Synergy Effects of Domestic and International M&A *

Kazutaka Takechi†

June 19, 2006

Abstract

This paper examines the productivity effects of domestic and international mergers and acquisitions (M&A). Since firms choose to engage in domestic and international M&A activities, it is important to control for M&A destinations and the endogeneity of M&A. By controlling for the selectivity bias, we find productivity gains from domestic and international M&A by using data on domestic and international M&A of Japanese electronics firms. We also find that motivations for M&A differ between these. These results imply that, while the determinants of M&A are different between domestic and international M&A, synergy gains exist irrespective of destinations.

JEL Classification: D24, F23, G34

Keywords: Mergers and Acquisitions, Direct Investment, Productivity, Firm Heterogeneity, Selectivity Bias

---

*I would like to thank seminar participants at the Institute of Comparative Economic Studies, Hosei University. Financial support for this research was provided through a Grant-in-Aid for Scientific Research by the Japan Society for the Promotion of Science (No.15330057).

†Faculty of Economics, Hosei University, 4342 Aihara-machi, Machida-shi, Tokyo 194-0298, Japan. Email: ktakechi@mt.tama.hosei.ac.jp

1 Introduction

The productivity gain from mergers and acquisitions (M&A) is an important issue when evaluating the effects of M&A. Firms' productivity improves through learning from partner firms or obtaining benefits from partners' complementary assets. On the other hand, M&A require firms to reorganize so that there could be costs of synchronizing corporate culture and the working environment. In addition, even if there are no gains from M&A, corporate managers might have an incentive to acquire firms if they have empire-building aspirations(Jensen (1986)). In these cases, a productivity loss may be found. Theoretically, it is difficult to determine whether productivity gains from M&A outweigh any productivity losses. Hence, the existence of synergy gains from M&A becomes an empirical issue.

With regard to synergy gains, one needs to address the issue of whether domestic and international M&A are different if firms pursue productivity gains. This paper analyzes M&A by Japanese electronics firms. Japanese firms not only engage in domestic M&A, but also in international M&A. If there are differences in motivation between domestic and international M&A, not taking into account the destinations of M&A might be misleading. Previous studies argue that international M&A are strongly intended to access the technology of foreign firms.[1] If so, positive productivity gains from M&A should be evident. However, M&A require organizational changes and communication between firms. Such adjustment costs may be higher for international than for domestic M&A because of cultural or language differences. Thus, total productivity might fall. By examining the effect of domestic and international M&A separately, we address the issue of whether there exist synergy gains from either domestic or international M&A or both.

[1]For direct investment, see Kogut and Chang (1991) and Blonigen (1997), and for M&A type direct investment, Branstetter (2000)

We use data on M&A by Japanese firms in the electronics industry from 1989 to 1998. Our primary interest is on the effect of M&A on Total Factor Productivity (TFP) of firms. One important issue arises when evaluating the synergy effect. Since firms choose M&A, in order to evaluate the M&A effect on productivity, we have to control for the endogeneity of M&A. We address this selectivity bias issue by employing a maximum likelihood estimation developed by Clerides, Lach, and Tybout (1998). Without controlling for the endogeneity of M&A decisions, we find positive effects of domestic M&A, but insignificant effects of international M&A. However, by controlling for the bias we find positive synergy gains from international M&A. These suggest that the selectivity bias is important for evaluating productivity gains from M&A. Therefore, this study contributes to the literature by finding empirical evidence of a positive relationship between productivity and M&A.

The effects of M&A on firm performance have been widely studied in the corporate finance literature. However, the findings on productivity gains from M&A are mixed. These depend on the productivity effect relative to which plants are examined, namely acquired plants, acquiring plants, or the composite firm. Lichtenberg and Siegel (1990) and McGuckin and Nguyen (1995) found positive productivity gains for acquired plants from M&A. Maksimovic and Phillips (2001) found that if firms buy productive firms, losses from M&A may be realized, and if firms purchase less productive firms, there are no significant gains. Overall, a positive productivity effect is obtained for all asset transactions including both partial acquisition and M&A. On the other hand, Schoar (2002) found a positive productivity effect of acquisitions on acquired plants, a negative effect on incumbent plants, and an insignificant effect overall. Here, we focus on the difference between domestic and international M&A and consider overall firms' productivity with self-selection controlled. This is because, from the acquiring firms' point of view, overall productivity is the most suitable measure to evaluate M&A gains. These two issues (domestic versus

international M&A and selectivity bias) have not to our knowledge been examined in the literature.

The studies on M&A are related to the issue of a *diversification discount*: diversifying firms have lower value than standalone firms. Diversification can be done through M&A. Many empirical studies confirm the discount (See Lins and Servaes (1999) on Japanese firms), but Campa and Kedia (2002) show that the diversification discount is due to the selectivity bias. They find a diversification premium after controlling for the endogeneity. Since M&A choice is endogenous, the same implication can be applied. We control for the selectivity bias of international M&A and find positive productivity gains.

