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(出版者 / Publisher)
Institute of Comparative Economic Studies, Hosei University / 法政大学比較経済研究所
(雑誌名 / Journal or Publication Title)
Working Paper / 比較経済研究所ワーキングペーパー
(巻 / Volume)
168
(開始ページ / Start Page)
1
(終了ページ / End Page)
27
(発行年 / Year)
2012-10-16

In Search of Synergy Effects: Mergers and Productivity*

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*We thank the participants at the seminar in Development Bank of Japan, Hosei University, Kyusyu University, SKEMA Business School, Waseda University, and the 2011 AsianFA Annual Meeting in Macao. We also thank the comments by E. Debodt, M.Hanazaki, K.Kubo, D. W. Lee, D.Miyakawa, A. Schwienbacher, H.Takekehara, K.Uchida, and P.Xu. Yasuhiro Arikawa is grateful for for the financial support from Grant-in-Aid for Scientific Research (A)(22243029) and (B)(22330089). Kazutaka Takechi is grateful for for the financial support from Grant-in-Aid for Scientific Research (C)(24530270) and the Seimaikai Foundation. All remaining possible errors are ours.

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Abstract

We propose an alternative method for investigating whether firms improve performance through mergers after taking into account the selection bias of merging firms. We simultaneously consider the dynamics of firm performance and the merger decision by employing full information maximum likelihood (FIML) estimation. Our study differs from previous studies in that state dependence, unobservable heterogeneity, and selection bias are incorporated simultaneously. Because the effects of mergers may be felt gradually, the dynamic effects of mergers and the factors associated with these dynamics should be taken into account. Our FIML approach complements the strategy used in the extant literature for investigating the effects of mergers on firm performance.

JEL classifications: D24, F23, G34

Keywords: Mergers and Acquisitions, Productivity, Selection Bias

1 Introduction

This paper focuses on firms' performance following corporate mergers. Identifying the gains from mergers is a difficult task, and the empirical studies to date provide mixed results. Some studies find that mergers improve firms' resource utilization. For example, using 264 large mergers of unregulated industrial firms in the United States during the period 1980–2004,Davos, Kadapakkam and Krishnamurthy (2008) demonstrate that the average total synergy in their sample is a highly significant 10.03% after being scaled by the combined premerger equity value of the merging firm. Other studies, however, show an insignificant effect of mergers on firm performance (Ghosh (2001)). Overall, the underlying sources of merger-related gains have not been clearly identified.

To identify a synergy gain, we must consider whether the performance of the two merging firms would have changed in the absence of the merger. One way to address this problem is to use any abnormal operating performance benchmarked to firms in the same industry as the two merging firms (e.g. Gugler, Mueller, and Yurtoglu (2003)). Typically, a median firm is used as the benchmark, and the overall assumption is that a merging firm's performance, as measured by, say, productivity or profits, would have changed in the same manner as the unmerged benchmark firm. However, acquiring firms' performance might be better than that not only of a target firm but also of a median firm. If this is the case, the reported results may fail to address the question of whether mergers improve performance.

Using US data, Ghosh (2001) reports statistically significant estimates of performance improvements of 2.4% per annum when firms' characteristics and acquiring firms' previous performance are not accounted for. However, when the postacquisition performance of merged firms is compared with that of matched firms based on pre-event performance and size, the median improvements following corporate acquisitions are reported as 0.27% and 0.26% per annum, respectively, with both estimates statistically indistinguishable from zero. Ghosh (2001) concludes that merged firms' postacquisition operating cash flow does not increase when control firms matched on performance and size from pre-event years are used as a benchmark. By contrast, based on the same methodology as Ghosh (2001), Powell and Stark (2005) show that the median increase in posttakeover operating performance for acquiring firms in the UK ranges from 0.13% per annum to a statistically significant 1.78% per annum.[1]

[1] Davos, Kadapakkam and Krishnamurthy (2008) use Value Line forecasts of financial data to assess the expected synergies. They compare the last available forecasts for the standalone acquiring and target firms with the first available forecasts for the merged firm, assuming that the premerger forecast incorporates any expected change in performance unrelated to the merger.

We agree with the argument in Ghosh (2001) that it is necessary to take into account the acquiring firms' characteristics and premerger performance when evaluating the effect of mergers. The problem is that the research design employed by Ghosh (2001) and Powell and Stark (2005) cannot avoid selection bias. They compare the postacquisition performance of merged firms with that of control firms matched on premerger performance and size based on Barber and Lyon (1996) and Loughran and Ritter (1997). In this procedure, it is assumed that merging firms differ from matched firms only in that they experience the merger, and that the merger is as good as randomly assigned conditional on the premerger performance and size. However, we do not see any particular reason why we can control the selection bias of merger decision by these covariates. Other factors such as leverage or previous merger history might also affect the likelihood of merger activity. In such cases, the estimated results would be biased.

Given this situation, we propose an alternative method of investigating whether firms improve performance through mergers after incorporating the selection bias of mergers. We simultaneously consider the dynamics of firm performance and the merger decision by employing full information maximum likelihood (FIML) estimation, as in the analysis by Clerides, Lach, and Tybout (1998) of the link between exports and firm performance. Our study differs from previous studies in that we exploit the dynamic nature of panel data by simultaneously incorporating state dependence, unobservable heterogeneity, and corrections for selection bias. Because the effects of mergers may be felt gradually, the dynamic effects of mergers and the factors associated with these dynamics should be taken into account. In particular, unobservable heterogeneity can be a driving force in estimating a dynamic decision problem. Our FIML approach complements the strategy used in the extant literature for investigating the effects of mergers on firm performance.

