industry-level productivity into within effects, between effects, and covari-ance effects. Thus the findings will further clarify the reasons for difference in productivity and FDI activity across sectors.

Notes

1）Among the total amount of 10 trillion US dollars, 2.5 trillion go to B-to-B（Business to Business）services, 0.7 trillion go to transportation and telecommunication, respectively.

2）According to the UNCTAD, U.S. Department of Commerce, and *the Eurostat*, the figures in 2004 are 74 percent in the U.S., 76 percent in the EU15（61 percent in the U.K., 79 percent in Germany and France）. The white paper also reports that the service-related FDI in Japan is skewed in the financial sector（48.8 percent）and not active in other service industries.

3）The data source is *The Basic Survey of Business Structure and Activity.*

4）The data source is *The Basic Survey of Business Structure and Activity.*

5）This is the concern for "exporting jobs" or "job-loss," which gains attention in some political debates in the U.S.

6）Desai, Foley, and Hines（2005）, with US manufacturing data, also present the result that the domestic and foreign capital investments are the complements.

7）They combine *The Basic Survey of Business Structure and Activity, The Basic Survey of Overseas Business Activity, and The Manufacturing Census* in 1995, 2000, and 2003

8）Head and Ries（2003）use the data of listed firms by Toyo-Keizai Inc., and Tomiura（2007）uses *The Basic Survey of Commercial and Manufacturing Structure and Activity*（*Sho-Kogyo Jittai Kihon Chosa*, in Japanese）by METI.

9）According to their findings, the labor productivity in the service sector shows high hetero-

geneity across industries, highest in the telecommunication industry (50 percent) to the lowest in electricity services (-15.5 percent). On average, there is a -2.7 percent annual growth in 1997-1999, and 1.5 percent in 2000-2002.

10) Amiti and Wei (2006) show that service outsourcing by manufacturing sector has positive influence on value added of that industry, using US manufacturing data of 1992-2000. But they do not analyze activities by domestic service industries.

11) Firms in finance or in insurance service are omitted from the database. We further omit firms in agriculture, mining, and construction, to make our definition of the service industry comparable to the JSIC (Japan Standard Industrial Classification) as of March, 2003.

12) The combination excludes the listed firms in some new security exchanges (Jasdaq, Hercules, and Mothers). Thus, 73 firms in DBJ Data Bank are left unmatched with the Toyo-Keizai database.

13) Therefore, any additional FDI in year t + 1 or later is not recorded as 1.

14) Here we use the TFP (in logarithm) of a firm, compared to its industry average, of the reporting year. Then we abstract industry dummies in regression.

15) See Cameron and Trivedi (2005) for detailed descriptions.

16) We also compute bootstrapped standard errors to adjust for additional sources of variability introduced by the estimation of propensity score. But the result do not change the level of significance shown in table 4.

17) Selection of entrants here omits the firms who started FDI before 1980. Since some firms start FDI as early as 1933, we consider these as not relevant for estimating the post-FDI effects over TFP. This cutoff eliminates a certain numbers of manufacturing giants and firms in relation, who set up foreign affiliates in earlier years as pioneers. Therefore the proportion of entrants in the selection is 49.2 percent in manufacturing, and 26.1 percent in service. In manufacturing, there is a decline in the proportion.

18) We denote the initial level as $TFP = 1$, i.e. $\ln TFP = 0$. The computation of TFP is given in the appendix.

19) We extract data of listed Japanese firms from the JECR (http://www.jcer.or.jp/eng/index.html). I would like to thank Young Gak Kim for his instruction on data and provision of related deflators.

20) We define the representative firm as a hypothetical firm whose logarithm value of gross output, inputs, and cost shared of all production factors are set at the industry averages.

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6. Appendix : Computation of TFP

This section gives a remark on the computation of TFP in our data. The description is based on Kim (2006).[19] Following Good, Nadiri, and Sickles (1997) and Aw, Chen, and Roberts (1997), we define the TFP level of firm f in year t in a certain industry in comparison with the TFP level of a hypothetical representative firm in year t in that industry as below.

$$clnTFP_{f,t} = (\ln Q_{f,t} - \overline{\ln Q_t}) - \sum_{i=1}^{n} \frac{1}{2}(S_{i,f,t} + \overline{S_{i,t}})(\ln X_{i,f,t} - \overline{\ln X_{i,t}}) \tag{6}$$

We call this the cross-sectional TFP index. In equation (6), $Q_{f,t}$ is the gross output, $S_{i,f,t}$ is the cost share of production factor i, $X_{i,f,t}$ is the input of factor i. We consider three factors of production as inputs : capital, labor hours, and intermediate inputs. A variable with an upper bar denotes the industry average (arithmetic mean) of those variables. So, the equation (6) denotes the gap between the TFP of firm f and TFP of the representative firm in the same industry and in year.[20]

We also view TFP in time-series. Suppose that the TFP of the hypo-thetical firm in year 0 (the initial year=1970) is equal to one, the TFP index for firm f in year t is defined as follows.

$$\begin{aligned}\ln TFP_{f,t} = {} & (\ln Q_{f,t} - \overline{\ln Q_t}) - \sum_{i=1}^{n} \frac{1}{2}(S_{i,f,t} + \overline{S_{i,t}})(\ln X_{i,f,t} - \overline{\ln X_{i,t}}) \\ & + \sum_{s=1}^{t}(\overline{\ln Q_s} - \overline{\ln Q_{s-1}}) - \sum_{s=1}^{t}\sum_{i=1}^{n} \frac{1}{2}(\overline{S_{i,s}} + \overline{S_{i,s-1}})(\overline{\ln X_{i,s}} - \overline{\ln X_{i,s-1}})\end{aligned} \tag{7}$$

We call this the multilateral TFP index. In equation (7), the third term shows the cumulative changes in output of the representative firm between year t and year 0, and the forth term shows those in inputs, weighted by the average of cost shares. The advantage of this index is that we do not need to assume any specific production function, except for the constant returns to scale assumption.

We also define the TFP growth index of firm *f* as follows.

$$dlnTFP_{f,t} = (\ln Q_{f,t} - \ln Q_{f,t-1}) - \sum_{i=1}^{n} \frac{1}{2}(S_{i,f,t} + S_{i,f,t-1})(\ln X_{i,f,t} - \ln X_{i,f,t-1}) \qquad (8)$$

Next, we explain our calculation of $Q_{i,f,t}$ (Output) and $X_{i,f,t}$ (Inputs). We use sales as output after adjusting the inventory. For the retailing and wholesale industry, the purchase of merchandize is subtracted from the sales. We use JIP 2006 deflators to get the real output values.

The inputs are capital, labor hours, and intermediate inputs. For capital inputs (capital stock), we use the values of fixed assets including plants, buildings, machinery tools, and transport equipment. We subtract the values of depreciation and convert to the real values using JIP 2006 database.

For labor inputs, we use the total man-hour. The number of employees in each firm is multiplied by the industry average hours worked. The annual labor hour data is taken from the JIP-database till the year by 2002 and the Monthly Labor Survey for 2003 and 2004. For the labor cost of each firm, we include wage with bonus, pension, retirement allowance and reserves, and employees' welfare.

For intermediate inputs, we use the sum of raw materials, fuel, electricity and subcontracting expenses. Then the nominal values are deflated by intermediate input deflators provided in the JIP 2006.