Firms' productivity is related to their decision to access foreign markets. In the international trade literature, it is shown that productive firms tend to export, and more productive firms tend to conduct direct investment in developed countries (Helpman, Melitz, and Yeaple (2004) and Head and Ries (2003)). On the other hand, Clerides, Lach, and Tybout (1998) show that firms starting to export do not necessarily become productive. There can be a significant difference between effects of M&A and exporting on productivity because of synergy gains from M&A. It is reasonable to consider that firms learn more easily from partners than from markets. Their efficiency might increase due to learning from foreign partners. Hence, unlike exports, there could be productivity gains from international M&A. Branstetter (2000) shows that Japanese firms receive technology spillover from U.S. subsidiaries through M&A-type direct investment. While he examines the relationship between Japanese M&A in the U.S. and patent citation, we deal with the endogeneity problem of M&A and focus on synergy gains. We extend the literature by considering the dynamic link between international M&A and productivity.

The paper proceeds as follows. In the next section, we set up theoretical and empirical models of M&A and productivity, and then introduce our data set. Then, we report our estimation results. The final section summarizes our conclusions.

2 Theoretical Framework

In this section, we set up a theoretical framework for synergy gains from M&A. First, we consider our productivity measure for examining the effect of M&A on productivity. Then, we consider the dynamic choice problem of M&A to control for the selectivity bias of M&A.

2.1 Productivity

Our productivity measure is TFP. We consider a simple Cobb-Douglas-type production function: $Q = AK^{\alpha_0}L^{\alpha_1}Raw^{\alpha_2}$, where Q is output, A is a shift parameter, K is capital, L is labor input, and Raw is raw material purchases. We use total sales as Q, depreciable assets as K, the number of employees as L, and raw material purchases as Raw. We estimate the following equation: $\ln Q = \ln A + \alpha_0 \ln K + \alpha_1 \ln L + \alpha_2 Raw + \mu_i + \epsilon_{it}$, where μ_i is the fixed effects term and ϵ_{it} is the iid error term. In order to control for unobservable heterogeneity, we employ a fixed effects estimation. The TFP is the residual from the above estimation equation with fixed effects added as in Maksimovic and Phillips (2001). Since our focus is not on the measurement of true productivity, but on the effect of M&A on productivity, if this TFP measure is positively correlated with the true one, this measure can be used for our analysis.

We consider that TFP is affected by M&A and by firm's own technology development activities. Thus, TFP is assumed to be a function of covariates: $TFP_t = f(Y_{t-1}, Z_t)$, where the covariates, Z_t, include R&D. Since it takes time for M&A effects to be effective, we use lagged M&A decisions. $\partial TFP_t / \partial Y_{t-1} > 0$ means that M&A increase productivity: there are synergy gains. Our purpose is to test the existence of synergy gains.

2.2 M&A Decision

Firms decide whether to engage in M&A or not at each period. Therefore, the problem firms confront is a dynamic discrete choice problem (Roberts and Tybout (1997) and Clerides, Lach, and Tybout (1998)). We assume that firms face uncertainty about future profits and have to incur sunk costs such as search costs of finding partners in order to engage in M&A activities. Since an M&A decision is discrete, we consider the following decision variable:

$$Y_{it} = \begin{cases} 1 & \text{if M\&A} \\ 0 & \text{otherwise} \end{cases}$$

By choosing the sequence of M&A decisions, firms maximize the sum of discounted future gross profits:

$$\max_{Y_i} E_t \sum_{t=1}^{\infty} \beta^{t-1} R(X_{it}, Y_{it})$$

where β is a discount factor, $R(.,.)$ is a gross profit function and X_{it} includes state and exogenous variables. The maximized choice of $Y_i = \{Y_{it}\}_{t=1}^{\infty}$ constructs a value function. There are search costs of M&A, C, which are the costs of finding a suitable partner. $C = F$ if $Y_{t-1} = 0$, and 0 otherwise. These costs are irreversible and sunk. The M&A decision has an option value under uncertainty, because if market conditions become better in the next period, it would be profitable to engage in M&A at that period. The Bellman equation is:

$$V = \max[V^1, V^0] = \max[R(X_t, 1) - F(1 - Y_{t-1}) + \beta EV(X_{t+1}, 1), R(X_t, 0) + \beta EV(X_{t+1}, 0)].$$

Firms decide to do M&A when

$$V^1 - V^0 > 0 \iff R(X_t, 1) - R(X_t, 0) + \beta[EV(X_{t+1}, 1) - EV(X_{t+1}, 0)] - F(1 - Y_{t-1}) > 0. \qquad (1)$$

Therefore, the decision depends on the profit difference, the future expected value difference, and the previous-period M&A decision.