We find that when we do not control for selection bias of merger decisions, mergers have no effect on firm productivity. After controlling for selection bias, however, we find a large decline in productivity following the merger, and at best only a small increase in the third year after the merger. These results suggest the importance of controlling for selection bias if the productivity gains from mergers are to be properly evaluated.

We also find that mergers by other firms in the same industry encourage the merger decision of each firm, consistent with the merger wave story. The positive effect on a firm's performance is found from

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This approach has the advantage that it effectively minimizes any concern regarding survivorship bias and the external noise associated with using a long time series of realized cash flow data because of the short interval in the timing of the forecast (three months between the two sets of forecasts).

other firms' mergers in the same industry. This might imply that the merger wave reflects the productivity shock to the industry (Mitchell and Mulherin (1996)), and the productivity shock at the industry level affects the firm's performance.

Previous work in this area tries to identify the types of merger that affect firm performance. For example, Conn, Cosh, Guest, and Hughes (2005) study the performances of acquired firms in the UK in more than 4,000 acquisitions of domestic, cross-border, public, and private targets. In this study, we consider domestic, cross-border, and horizontal mergers, and examine the effect of each type of merger on productivity after controlling for selection bias. Our findings reveal that not all types of merger provide positive effects on productivity and, especially, that domestic mergers have positive productivity effects.

The rest of the paper is organized as follows. Section 2 reviews the related literature. Sections 3 and 4 present our theoretical and empirical model. Section 5 describes our sample and presents some descriptive statistics. Section 6 presents the major empirical results and Section 7 addresses robustness issues. In Section 8, we examine the effects of different types of merger on productivity and we conclude in Section 9.

2 Related Literature

The effects of mergers on firm performance have been widely studied in the corporate finance and industrial organization literature. When productivity serves as a performance measure, the results regarding performance gains from mergers are mixed, depending on whether the examined plants are acquired, acquiring, or a composite of the two. For example, Lichtenberg and Siegel (1990) and McGuckin and Nguyen (1995) reveal positive productivity gains from mergers with more productive firms or plants. Maksimovic and Phillips (2001) conclude that the gain in productivity of assets under new ownership is higher when selling firm's productivity is low and is higher the more productive the buyer. Schoar (2002) find positive productivity effects in acquired plants and negative effects in incumbent plants.

Our paper is also related to the issue of a *diversification discount*; that is, diversifying firms have a lower value than standalone firms. Many empirical studies confirm the presence of a diversification discount (e.g. Lins and Servaes (1999)), although Campa and Kedia (2002) and Villalonga (2004) show that the existence of the diversification discount is subject to selection bias.[2] Indeed, both these studies find that the diversification discount disappears after controlling for endogeneity. Given that the choice

[2]To control for selection bias,Campa and Kedia (2002)use Heckman (1979)'s two-step estimator and Villalonga (2004)

of counterparty for any merger is an endogenous decision, the same implication can apply not only to diversification cases, but to all mergers.

3 Theoretical Framework

In this section, we establish a theoretical framework for understanding the effects of mergers on productivity. We first consider our productivity measure for examining the effects of mergers. We then consider the dynamic choice problem of mergers to control for the problem of selection bias.

3.1 Productivity

We employ productivity measured by total factor productivity (TFP) as our performance measure. We consider a simple Cobb–Douglas-type production function:

$Q = AK^{\kappa_0}L^{\kappa_1}Raw^{\kappa_2}$,

where Q is output, A is a technology shift parameter, K is capital, L is labor input, Raw is raw material purchases, and κ are parameters. 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:

$\ln Q_{it} = \ln A + \kappa_0 \ln K_{it} + \kappa_1 \ln L_{it} + \kappa_2 Raw_{it} + \nu_{it}$,

where ν_{it} is the error term. To control for unobservable heterogeneity, we employ fixed-effects estimation. Note that our measure of TFP is real TFP, which is the residual from the above estimation equation normalized by the producer price index.

We consider that both mergers and technology development activities affect TFP; thus, assume that TFP is a function of covariates: $TFP_t = f(Y_{t-1}, Y_{t-2}, \cdots, Y_{t-j}, Z_t, \cdots, Z_{t-k})$, where Y_t denotes a merger in period t, Z_t are covariates such as R&D expenses, and j and k are lagged indices. As it takes time for mergers to have an effect on merged firms, we specify the effects of lagged merger decision variables on TFP. Then, our purpose is to test for the existence of potential synergy gains. For instance, we examine whether we find $\partial TFP_t / \partial Y_{t-1} > 0$, that is, whether or not the one-year lagged merger increases productivity.

uses a propensity score method.

