September 7, 2009

Mergers, Innovation, and Productivity: Evidence from Japanese Manufacturing Firms

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Abstract

We investigate the impacts of merger on innovation and efficiency using a micro dataset of Japanese manufacturing firms including unlisted firms during the merger wave period of 1995-1999. To deal with the endogeneity bias arising from the merger decision, we adopt the propensity score matching method to select a control group. Our main findings are the followings. First, the acquirer's total factor productivity (TFP) decreases immediately after mergers and does not significantly recover to the pre-merger level within three years after mergers. Second, the R&D intensity does not significantly change after mergers despite a significant increase in the debt-to-asset ratio. Third, the recovery of TFP after mergers is significant for inter-industrial mergers or within-group mergers. Our results suggest that though the costs of business integration are generally large and persistent, a synergy effect works well and integration costs are small for inter-industrial or within-group mergers.

Key Words: Merger, Research and Development, Total Factor Productivity

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Mergers and Innovation: Evidence from Japanese Manufacturing Firms

1. Introduction

There was a large wave of mergers and acquisitions (M&As) in Japan for more than a decade from 1996. The number of M&As in which Japanese firms were acquired by either domestic or foreign firms was 220 per year on average during the period of 1985-1995, jumped to 616 in 1996, then increased steadily, reaching the peak of 2738 in 2007. Although such a rising trend stopped in 2008, when the world-wide financial crisis hit the Japanese economy, there are continued interests in the consequences of M&As. Do they improve the reallocation of capital in the sense that less efficient firms are taken over and improved by more efficient firms? From the viewpoint of a longer horizon, do M&As promote or inhibit innovative activities and how do they affect the productivity growth? These questions are of great importance to understand the role of mergers in the reallocation of capital in a macroeconomy. They also have implications to competition policy and hence gained attention of both economists and regulators (e.g., Federal Trade Commission, 1996).

The U.S. and European merger waves in the 1980s and 1990s have attracted many researchers' attention. Hall (1999) surveys literature examining the effects of corporate mergers and restructuring on productivity and technical change, summarizing that these transactions were followed by productivity improvements in firms involved. However, despite a growing world-wide concern about the consequences of M&As, literature on M&As outside the U.S. or Europe is still scarce. We try to void this gap using a micro dataset of Japanese manufacturing firms including unlisted firms during the period of 1995-1999. Though some preceding studies focus on the recent Japanese M&A wave and find evidences that are consistent with the role of M&As as capital reallocation (e.g., Arikawa and Miyajima, 2006), they do not focus on the dynamic aspects of M&As through their impact on the firms' innovative activity. We investigate the impact of mergers on the acquiring firm's R&D intensity and productivity.

We contribute to the literature on the consequences of mergers in three ways.

First, we deal with the endogeneity problem of the merger decision. If, for example, a growing firm tends to be an acquirer, we may mistakenly attribute the improvement of its performance to the effect of mergers. To lessen this type of bias, many preceding studies select a control group to be compared with acquirers from

those firms that are similar to acquiring firms in terms of the industry, size, or profitability. To form a more suitable control group, we adopt the propensity score matching method advocated by Rosenbaum and Rubin (1983). Thus we can evaluate the effect of mergers by comparing the acquirers and the control group of firms that had been most likely to be an acquirer but actually were not.

Second, our sample consists of small and medium-sized, unlisted firms as well as listed firms while most of the preceding studies analyze mergers of listed firms. In our sample, 47 percent of mergers were conducted by non-listed firms. Given that such a high proportion of mergers conducted by unlisted firms, excluding unlisted firms from the sample may be misleading when we analyze the restructuring process at the industry level,

Finally, we take into consideration the heterogeneity of mergers. It is of great importance to consider the possibility that different types of mergers have different impacts on innovation and productivity. Specifically, we examine whether mergers within an industry have different impacts from mergers across different industries. Synergy effects and business integration costs may differ between intra-industrial and inter-industrial mergers. In addition, we investigate the possibility that mergers undertaken within a business group may have different impacts from the others. Some preceding studies on mergers in Japan find competing results on the role of a business group in improving the efficiency of mergers (Yeh and Hoshino, 2002; Iwaki 2007). A parent firm may conduct a merger for the aim of rescuing a financially distressed affiliated firm, which may result in poor merger performance. On the other hand, if firms within a business group have much in common in information system or business culture prior to mergers, they may successfully reap the yields of mergers.