3 Data

We have compiled data on M&A, R&D, and firm characteristics for publicly listed Japanese electronics firms classified by Nikkei. Data on M&A came from the *Nihon Kigyo no M&A Databook 1988–2002* (M&A Databook of Japanese firms in 1988–2002) by Recof (in Japanese). The databook covers both domestic and international M&A and contains firms' names, targeted firms' names, dates, industries, countries (if international M&A), and amounts paid for acquisition (if available). M&A includes mergers, acquisitions, partial acquisitions, and equity increases. The publisher collected data by going through media releases of M&A announcements. We do not use the information of the size of M&A due to missing values of the amount of money allocated for M&A. This approach is reasonable since our research is trying to find the existence of synergy effects, and not trying to quantify the synergy effect.

For R&D, our data source is *Japan Company Handbook* (several issues) published by Toyo Keizai. Since accounting R&D input data of electronics industry firms are considered noisy data (Griliches and Mairesse (1985)), we collected them from the handbook (for example, Branstetter (2000) also uses this data source). The handbook indicates yearly R&D spending. Our data period ranges from 1989 to 1998. Since we have concentrated our research on the electronics industry, we have used a sample of 141

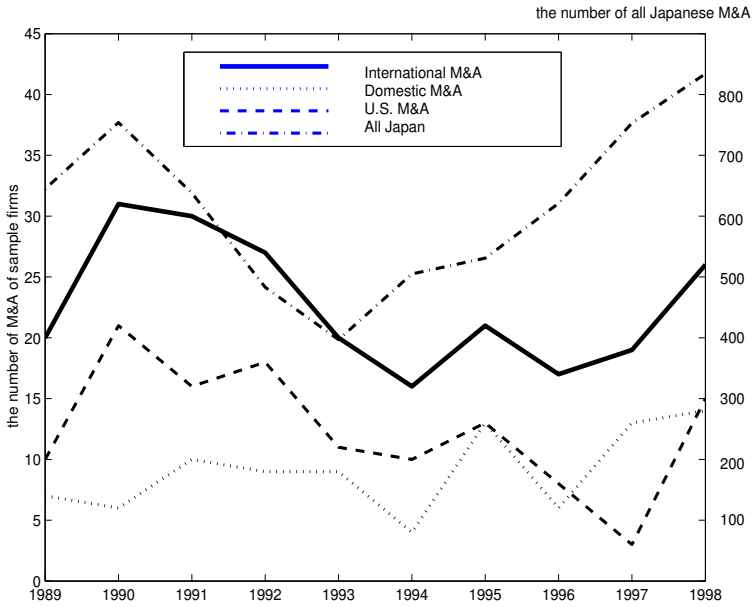

Figure 1: M&A

publicly traded firms, providing 1410 observations. We used this sample size to obtain a balanced panel due to missing data. All R&D spending data are the only parent firms' R&D spending, because our data set is nonconsolidated.

In total, 91 domestic M&A and 227 international M&A over 10 years are included in our sample. More than half of the international M&A are in the U.S. (125 out of 227). Other destinations include Australia, Brazil, Canada, China, Denmark, Finland, France, Greece, Germany, Hong Kong, India, Indonesia, Italy, Malaysia, the Netherlands, Pakistan, Poland, Portugal, Singapore, South Korea, Spain, Sweden, Switzerland, Taiwan, Thailand, and the UK. Figure 1 shows the time series data of M&A over our sample period. The pattern of all Japanese M&A is similar to that of our sample firms' M&A. There was a downward trend in the middle 1990s, reverting to an increase in the late 1990s. Hence, it may be safe to claim that our sample firms' M&A activities are similar to all Japanese firms' M&A activities.

For other covariates, such as the number of employees, depreciable assets, total assets, total debt, sales, and raw material purchases, we use the data gathered from the Nikkei Economic Electronic

Database (NEEDS). The financial data are used to control for observable heterogeneity of firms. Table 1 reports summary statistics. Our sample has a large dispersion, for example in terms of size, with the number of employees ranging from 96 to 81,488.

Table 1: Summary Statistics

	Mean	St.d.	Min	Max
Sales (million yen)	275271	714112	4118	4994719
Employees	5368	12207	96	81488
R&D (million yen)	22296	66984	24	480500
The number of firm=141				
period 1989–1998				

The financial data correspond to a firm's fiscal year, which is not necessarily the calendar year as in Blonigen and Taylor (2000). Hence, we compiled the M&A data that correspond to each firm's fiscal year. Also, during the sample period several firms changed their fiscal year. At that point, R&D spending dropped irregularly (for example, if some firm changes its fiscal year-end from September to March, R&D spending drops by nearly half of other periods' spending), so we adjusted the data proportionally. We used sales data as a denominator of R&D intensity. Table 2 reports each year's M&A, R&D intensity, and average M&A per firm in each year. In our sample period in Japan the R&D to GDP ratio was about 2.8 percent, so our sample firms' R&D intensity was about double the country's level. In R&D-intensive industries, such as the electronics industry, M&A is an important way to acquire technology. Hence, productivity gains from M&A might be prominent in such industries.