3.2 Merger decision

To consider the self-selection problem explicitly, we model merger choice. Firms decide whether to engage in a merger in each period, which leads to the situation where firms confront a dynamic discrete choice problem (see, for example, Adda and Cooper (2003) and Roberts and Tybout (1997)). We assume that firms face uncertainty about future profits and have to incur sunk costs such as entry costs to engage in merger activity. As the merger decision is discrete, we consider the following decision variable:

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

By choosing the sequence of merger decisions, firm i maximizes the sum of discounted future gross profits in period t:

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

where β is the discount factor, $R(.,.)$ is the gross profit function, and X_{it} includes state and exogenous variables. The maximized choice of $Y_i = \{Y_{it}\}_{t=1}^{\infty}$ constructs the value function. There is an entry cost of merger, C, which is the cost of developing an in-house legal department or obtaining consulting services for merger transactions. Once firms have set up these facilities, the entry cost can be saved, such that $C = F$ if $Y_{t-1} = 0$, and 0 otherwise. We consider that knowledge about merger transactions is sustained or depreciates only gradually, so if $Y_{t-1} = 1$ but $Y_{t-2} = 0$, firms have to incur costs, $F'(\leq F)$. We assume that these costs are irreversible and sunk, and thus the merger decision has an option value under uncertainty. For example, if market conditions improve in the next period, it would be more profitable to engage in a merger during that period. The Bellman equation is:

$$V = \max[V^1, V^0] = \max[R(X_t, 1) - F(1 - Y_{t-1}) - F'Y_{t-1}(1 - Y_{t-2}) + \beta EV(X_{t+1}, 1), R(X_t, 0) + \beta EV(X_{t+1}, 0)].$$

Firms decide to undertake a merger when:

$$V^1 - V^0 > 0 \iff R(X_t, 1) - R(X_t, 0) + \beta[EV(X_{t+1}, 1) - EV(X_{t+1}, 0)] - F(1 - Y_{t-1}) - F'Y_{t-1}(1 - Y_{t-2}) > 0. \tag{1}$$

Therefore, the merger decision depends on the difference in profitability, the difference in future expected value, and the previous period's merger decision.

4 Empirical Specifications

In this section, we introduce the specifications used in the empirical analysis.

4.1 Models

Although it is difficult to specify what affects TFP in general, R&D is known to be one of the most important factors accounting for the variance in TFP (e.g. Lichtenberg and Siegel (1990)). It may take several years for R&D expenditure to have a significant impact on TFP, but our sample period is not sufficiently long to capture this aspect completely. Therefore, we proxy average R&D expenditure in the past by including current and one- and two-year lagged R&D in the regression. Given that R&D expenditure fluctuates less frequently than capital expenditure, we may assume a high correlation between R&D expenditures in each period.

We express TFP using the following linear form:

$$TFP_{it} = \gamma_0 + \gamma_1 Y_{it-2} + \gamma_2 Y_{it-3} + \gamma_3 R\&D_{it} + \gamma_4 R\&D_{it-1} + \gamma_5 R\&D_{it-2} + \eta_{it}, \tag{2}$$

where Y_{it-2} and Y_{it-3} are the merger and acquisition (M&A) decisions in years $t-2$ and $t-3$, respectively. Considering the accounting irregularity just after the merger, we use only two- and three-year merger lags in the analysis. Similarly, $R\&D_{it}$, $R\&D_{it-1}$, and $R\&D_{it-2}$ are R&D expenditures in years t, $t-1$, and $t-2$, respectively.

With respect to the merger decision, we follow the reduced-form approach as in Roberts and Tybout (1997) and Clerides, Lach, and Tybout (1998). We consider the value function as a function of covariates, and 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 $\beta_1 Y_{it-1} + \beta_2 Y_{it-1}(1 - Y_{it-2}) + X_{it}\delta + \epsilon_{it} > 0$. The sunk costs of mergers allow us to include previous merger decisions, Y_{it-1} and Y_{it-2}.

4.2 FIML estimation: Selection bias

To address the self-selection problem, we employ the FIML estimation as in Clerides, Lach, and Tybout (1998). The main equation is the TFP equation as expressed by Equation (2).

We denote that the decision to engage in a merger is 1 if $V^1 - V^0 > 0$ and 0 otherwise. Thus, the merger decision depends on firms' characteristics and performance and their previous merger decisions:

$$Y_{it} = I(\beta_1 Y_{it-1} + \beta_2(1 - Y_{it-1})Y_{it-2} + X_{it}\delta + \alpha_1 + \xi_{1it} > 0),$$

where $I(\cdot)$ is the indicator function and:

$$X_{it}\delta = \delta_0 + \delta_1 \text{TFP}_{it} + \delta_2 \text{Emp}_{it} + \delta_3 \text{Debt/Asset}_{it} + \delta_4 \text{CapitalIntensity}_{it}.$$

The covariates are TFP, the number of employees (Emp), the debt–asset ratio (Debt/Asset), the capital–labor ratio (CapitalIntensity), and time dummies. These are all considered in the existing literature as determinants of merger. TFP is included to control for performance. We use the number of employees to control for the effects of firm size. For instance, Arikawa and Miyajima (2008) argue that larger firms tend to engage in M&A more frequently. To control for the effect of capital structure on the merger decision, we include the ratio of debt to total assets. Here, we assume that firms with higher leverage have less incentive to engage in mergers because of the threat of bankruptcy. By contrast, firms with greater capital intensity may be more likely to engage in mergers, as the efficient merger of human resources is more difficult than that of physical capital; therefore, we use capital intensity as an independent variable. We also include year dummies to control for macroeconomic shocks.