Our main findings can be summarized as follows. First, the acquirer's total factor productivity (TFP) decreases immediately after mergers and does not significantly recover to the pre-merger level within three years after mergers. Second, the R&D intensity does not significantly change after mergers despite a significant increase in the debt-to-asset ratio. Finally, the recovery of TFP after mergers is significant for mergers across different industries or within the same business group. Overall, our results suggest that the costs of business integration are large and persistent but that a synergy effect works well and integration costs are small for intra-industrial mergers or within-group mergers.

The rest of this paper consists of six sections. In Section 2, we present some

hypotheses on the motives of mergers and their consequences on the innovative activity and productivity. In Section 3, we review some related literature. Section 4 describes our dataset. In Sections 5 and 6, we present our empirical results for the motives of acquiring firms and consequences on their R&D intensity and productivity, respectively. In Section 7, we present evidences on how the pre-merger characteristics of acquires are related to the post-merger performance. Section 8 concludes.

2. Hypotheses

In this section, we present three major hypotheses concerning the effects of mergers on the acquirer's productivity and innovative activities. Table 1 summarizes these hypotheses.

A. Value Creation

More productive firms acquire less productive firms to increase their profits by extending their superior technology or managerial skills to the acquired assets (Maksimovic and Phillips, 2002; Jovanovic and Rousseau, 2004). Though the profit maximization motive suggests that the productivity of the acquired assets increases after mergers, it is not clear whether the acquirers increase productivity. If there is some scale or scope economy or synergy effects, the acquirer's productivity increases. On the other hand, managers may find it more difficult to manage a large firm than a small one. In particular, if acquisitions of inefficient plants require substantial management costs of integrating business, the acquirer's' productivity decreases.

The impact of mergers on R&D depends on technological aspects of acquired assets. When mergers occur among firms that focus on the same or substitutable technological areas, acquirers tend to reduce R&D activities to avoid the duplication with acquired firms. In this case, the acquirer's low R&D does not result in low productivity. On the other hand, when mergers occur among the firms that operate in complementary technological areas, acquirers tend to increase R&D to take advantage of the synergy effects associated with mergers.

B. Conflicts of Interest between Managers and Shareholders

Takeover decisions may be influenced by conflicts of interest between managers and shareholders. Self-interested managers may undertake acquisitions for empire-building or managerial entrenchment (e.g., Morck, Shleifer and Vishny, 1990).

This view suggests that mergers tend to occur in matured or shrinking firms that have excess cash flow and in industries where returns to investment projects are low (Jensen, 1986). In this case, no efficiency gains are realized by mergers.

If managers enjoy private benefits from R&D projects including unproductive ones, there are some possible consequences of mergers on firm productivity and R&D intensity. They may increase R&D at the sacrifice of productivity after they have established an empire through mergers. On the other hand, if mergers substantially increase acquires' indebtedness and probability of bankruptcy, managers will reduce spending on unprofitable R&D projects to avoid bankruptcy and maintain their positions (Hart and Moore, 1995). If such a disciplinary role of debt works effectively, the acquiring firm that used to be run inefficiently by privately-motivated managers may decrease unproductive R&D and improve efficiency after mergers.

C. External Finance Constraints

Mergers often increase acquirers' leverage and reduce their cash holdings. If acquirers cannot obtain sources of financing new R&D projects or have to pay high external financing costs due to financial market frictions, they have to give up their profitable R&D projects. Examples of financial market frictions are debt overhang due to asymmetric information and myopic markets that do not value long-term investment like R&D (Myers, 1977). In this case, acquirers will reduce productivity due to low R&D intensity.