Table 2: M&A and R&D

	#Int'l M&A	#D M&A*	#U.S. M&A	R&D intensity	per firm domestic M&A	per firm int'l M&A	per firm U.S. M&A
1989	20	7	10	0.0494	0.0496	0.1418	0.0709
1990	31	6	21	0.0492	0.0426	0.2199	0.149
1991	30	10	16	0.049	0.0709	0.2128	0.1135
1992	27	9	18	0.051	0.0638	0.1915	0.1277
1993	20	9	11	0.0531	0.0638	0.1418	0.078
1994	16	4	10	0.0522	0.0284	0.1135	0.0709
1995	21	13	13	0.0544	0.0922	0.149	0.0922
1996	17	6	8	0.0526	0.0426	0.1206	0.0567
1997	19	13	3	0.0513	0.0922	0.1348	0.0213
1998	26	14	15	0.0529	0.0992	0.1844	0.1064

$*$: #D M&A is the number of domestic M&A.

4 Empirical Specifications

In this section, we introduce specifications used in empirical analysis. Our purpose is to test the existence of synergy gains. We express TFP by the linear form: $TFP_{it} = \gamma_0 + \gamma_1 Y_{it-1} + \gamma_2 R\&D_{it} + \gamma_3 R\&D_{it-1} + \eta_{it}$, where $R\&D_{it}$ is firm i's R&D intensity (the R&D expenditure/sales ratio) in year t. Y_{it-1} is either international or domestic M&A decision. If the motivation for undertaking M&A is different between international and domestic M&A, estimated results of synergy effects might also be different.

With respect to the M&A decision, since we focus on the existence of a synergy effect (the effect of M&A on productivity), we adopt the reduced form approach to express M&A decisions as in Roberts and Tybout (1997) and Clerides, Lach, and Tybout (1998). We consider the value function as a function of covariates. We denote the first part of Equation (1) by $R(X_{it}, 1, Y_{it-1}) - R(X_{it}, 0, Y_{it-1}) + \beta[EV(X_{it+1}, 1) - EV(X_{it+1}, 0)] = X_{it}\delta + \epsilon_{it}$, where X_{it} is a matrix of covariates and δ is a parameter vector. Hence, $V^1 - V^0 > 0$ is expressed by $\beta_1 Y_{it-1} + X_{it}\delta + \epsilon_{it} > 0$. Considering sunk costs of M&A allows us to include previous M&A decisions, Y_{it-1}.

In the empirical analysis, we consider domestic and international M&A decisions separately: 1)

whether to engage in international M&A, or 2) whether to engage in domestic M&A. In each case, we denote that the decision to embark on M&A is 1 if $V^1 - V^0 > 0$ and 0 otherwise. Thus, the decision is based on firms' characteristics: $Y_{it} = I(\beta_1 Y_{it-1} + X_{it}\delta + \epsilon_{it} \geq 0)$, where $I(\cdot)$ is the indicator function and $X_{it}\delta = \delta_0 + \delta_1 \text{TFP}_{it} + \delta_2 \text{FirmSize}_{it} + \delta_3 \text{Debt/Asset}_{it} + \delta_4 \text{Profitability}_{it}$. The covariates are:

- TFP: TFP to control for productivity
- Firm Size: the number of employees to control for firm size
- Debt/Asset: the debt/assets ratio to control for financial structure
- Profitability: the EBITDA/assets ratio to control for profitability

These are considered as the traditional determinants of M&A.

4.1 Equation-by-Equation Estimation

Two equations, the TFP equation and the M&A decision equation, are examined in our empirical analysis. First, we estimate these equations separately as in Maksimovic and Phillips (2001). Then, we adopt a joint estimation procedure. First, we describe the equation-by-equation estimations for the TFP equation and the M&A decision equation.

4.1.1 Productivity Equation

First, we describe the estimation procedure for the TFP equation. Our specification of the TFP equation is: $TFP_{it} = \gamma_0 + \gamma_1 R\&D_{it} + \gamma_2 R\&D_{it-1} + \gamma_3 Y_{it-1} + \eta_{it}$. This equation is static and linear, so we employ random and fixed effects estimations. There can be an unobservable heterogeneity causing correlation

between regressors and the error term. If we assume that an unobservable factor affecting TFP is invariant over time, fixed effects estimation yields a consistent estimator.