We consider the joint distribution of (TFP_{t+1}, Y_t), and assume that the distribution of errors is joint normal: $(\xi_1, \xi_2) \sim N(0, \Sigma)$. We incorporate unobserved heterogeneity terms, α_1 and α_2, in this likelihood function and integrate out these unobservable terms using the Gauss–Hermite quadrature method with five grid points.

In a dynamic model, we need to control for the initial condition problems (Heckman (1981)). We adopt an approximation solution that represents the initial period's choice probability using probit and allows the initial period error term to correlate with the errors in subsequent periods. The likelihood function is then:

$$L = \int\int [\Pi_{n=1}^{N}\Pi_{\tau=1}^{2}\phi(W_{1n\tau+1})[1-\Phi(W_{2n\tau})]^{Y_{n\tau}}\Phi(W_{2n\tau})^{1-Y_{n\tau}}]$$

$$\times \Pi_{n=1}^{N}\Pi_{t=3}^{T}\phi(W_{1nt+1})[1-\Phi(W_{2nt})]^{Y_{nt}}\Phi(W_{2nt})^{1-Y_{nt}}h(\alpha_1,\alpha_2)d\alpha_1 d\alpha_2,$$

where $W_{1n\tau+1} = (TFP_{n\tau+1} - Z_{n\tau+1}\tilde{\gamma} - \rho_2\alpha_2)/\sigma_2$, $W_{2n\tau} = -[X_{n\tau}\tilde{\delta} + \rho_1\alpha_1(\sigma_{12}/\sigma_2)(TFP_{n\tau} - Z_{n\tau}\tilde{\gamma} - \alpha_2)]\sqrt{\sigma_1 - \sigma_{12}/\sigma_2}$, $W_{1nt} = (TFP_{nt} - Z_{nt}\gamma - \gamma_3 Y_{nt-1} - \gamma_4 Y_{nt-2} - \gamma_5 Y_{nt-3} - \alpha_2)/\sigma_2$, and $W_{2nt} = -[\beta_1 Y_{nt-1} + \beta_2(1-Y_{nt-1})Y_{nt-2} + X_{nt}\delta + \alpha_1(\sigma_{12}/\sigma_2)(TFP_{nt} - Z_{nt}\gamma - \gamma_3 Y_{nt-1} - \gamma_4 Y_{nt-2} - \gamma_5 Y_{nt-3} - \alpha_2)]\sqrt{\sigma_1 - \sigma_{12}/\sigma_2}$.

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 selection bias of mergers. To assess the short- and long-run effects of mergers, we incorporate not only the one-year lagged value in the TFP equation, but also the two- and three-year lagged values.

5 Data and Summary Statistics

5.1 Sample selection

We employ data for 589 Japanese firms listed on the First and Second Sections of the Tokyo Stock Exchange. The sample period is 1999–2006. We exclude firms in the financial and utility sectors from our sample because the regulation of these sectors is substantially different from that of other sectors. We also exclude firms without any R&D expenditure record during the sample period. This process generates a sample of 523 of the 589 firms included in the manufacturing sector. The financial data for the sample firms are from the Nikkei AMSUS and NEEDS databases. Our merger data originate from RECOF's M&A database of Japanese companies.

We identify (a) all mergers with publicly traded bidding firms and (b) all acquisitions including partial acquisitions with publicly traded bidding firms. We classify firms as engaging in a merger in the year in which they announced the merger decision. In other years, firms are classified as nonmerger firms.[3]

5.2 Summary statistics

Table 1 details the number of mergers by year and type. As shown, during the period from 1999 to 2006, there were 629 merger announcements. The aggregate value of the Japanese M&A market, which had been around 2 trillion yen per annum through to 1997, surged to 18 trillion yen in 1999 when a series of bank consolidations were announced (mergers involving nonfinancial firms accounted for about 8 trillion yen). Since 2000, the scale of the M&A market has been in the range of around 5 to 11 trillion yen per year, but surpassing 15 trillion yen in 2006 (Arikawa and Miyajima (2008)). In our sample, the number of mergers rose from 60 deals in 1999 to 107 deals in 2006.

We classify each merger as horizontal or nonhorizontal, and domestic or nondomestic. A merger is defined as horizontal where the bidder and target are in the same industry, and nonhorizontal otherwise. Horizontal mergers make up around 52–62% of all deals in the sample. We define a domestic merger as a deal where both the bidder and target firms are Japanese. Domestic mergers, which took place at a low level during the 1980s, started to increase rapidly from the late 1990s, ultimately averaging about 70% of all deals during our sample period. We define a deal as a cross-border merger where the bidder is domestic and the target firm is in another country. Table 2 provides descriptive statistics of the variables used in the analysis and the basic characteristics of the bidding firms in our sample.

6 Results: Productivity Changes and the Merger Decision

In this section, we first report the results on whether mergers on average increase the productivity of acquiring firms.

The first and second columns in Table 3 provide the results of the TFP equation estimated by the fixed-effects model of panel estimation without considering the selection bias. We include the R&D ratio of the current period in column (1), and we add one- and two-year lags of R&D ratio in the regression for column (2). We can see no significant effect of mergers on TFP in the sample firms. The coefficients for the two- and three-year merger lags show no significant results in the regression.

[3] The indicator variable takes a value of one for firms that undertake multiple mergers in the same year.

The estimates in columns (3) and (4) of Table 3 reflect the use of FIML to correct for selection bias. We include the R&D ratio of the current period in column (3), while we add the one- and two-year lags of R&D ratio in the regression for column (4). Then, we find a significant effect of mergers on firm performance; this shows the importance of controlling for self-selection bias in the estimation. In column (3), for example, we observe a 12.6% decline in productivity two years after the merger. Conversely, the estimated coefficients for the three-year merger lags are significantly positive at the 1% level. This suggests that the productivity of firms declines significantly after the merger, and begins to increase slightly three years after the merger. Firms, on average, have at best small productivity gains from mergers following the painstaking process of organizational integration.

Consider now our FIML estimates of the merger decision. Our hypothesis is that because of the presence of sunk costs, such as the cost of developing an in-house legal department or obtaining consulting services for merger transactions, the probability of the current merger decision should positively relate to previous merger decisions. That is, we expect the coefficient for the merger lag to be positive. As shown in Table 4, however, we find no evidence that previous merger decisions affect current merger decisions when using the full sample in columns (1) and (2).

In terms of control variables, we find results that are fully consistent with our expectations. First, the coefficient of the number of employees is significantly positive, which means that larger firms tend to engage in mergers more frequently. As for the debt–asset ratio, the coefficient is significantly negative, as firms with less leverage are more likely to engage in mergers. Finally, the coefficient of the capital–labor ratio is significantly positive; therefore, firms with greater capital intensity are more likely to engage in mergers.

7 Robustness

The basic pattern of results in the previous section is robust to a number of alternative specifications. We show these results in this section.

7.1 Effect of other firms' mergers

Industry mergers are known to occur in waves because of the technological link between firms in the same industry.[4] For example, a merger by a firm that is implementing a technological innovation may induce follow-on takeovers among industry rivals for these to remain competitive. Then, we investigate whether other firms' mergers in the same industry influence further merger decisions, and also explore whether or not the effects of mergers on firm performance are affected by other firms' mergers in the same industry.

Column (1) of Table 5 shows positive effects from other firms' mergers in the same industry. The increase in merger activity in the industry as a whole leads to an improvement in the productivity in each firm. Given that the merger wave reflects the productivity shock to the industry as a whole (Andrade, Mitchell, and Stafford (2001)), this might suggest that the productivity shock in the industry level affects firms' performance.

In column (1) of Table 6, we find significant results for mergers by industry peers. When the number of mergers by other firms in the same industry is higher, the firm is more likely to engage in merger activity. In other words, mergers by other firms in the same industry encourage further merger decisions. This is consistent with the "merger wave" literature, which suggests that mergers cluster by industries, and that merger decisions are affected by prior mergers by industry peers (Cai,Song, and Walking (2011)). In terms of the coefficients for other control variables, we find results similar to our previous findings. The coefficient of the number of employees is significantly positive, the coefficient of the debt–asset ratio is significantly negative, and the coefficient of the capital–labor ratio is significantly positive.

7.2 Alternative TFP

In the above analysis, we use fixed-effect models to estimate the production function, and TFP is the residual from these estimates. As Levinsohn and Petrin (2003) point out, however, the estimates of the production function yield biased parameter estimates if there is a correlation between input levels and the unobserved firm-specific productivity. It is highly likely that firms experience unobserved productivity shocks caused by mergers, and therefore we observe a correlation between input levels and the unob-

[4]There is substantial industrial evidence of industry-clustering mergers, such as in Arikawa and Miyajima (2008), Mitchell and Mulherin (1996), Maksimovic and Phillips (2001), Andrade and Stafford (2004), and Harford (2005).

served firm-specific productivity when firms that have a positive productivity shock respond by using more inputs.

The results in column (2) of Tables 5 and 6 use TFP, which is measured based on the Levinsohn and Petrin (2003) method for estimating production functions. Consistent with previous results, the coefficient for the two-year merger lag is significantly negative in column (2) of Table 5, although the magnitude of the effect falls to almost one-tenth of the results given in column (3) of Table 3. As for the coefficient for the three-year merger lag, we do not find any significant results. These results suggest that the firms' productivity declines after mergers.

Column (2) of Table 6 shows the results of merger decisions, and we find similar results to those in Table 4 except for the debt–asset ratio, for which we do not find any significant results for the coefficient of previous mergers on current merger decisions.

8 Types of Merger

Table 7 shows the results when we split the full sample into domestic and cross-border mergers. The results for domestic mergers appear similar to those obtained for the full sample. We again observe a 13.0% decline in productivity in the year following the merger, whereas the coefficient for the three-year lagged merger decision is significantly positive at the 10% level when the acquiring and target firms reside in the same country. Consistent with the previous results, the positive effect of the year $t-3$ merger on productivity is very small relative to the negative effect of the year $t-3$ merger.

For cross-border mergers, we find no positive result for the contribution of mergers to productivity when domestic firms purchase foreign firms, and productivity even declines by 1% after the merger. This result is consistent with the findings in Benfratello and Sembenelli (2006), who concluded that the effect on TFP of a change from domestic to foreign ownership is, at best, zero unless the new ownership is through a US affiliate. The key difference is that in this paper, all bidding firms are Japanese. One interpretation of the negative effect of cross-border mergers on firm performance, as suggested by Bertrand and Zuniga (2008), is the missed opportunity to attain economies of scale. That is, although cross-border mergers enable firms to gain from geographically dispersed intangible assets, they make it difficult for firms to achieve economies of scale through the concentration of production in a single location. Thus, even if there might be an efficiency gain from a cross-border merger, the loss of any potential economies of scale offsets such gains.