4.1.2 M&A Decision

On the M&A decision equation, we use linear probability models and estimate these by GMM. This specification enables us to control for the firm's specific effects as fixed effects. Although the predicted probability does not necessarily constrain between zero and one, the linear probability model is robust to the form of unobserved heterogeneity. Even if the error term and regressors are correlated, we can obtain a consistent estimator.

The linear probability model uses the following regression equation: $Y_{it} = \beta_1 Y_{it-1} + X_{it}\delta + \epsilon_{it}$, where $\epsilon_{it} = \alpha_i + \kappa_{it}$, α_i is the fixed effects term, and κ_{it} is the iid error term. In order to control for a firm's fixed effects, we can take the first difference or apply a within transformation. In a static model, this produces a consistent estimator. However, this estimator is not consistent in a dynamic model. Arellano and Bond (1991) develop a GMM estimator to obtain a consistent estimator. Taking the first difference yields: $\Delta Y_{it} = \beta_1 \Delta Y_{it-1} + \Delta X_{it}\delta + \Delta\epsilon_{it}$. In this case, the lagged level variables are uncorrelated with the error term. Thus, the moment conditions are: $E[\Delta\eta_{it} Y_{it-s}] = 0, E[\Delta\eta_{it} X_{it-s+1}] = 0, t = 3, \ldots, T,$ and $s \geq 2$. The level variables are used as instruments for the first difference estimation. Thus, the GMM estimator yields a consistent estimator.

However, Blundell and Bond (1998) demonstrate that this GMM estimator has poor finite sample properties when the lagged levels of the series correlate with subsequent first differences only weakly. Blundell and Bond (1998) go on to show that the GMM estimation in combination with levels equations corrects the downward bias and improves efficiency, so we employ the Blundell and Bond GMM

method.[2] This is called a system GMM estimation, because first differences equations and levels equations are used simultaneously. For levels equations, we use first-differenced variables as instruments based on the following moment conditions: $E[\epsilon_{it}\Delta Y_{it-1}] = 0$ and $E[\epsilon_{it}\Delta X_{it}] = 0$.

4.2 Maximum Likelihood Estimation

There are two problems in equation-by-equation estimation: one is the self-selection problem and the other is the initial conditions problem. In order to deal with these problems, we employ a full information maximum likelihood estimation as in Clerides, Lach, and Tybout (1998). We use the system of equations: $Y_{it} = I(\beta_1 Y_{it-1} + X_{it}\delta + \alpha_1 + \xi_{1it} > 0)$ and $TFP_{it} = \gamma_0 + \gamma_1 R\&D_{it} + \gamma_2 R\&D_{it-1} + \gamma_3 Y_{it-1} + \alpha_2 + \xi_{2it}$. We assume that the distribution of errors is joint normal: $(\xi_1, \xi_2) \sim N(0, \Sigma)$. We have the unobserved heterogeneity terms, α_1 and α_2, in this likelihood function. We integrate out these unobservables by using Gauss-Hermit quadrature with six grid points.

In a dynamic model, we need to control for initial condition problems (Heckman (1981)). We adopt an approximation solution for initial condition problems, which represents initial periods choice probability by probit and allows the initial period error term to be correlated with subsequent periods' errors. Then, the likelihood function is given by:

$$L = \int\int [\Pi_{n=1}^{N}\Pi_{j=1}^{J}\phi(W_{1nj})[1-\Phi(W_{2nj})]^{Y_{nj}}\Phi(W_{2nj})^{1-Y_{nj}}]\Pi_{n=1}^{N}\Pi_{t=1}^{T}\phi(W_{1nt})[1-\Phi(W_{2nt})]^{Y_{nt}}\Phi(W_{2nt})^{1-Y_{nt}}d\alpha_1 d\alpha_2,$$

where $W_{1nj} = (TFP_{nj} - Z_{nj}\tilde{\gamma} - \tilde{\gamma}_3 Y_{nj-1} - \rho_2\alpha_2)/\sigma_2$, $W_{2nj} = -[\tilde{\beta}_1 Y_{nj-1} + X_{nj}\tilde{\delta} + \rho_1\alpha_1(\sigma_{12}/\sigma_2)(TFP_{nj} - Z_{nj}\tilde{\gamma} - \tilde{\gamma}_3 Y_{nj-1} - \alpha_2)]\sqrt{\sigma_1 - \sigma_{12}/\sigma_2}$, $W_{1nt} = (TFP_{nt} - Z_{nt}\gamma - \gamma_3 Y_{nt-1} - \alpha_2)/\sigma_2$, and $W_{2nt} = -[\beta_1 Y_{nt-1} + X_{nt}\delta +$

[2]The DPD package for Ox is used for this estimation (see Doornik, Arellano, and Bond (2002) for usage).