In Table 8, we show the results when we use only horizontal mergers. In the case of horizontal mergers, the coefficient for a year $t-2$ merger is significantly negative, whereas the coefficient for a year $t-3$ merger is insignificant. We observe an 11.2% decline in productivity two years after the horizontal merger.

All the results of merger decisions in Tables 9 and 10 show that larger firms are the most likely to engage in mergers. As for the effect of leverage on merger decisions, we find that only the case of cross-border mergers shows a negative effect of leverage on the merger decisions in Table 9. This means that a firm with a higher equity ratio seeks to expand its business abroad using mergers. We also find no contribution of previous mergers to the current merger decision in Tables 9 and 10; this is consistent with previous results in the paper.

9 Conclusion

In this paper, we propose an alternative way of analyzing whether there is any evidence that firms improve performance through mergers after incorporating the selection bias of mergers. We simultaneously consider the dynamics of firm performance and the merger decision by employing FIML estimation.

We find that, without controlling for selection bias of merger decisions, mergers have no effect on firm productivity. After controlling for selection bias, however, we find a large decline in productivity following mergers, and a small increase at best in the third year after the merger. These results suggest the importance of controlling selection bias to properly evaluate the productivity gains from mergers.

Our study differs from previous studies in that we incorporate state dependence, unobservable heterogeneity, and selection bias simultaneously. Because the effects of mergers may be felt gradually, the dynamic effects of mergers and the factors associated with these dynamics should be taken into account. Our FIML approach complements the strategy used in the extant literature for investigating the effects of mergers on firm performance.

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	1999	2000	2001	2002	2003	2004	2005	2006	Sum
Mergers(A)	60	61	71	84	71	88	87	107	629
Horizontal mergers(B)	32	33	43	44	44	49	46	67	358
(B)/(A)(%)	53.3	54.0	60.5	52.3	61.9	55.6	52.8	62.6	56.9
Domestic mergers (C)	40	42	53	68	54	66	53	68	444
Cross-border mergers(D)	20	19	18	16	17	22	34	39	185
(C)/(C+D)(%)	66.6	68.8	74.6	80.9	76.0	75.0	60.9	63.5	70.5

Table 1: Number of mergers. A merger is defined as horizontal where the bidder and target are in the same industry. A merger is defined as domestic where both the bidder and target firms are Japanese. A merger is defined as cross-border where the bidder is domestic and the target firm is in another country.

Bidder characteristics	Mean	Median	Std	Q1	Q3
Number of Employee	4405	1817	8717.331	853	4333
Debt Asset	0.551	0.562	0.193	0.415	0.690
Cap/Lab	49.394	41.408	35.113	28.784	59.313
Sales	199941.9	68324	520918	30712	170757
Operational Profit	10510	2701	39470	1054	7437
ROA	0.045	0.040	0.040	0.021	0.064
q	1.100	0.999	0.495	0.866	1.191

Table 2: Summary statistics of bidding firms. We employ data for 589 Japanese firms listed on the First and Second Sections of the Tokyo Stock Exchange. The sample period is 1999–2006. We exclude firms in the financial and utility sectors from our sample because the regulation of these sectors is substantially different from that of other sectors. We also exclude firms without any R&D expenditure record during the sample period. This process generates a sample of 523 of the 589 firms included in the manufacturing sector. The financial data for the sample firms are from the Nikkei AMSUS and NEEDS databases. Our merger data originate from RECOF's M&A database of Japanese companies. We identify (a) all mergers with publicly traded bidding firms and (b) all acquisitions including partial acquisitions with publicly traded bidding firms. We classify firms as engaging in a merger in the year in which they announced the merger decision. In other years, firms are classified as nonmerger firms. Debt Asset is the ratio of debt to total assets. Cap/Lab is capital intensity. ROA is the ratio of operational returns to total assets. q is Tobin's q.

TFP eq	(1)		(2)		(3)		(4)	
	OLS		OLS		FIML		FIML	
	Full sample		Full sample		Full sample		Full sample	
	Coefficient	t value	Coefficient	t value	Coefficient	Z value	Coefficient	Z value
MA(-2)	0.000	0.000	-0.000	-0.050	-0.126	-10.422	-0.126	-10.461
MA(-3)	0.007	0.680	0.007	0.660	0.0253	2.837	0.025	3.046
TFP(-1)	0.443	23.640	0.441	23.460	0.417	18.358	0.412	18.505
TFP(-2)	-0.117	-6.120	-0.112	-5.890	-0.0878	-4.016	-0.082	-3.830
R&D	-0.017	-1.580	-0.002	-0.140	0.005	2.439	0.033	2.701
R&D(-1)			-0.036	-2.720			-0.055	-3.637
R&D(-2)			0.017	1.450			0.027	2.737
C	0.124	1.670	0.149	1.530	-0.023	-1.450	-0.022	-1.461
Log-Likelihood					-1068.657		-1076.674	
Adj-R^2	0.194		0.196					
Num of Obs	2945		2945		4712		4712	

Table 3: TFP equation. MA(-2) is a dummy variable equal to one if a firm announces a merger in year t-2, and otherwise zero. MA(-3) is a dummy variable equal to one if a firm announces a merger in year t-3, and otherwise zero. TFP(-1) is TFP in year t-1. TFP(-2) is TFP in year t-2. RD is R&D expenditure in year t. R&D(-1) is R&D expenditure in year t-1. R&D(-2) is R&D expenditure in year t-2. C is the constant term. Year dummy variables are included in the regression.

Merger eq	(1)		(2)	
	FIML		FIML	
	Full Sample		Full Sample	
TFP equation	(3) in Table 3		(4) in Table 3	
	Coefficient	Z value	Coefficient	Z value
MA(-1)	0.103	0.783	0.109	0.875
MA(-2)	-0.023	-0.189	-0.014	-0.106
TFP(-1)	0.190	0.717	0.184	0.767
Emp	0.383	11.183	0.382	11.364
Debt	-0.387	-2.140	-0.388	-2.163
Caplab	0.142	2.220	0.143	2.192
C	-4.468	-11.482	-4.465	-11.168
corr12	0.665		0.666	
corralpha12	-0.493		-0.496	
Log-Likelihood	-1068.657		-1076.674	
Num of Obs	4712		4712	

Table 4: Merger equation. MA(-1) is a dummy variable equal to one if a firm announces a merger in year t-1, and otherwise zero. MA(-2) is a dummy variable equal to one if a firm announces a merger in year t-2, and otherwise zero. TFP(-1) is TFP in year t-1. Emp is the number of employees. Debt is the debt-asset ratio. Caplab is capital intensity. C is the constant term. Year dummy variables are included. corr12 is the correlation between the distribution of errors, (ξ_1, ξ_2). corralpha12 is the correlation coefficient between the unobserved heterogeneity terms,α_1 and α_2.

TFP eq	(1)		(2)	
	FIML		FIML	
	Full Sample		Full Sample	
	Coefficient	Z value	Coefficient	Z value
MA(-2)	-0.125	-10.246	-0.014	-2.105
MA(-3)	0.024	2.773	0.000	0.110
TFP(-1)	0.417	17.638	1.054	36.971
TFP(-2)	-0.087	-3.997	-0.0349	-1.216
RD	0.005	2.300	0.002	3.949
Other MA(-2)	0.001	2.375		
C	-0.029	-1.836	-0.006	-1.629
Log-Likelihood	-1072.384		-5859.522	
Num of Obs	4712		4712	

Table 5: TFP equation. MA(-2) is a dummy variable equal to one if a firm announces a merger in year t-2, and otherwise zero. MA(-3) is a dummy variable equal to one if a firm announces a merger in year t-3, and otherwise zero. TFP(-1) is TFP in year t-1. TFP(-2) is TFP in year t-2. rd is R&D expenditure in year t. OtherMA(-2) is the number of mergers by firms in a same industry. C is the constant term. Year dummy variables are included in the regression. For the result in column (2), we measure TFP based on Levinsohn and Petrin(2003).

Merger eq	(1)		(2)	
	FIML		FIML	
	Full Sample		Full Sample	
TFP Equation	(1) in Table 5		(2) in Table 5	
	Coefficient	Z value	Coefficient	Z value
MA(-1)	0.090	0.726	-0.127	-0.766
MA(-2)	-0.029	-0.245	-0.076	-0.517
TFP(-1)	0.186	0.878	0.210	0.967
Other MA(-2)	0.016	2.163		
Emp	0.387	10.828	0.400	10.068
Debt	-0.368	-1.902	0.068	0.358
Caplab	0.148	2.381	0.184	2.549
C	-4.621	-11.238	-5.061	-11.866
corr12	0.662		0.344	
corralpha	-0.497		-0.185	
Log-Likelihood	-1072.384		-5859.522	
Num of Obs	4712		4712	

Table 6: Merger equation. MA(-1) is a dummy variable equal to one if a firm announces a merger in year t-1, and otherwise zero. MA(-2) is a dummy variable equal to one if a firm announces a merger in year t-2, and otherwise zero. TFP(-1) is TFP in year t-1. OtherMA(-2) is the number of mergers by firms in a same industy. Emp is the number of employees. Debt is the debt–asset ratio. Caplab is capital intensity. C is the constant term. Year dummy variables are included. corr12 is the correlation between the distribution of errors, (ξ_1, ξ_2). corralpha12 is the correlation coefficient between the unobserved heterogeneity terms,α_1 and α_2. For the result in column (2), we measure TFP based on Levinsohn and Petrin(2003).

TFP eq	(1)		(2)		(3)		(4)	
	FIML		FIML		FIML		FIML	
	Domestic		Cross-border		Domestic		Cross-border	
	Coefficient	Z value	Coefficient	Z value	Coefficient	Z value	Coefficient	Z value
MA(-2)	-0.130	-9.423	-0.099	-4.808	-0.129	-9.474	-0.099	-4.410
MA(-3)	0.017	1.744	0.018	1.145	0.016	1.769	0.019	1.170
TFP(-1)	0.418	18.116	0.423	16.677	0.413	17.916	0.418	18.620
TFP(-2)	-0.0893	4.010	-0.091	-3.951	-0.085	-3.977	-0.086	-4.067
R&D	0.004	1.736	0.003	1.320	0.033	3.117	0.033	3.072
R&D(-1)					-0.058	-3.853	-0.054	-3.874
R&D(-2)					0.025	2.516	0.023	2.326
C	-0.015	-0.942	-0.018	-1.071	-0.014	-0.823	-0.0156	-1.017
Log-Likelihood	-1206.983		-1802.175		-1218.158		-1809.944	
Num of Obs	4712		4712		4712		4712	