$\alpha_1(\sigma_{12}/\sigma_2)(TFP_{nt} - Z_{nt}\gamma - \gamma_3 Y_{nt-1} - \alpha_2)]\sqrt{\sigma_1 - \sigma_{12}/\sigma_2}$. Z_{nt} and Z_{nj} include R&D, (α_1, α_2) are assumed to be joint normal, and ρ_1 and ρ_2 are correlation parameters. The derivation of the likelihood function is drawn from Clerides, Lach, and Tybout (1996). This specification takes into account the selectivity bias of M&A.

5 Results

In this section, we report our empirical results. First, we report estimation results obtained by equation-by-equation estimation. Then, we show the results of maximum likelihood estimation with the selectivity bias controlled.

5.1 International M&A

This section reports the results of international M&A decisions. In Table 3, columns 1 to 3 show the results of equation-by-equation estimates. The top five rows are the estimates from the M&A decision equation and the next three rows are from the TFP equation. For reference, columns 1 and 2 show estimation results of random and fixed effects, respectively. Column 3 reports the GMM results. Since the GMM estimator yields a consistent estimator, we mainly discuss the GMM results for M&A decisions. Column 3 in Table 3 shows that the lagged dependent variable (Y_{t-1}) is positively related to the current M&A decision (0.121), suggesting the existence of sunk costs of M&A. Firms need to incur large informational costs to find foreign partners, so previous experience helps save such costs.

Productivity is positively correlated with M&A (0.062). This implies that productive firms tend to acquire foreign firms. Firm size is also found to be positive (0.081). It is known in the literature that

Table 3: International M&A

M&A Decision Eq.	Random	Fixed	GMM-SYS	Pooled	FIML
Y_{t-1}	0.548^a	-0.011	0.121^b	1^a	0.285^a
	(0.025)	(0.04)	(0.049)	(0.152)	(0.076)
$Productivity_t$	0.024	0.024	0.062^c	0.234	0.762^a
	(0.015)	(0.071)	(0.032)	(0.191)	(0.066)
Firm Size	0.045^a	0.032	0.081^a	0.516^a	0.38^a
	(0.005)	(0.067)	(0.015)	(0.06)	(0.054)
Debt/Asset	-0.022^c	-0.014	-0.033	-0.279^b	0.052
	(0.012)	(0.053)	(0.023)	(0.139)	(0.105)
Profitability	-0.112	0.349^a	0.091	1.037^c	2.19^a
	(0.122)	(0.124)	(0.086)	(0.56)	(0.027)
Productivity Eq.					
Y_{t-1}	0.004	0.002		0.67^c	0.319^a
	(0.011)	(0.009)		(0.038)	(0.036)
$R\&D_t$	0.111^a	0.088^a		0.938^b	0.292^a
	(0.014)	(0.029)		(0.448)	(0.098)
$R\&D_{t-1}$	-0.016	-0.033		-0.715	-0.145
	(0.014)	(0.021)		(0.438)	(0.109)
std(ξ_1)				1^*	0.983^*
std(ξ_2)				21.387	6.598
corr(ξ_1, ξ_2)				-0.047	-0.269
std(α_1)					0.181^*
std(α_2)					0.395
corr(α_1, α_2)					-0.29

The numbers in parentheses are standard errors. The superscripts ^{a}, ^{b}, and ^{c} indicate statistical significance at the 1 percent, 5 percent, and 10 percent levels.
$*$: The variance of ξ_1 and that of $\xi_1 + \alpha_1$ are normalized to 1 in the pooled case and FIML, respectively.

large firms are likely to engage in M&A activities. Here, the same result is confirmed. On the other hand, other determinants, debt/asset ratio and profitability, are insignificant. This suggests that corporate finance factors are not the main determinants for international M&A. We find below that the debt/asset ratio is significant for domestic M&A.

With respect to the productivity equation, columns 1 and 2 in Table 3 show that the productivity effect of M&A is not found in the equation-by-equation estimation. On the contrary, contemporaneous R&D positively affects productivity (0.088 in fixed effects). Hence, we do not find a synergy effect in the equation-by-equation estimation.

Columns 4 and 5 in Table 3 report the results of maximum likelihood estimation. Column 4 shows the results when the data are treated as pooled data. In this case, we do not have unobservable effects and need not take initial conditions into account. Column 5 reports the FIML results. For M&A decisions, in both cases, lagged dependent variables are positively correlated with M&A decisions (1 for pooled and 0.285 for FIML). This result is the same as in equation-by-equation estimation. With respect to the TFP equation, contrary to the equation-by-equation estimation, we obtain a positive effect of M&A on productivity (0.67 for pooled and 0.319 for FIML). This implies the existence of synergy gains from international M&A.

In column 5, the correlations between errors in M&A decisions and TFP equations are found to be negative ($\sigma_{12} = -0.269$ and $corr(\alpha_1, \alpha_2) = -0.29$). This shows that unobservable factors affecting M&A positively are related to TFP negatively. This causes selectivity bias in the estimation of the TFP equation. By taking this into account, we find a positive productivity effect of international M&A. Since firms choose whether to engage in M&A activities, controlling for the selectivity bias is important for the evaluation of M&A effects.

5.2 Domestic M&A

In this section, we report estimation results of domestic M&A. In Table 4, columns 1 to 3 report the results of equation-by-equation estimation. With regard to M&A decisions, as before, we focus on the GMM results. Column 3 shows that the coefficient of the lagged dependent variable is insignificant. This contrasts with the international M&A. It suggests that sunk costs are small for domestic M&A, because firms may know domestic firms better than foreign ones. Productivity and firm size are positively correlated with M&A (0.053 and 0.051). This confirms the argument that productive and large

firms tend to acquire other firms. The debt/asset ratio, which was insignificant in international M&A, is significantly negative to domestic M&A (−0.03). This implies that financial constraints restrict domestic M&A activities. This difference between international and domestic M&A reveals the difference in M&A motivations. Corporate financial aspects are important for domestic M&A.

For the TFP equation, we find positive productivity gains in both random and fixed effects (0.028 in random and 0.026 in fixed effects). This contrasts with those in international M&A. Thus, for Japanese firms, gains from domestic M&A are found even without controlling for the selectivity bias.

Columns 4 and 5 in Table 4 report the results of maximum likelihood estimations. The major difference from the results in equation-by-equation estimates is that profitability has a significantly negative effect on M&A (−0.709 in FIML), which is insignificant in equation-by-equation estimations. Profitable firms are less likely to engage in domestic M&A activities. With respect to the TFP equation, we find a positive effect of lagged M&A on TFP (0.204 in FIML). Hence, productivity gains from domestic M&A are robust.

Comparing the estimates of international and domestic M&A shows different motivations for each M&A. The determinants of domestic and international M&A differ in sunk costs, debt/asset ratio and profitability. Sunk costs have no effect on domestic M&A, but have a positive effect on international M&A. Search costs might be lower for domestic than for international M&A. The debt/asset ratio has no effect on international M&A, but has a negative effect on domestic M&A. This implies that financial structure is important for the decision to undertake domestic M&A.

Profitability is positively related to the international M&A decision, but negatively related to domestic M&A. This reinforces the idea that strong firms tend to seek foreign markets suggested by Roberts and Tybout (1997), Clerides, Lach, and Tybout (1998), and Helpman, Melitz, and Yeaple (2004). While

Table 4: Domestic M&A

M&A Decision Eq.	Random	Fixed	GMM-SYS	Pooled	FIML
Y_{t-1}	0.472^a	-0.078	0.003	0.686^a	0.061
	(0.026)	(0.048)	(0.083)	(0.229)	(0.073)
$Productivity_t$	0.028^a	0.076	0.056^a	0.541^a	0.65^a
	(0.011)	(0.053)	(0.021)	(0.241)	(0.026)
Firm Size	0.032^a	0.04	0.05^a	0.513^a	0.337^a
	(0.003)	(0.033)	(0.012)	(0.064)	(0.035)
Debt/Asset	-0.019^b	0.016	-0.031^c	-0.606^a	-0.32^a
	(0.009)	(0.063)	(0.017)	(0.171)	(0.085)
Profitability	-0.171^c	0.03	-0.073	-2.36^c	-0.709^a
	(0.09)	(0.102)	(0.089)	(1.327)	(0.027)
Productivity Eq.					
Y_{t-1}	0.028^c	0.026^a		0.338^b	0.204^a
	(0.015)	(0.008)		(0.175)	(0.025)
$R\&D_t$	0.111^a	0.087^a		1.049^a	-0.145
	(0.015)	(0.029)		(0.402)	(0.11)
$R\&D_{t-1}$	-0.016	-0.034^c		-0.956	0.254^a
	(0.014)	(0.021)		(0.62)	(0.092)
std(ξ_1)				1	0.936^*
std(ξ_2)				30.58	8.322
corr(ξ_1, ξ_2)				-0.033	-0.154
std(α_1)					0.352^*
std(α_2)					0.372
corr(α_1, α_2)					-0.139

The numbers in parentheses are standard errors. The superscripts ^{a}, ^{b}, and ^{c} indicate statistical significance at the 1 percent, 5 percent, and 10 percent levels.
$*$: The variance of σ_1 and that of $\xi_1 + \alpha_1$ are normalized to 1 in the pooled case and FIML, respectively.

technical elements, such as TFP, have been examined as determinants of M&A, financial elements, such as profitability, have not been considered in the literature. When considering M&A that entail financial transactions, financial elements are important. Thus, a similar argument holds for the relationship between profitability and M&A-type investment. Profitable firms tend to choose international M&A, but are less likely to engage in domestic M&A activities.