Table 7: TFP equation. Domestic includes only the deals between domestic firms as the dependent variable. Cross-border includes only the deals where the bidder is a domestic firm and the target firm is from another country as the dependent variable. MA(-2) is a dummy variable equal to one if a firm announces a merger in year t-2, and otherwise zero. MA(-3) is a dummy variable equal to one if a firm announces a merger in year t-3, and otherwise zero. TFP(-1) is TFP in year t-1. TFP(-2) is TFP in year t-2. RD is R&D expenditure in year t. R&D(-1) is R&D expenditure in year t-1. R&D(-2) is R&D expenditure in year t-2. C is the constant term. Year dummy variables are included in the regression.

TFP eq	(1)		(2)	
	FIML		FIML	
	Horizontal		Horizontal	
	Coefficient	Z value	Coefficient	Z value
MA(-2)	-0.112	-6.989	-0.112	-6.701
MA(-3)	-0.001	-0.056	-0.003	-0.214
TFP(-1)	0.420	19.791	0.415	18.767
TFP(-2)	-0.087	-4.083	-0.083	-4.133
RD	0.004	2.176	0.035	3.178
R&D(-1)			-0.055	-3.903
R&D(-2)			0.025	2.459
C	-0.023	-1.546	-0.022	-1.377
Log-Likelihood	-1410.555			
Num of Obs	4712		4712	

Table 8: TFP equation. Horizontal includes the only deals between firms in the same industry as the dependent variable. MA(-2) is a dummy variable equal to one if a firm announces a merger in year t-2, and otherwise zero. MA(-3) is a dummy variable equal to one if a firm announces a merger in year t-3, and otherwise zero. TFP(-1) is TFP in year t-1. TFP(-2) is TFP in year t-2. rd is R&D expenditure in year t. R&D(-1) is R&D expenditure in year t-1. R&D(-2) is R&D expenditure in year t-2. C is the constant term. Year dummy variables are included in the regression.

Merger eq	(1)		(2)		(3)		(4)	
	FIML		FIML		FIML		FIML	
	Domestic		Cross-border		Domestic		Cross-border	
TFP equation	(1) in Table 7		(2) in Table 7		(3) in Table 7		(4) in Table 7	
	Coefficient	Z value	Coefficient	Z value	Coefficient	Z value	Coefficient	Z value
MA(-1)	0.118	0.682	-0.210	-0.881	0.129	0.517	-0.207	-0.811
MA(-2)	0.024	0.145	-0.047	-0.208	0.035	0.165	-0.042	-0.180
TFP(-1)	0.202	1.037	-0.472	-1.017	0.192	0.697	-0.468	-0.985
Emp	0.293	8.082	0.535	8.762	0.292	7.694	0.533	8.627
Debt	-0.117	-0.536	-1.272	-4.013	-0.119	-0.607	-1.269	-3.882
Caplab	0.121	1.717	0.083	0.802	0.124	1.757	0.083	0.820
C	-3.984	-9.733	-5.763	-8.977	-3.987	-10.084	-5.754	-9.017
corr12	0.616		0.604		0.615		0.604	
corralpha12	-0.519		-0.638		-0.529		-0.638	
hline Log-Likelihood	-1206.983		-1802.175		-1218.158		-1809.944	
Num of Obs	4712		4712		4712		4712	

Table 9: Merger equation. MA(-1) is a dummy variable equal to one if a firm announces a merger in year t-1, and otherwise zero. MA(-2) is a dummy variable equal to one if a firm announces a merger in year t-2, and otherwise zero. TFPlag is TFP in year t-1. Emp is the number of employees. debt is the debt–asset ratio. Caplab is capital intensity. C is the constant term. Year dummy variables are included. corr12 is the correlation between the distribution of errors, (ξ_1, ξ_2). corralpha12 is the correlation coefficient between the unobserved heterogeneity terms,α_1 and α_2.

Merger eq	(1)		(2)	
	FIML		FIML	
	Horizontal		Horizontal	
TFP Equation	(1) in Table 8		(2) in Table 8	
	Coefficient	Z value	Coefficient	Z value
MA(-1)	0.093	0.693	0.086	0.626
MA(-2)	0.225	1.648	0.227	1.643
TFP(-1)	0.248	0.677	0.342	0.929
Emp	0.374	10.192	0.374	10.172
Debt	-0.340	-1.686	-0.338	-1.628
Caplab	0.177	2.426	0.180	2.667
C	-4.858	-10.770	-4.874	-11.241
corr12	0.516		0.516	
corralpha	0.702		0.703	
Log-Likelihood	-1410.555		-1418.709	
Num of Obs	4712		4712	

Table 10: Merger equation. MA(-1) is a dummy variable equal to one if a firm announces a merger in year t-1, and otherwise zero. MA(-2) is a dummy variable equal to one if a firm announces a merger in year t-2, and otherwise zero. TFP(-1) is TFP in year t-1. Emp is the number of employees. Debt is the debt–asset ratio. Caplab is capital intensity. C is the constant term. Year dummy variables are included. corr12 is the correlation between the distribution of errors, (ξ_1, ξ_2). corralpha12 is the correlation coefficient between the unobserved heterogeneity terms,α_1 and α_2.