In summary, with respect to synergy gains, after controlling for the selectivity bias, we find positive effects of domestic and international M&A. While determinants of M&A differ between domestic and international M&A, productivity gains do not. This has an important implication. Firms become produc-

tive by acquiring both domestic and foreign firms. While the costs of organizational adjustment may be higher for international M&A, Japanese firms succeed in gaining from M&A.

6 Conclusion

We have examined productivity gains from domestic and international M&A by Japanese firms. The productivity gains, synergy gains, are considered to be important for firms' choice of strategy. We found that after controlling for selectivity bias there exist positive productivity effects of M&A. We also found that corporate financial elements are only significant for domestic M&A decisions. Thus, while the determinants of M&A are different between domestic and international M&A, productivity gains are prominent in both M&A activities.

The growth of international M&A has attracted attention to the effects of these M&A. The literature has examined the effects on acquired plants. For example, in the development literature, the productivity effect on acquired firms as a result of direct investment has been investigated. Our results suggest that source countries' firms also gain from foreign firms, i.e., productivity gains feedback. Our research sheds light on not only the determinants of international M&A, but also the productivity effect on source firms.

References

Arellano, M., and S. R. Bond (1991): "Some tests of specification for panel data: Monte Carlo evidence and an application to employment equations," *Review of Economic Studies*, 58, 277–297.

Blonigen, B. A. (1997): "Firm-specific assets and the link between exchange rates and foreign direct investment," *American Economic Review*, 87, 447–465.

Blonigen, B. A., and C. T. Taylor (2000): "R&D intensity and acquisitions in high-technology industries: evidence from the US electronic and electrical equipment industries," *Journal of Industrial Economics*, 48, 47–70.

Blundell, R., and S. Bond (1998): "Initial conditions and moment restrictions in dynamic panel data models," *Journal of Econometrics*, 87, 115–143.

Branstetter, L. (2000): "Is foreign direct investment a channel of knowledge spillovers? Evidence from Japan's FDI in the United States," NBER working paper 8015.

Campa, J. M., and S. Kedia (2002): "Explaining the diversification discount," *Journal of Finance*, 57, 1731–1761.

Clerides, S. K., S. Lach, and J. R. Tybout (1996): "Is learning by exporting important? Micro-dynamic evidence from Colombia, Mexico and Morocco," NBER working paper 5715.

——— (1998): "Is learning by exporting important? Micro-dynamic evidence from Colombia, Mexico and Morocco," *Quarterly Journal of Economics*, 113, 903–947.

Doornik, J. A., M. Arellano, and S. Bond (2002): "Panel Data estimation using DPD for Ox," www.nuff.ox.ac.uk/Users/Doornik/papers/dpd.pdf.

Griliches, Z., and J. Mairesse (1985): "R&D and productivity growth: comparing Japanese and U.S. manufacturing firms," NBER working paper 1778.

Head, K., and J. Ries (2003): "Heterogeneity and the foreign direct investment versus exports decision of Japanese manufacturers," *Journal of the Japanese and International Economics*, 17, 448–467.

Heckman, J. J. (1981): "The incidental parameters problem and the problem of initial conditions in estimating a discrete time-discrete data stochastic process," in *Structural Analysis of Discrete Data*, ed. by C. Manski, and D. McFadden, chap. 3. MIT Press.

Helpman, E., M. J. Melitz, and S. R. Yeaple (2004): "Export versus FDI with heterogenous firms," *American Economic Review*, 94, 300–316.

Jensen, M. (1986): "Agency costs of free cash flow, corporate finance, and takeovers," *American Economic Review*, 76, 323–329.

Kogut, B., and S. J. Chang (1991): "Technological capabilities and Japanese foreign direct investment in the United States," *Review of Economics and Statistics*, 73, 401–413.

Lichtenberg, R. R., and D. Siegel (1990): "The effects of leveraged buyouts on productivity and related aspects of firms behavior," *Journal of Financial Economics*, 27, 165–194.

Lins, K., and H. Servaes (1999): "International evidence on the value of corporate diversification," *Journal of Finance*, 54, 2215–2239.

Maksimovic, V., and G. Phillips (2001): "The market for corporate assets: who engages in mergers and asset sales and are there efficiency gains?," *Journal of Finance*, 56, 2019–2064.

McGuckin, R. H., and S. V. Nguyen (1995): "On productivity and plant ownership change: new evidence from the Longitudinal Research Database," *Rand Journal of Economics*, 26, 257–276.

Roberts, M. J., and J. R. Tybout (1997): "The decision to export in Colombia: an empirical model of entry with sunk costs," *American Economic Review*, 87, 545–564.

Schoar, A. (2002): “Effects of corporate diversification on productivity,” *Journal of Finance*, 57, 2379–2403.