3. Literature

Many preceding studies obtained evidences supporting the value creation hypothesis. Maksimovic and Philips (2001) examined the market for corporate assets, i.e., partial asset sales and mergers, using the U.S. plant-level data for manufacturing plants, and found that most transactions result in productivity gains for the transferred asset, which is consistent with the profit-maximizing behavior. Lichtenberg and Siegel (1987) find that plants changing owners had higher productivity growth than those plants that did not change owners. Lang, Stultz and Walking (2002) show that the total stock market gains in tender offers are highest when the bidder has a high Tobin's q and the target has a low q. This is also consistent with the value creation hypothesis. Servases (1991) obtained similar results. Hall (1999) used the data of U.S. publicly traded manufacturing firms during the period of 1976 to 1995 and found that R&D intensities and TFP

increased for the firms with a high probability of merging (i.e., with a large size, a low R&D intensity, a high Tobin's Q, and more cash flow).

There is also some evidence for self-interested managers' motive for mergers. Morck, Shleifer and Vishny (1990) find evidence that the stock market reacts negatively to diversifying acquisitions and to acquisitions where the acquirers perform poorly prior to the acquisitions. Maksimovic and Philips (2001) found that firm productivity declines in the case of mergers by acquirers with lower productivity than that of the assets they purchase, which is consistent with the self-interested managerial behavior. McGuckin and Ngyen (1995) and Schoar (2000) also find that the productivity of acquiring firms' plants falls and that the productivity of the targets' plants rises following a takeover.

For financial constraint effects, Hall (1999) finds that R&D was frequently reduced following a major increase in debt levels, whether or not accompanied by mergers.

Literature on the impacts of mergers of Japanese firms on R&D and productivity is scarce. Yeh and Hoshino (2002) examined 86 Japanese mergers completed from 1970 to 1994 and found that acquirers did not improve TFP but deteriorated profitability. Fukao et al. (2006) analyze the post-acquisition performance of the acquired Japanese firms and find that those firms acquired by foreign firms improve TFP and labor productivity while those acquired by domestic firms do not. Iwaki (2006) analyzes mergers and acquisitions by Japanese publicly-listed firms completed from 1980 to 2004[1] and finds that mergers increase labor productivity and that the positive effect of mergers is stronger for within-group mergers than others. However, she does not distinguish acquirers from targets. None of these preceding studies control for the endogeneity of mergers in selecting control samples with which acquiring or acquired firms are to be compared, which may cause a bias in estimating the effects of mergers, as is discussed in the introduction. As a related issue, Hosono, Tomiyama and Miyagawa (2004) examined the Japanese manufacturing firms and showed that R&D tended to increase the firm value in the latter half of the 1990s, against the view that R&D is a managerial perquisite.

Concerning the role of a business group in Japan, there are competing evidences. Some suggest that a close relationship within a business group worsens the conflicts of interests between managers and shareholders by strengthening the managerial entrenchment. Yeh and Hoshino (2002) found that mergers by firms within the same Japanese business group, *keiretsu*, worsened the acquiring firm's profitability, suggesting that mergers within a keiretsu were often conducted for the

purpose of bailing out a financially distressed affiliated firm. Others suggest that a close relationship within a business group help mitigate the information problem and create higher values through mergers. Iwaki (2006) found that mergers within a business group tend to increase labor productivity and return on assets (ROA), suggesting that pre-merger information sharing through the dispatch of directors from the parent company to its subsidiary and clear power balance between the acquiring and acquired firms within the business group help improve post-merger efficiency.

4. Data

We construct the dataset of manufacturing firms by matching firms contained in *Basic Survey of Japanese Business Structure and Activities* (JBSA) and firms in *MARR M&A Data* (MARR) published by RECOF.

JBSA covers all the firms with 50 or more employees and with 30 million yens or more of equity capital belonging to mining, manufacturing and nonmanufacturing industries except for finance and some other service industries. The number of sample firms amounts to about 30 thousand each year. JBSA contains information on key financial indicators, research and development expenditures, and other detailed information on business activities. MARR contains mergers and acquisitions (M&As) involving Japanese firms, dates on which M&A information was released, M&A type (mergers, acquisitions, transfer of business, increase in capital investment, and others), industries and nationalities of firms involved, and information on whether M&As were undertaken within the same business group or not.

Our dataset covers mergers completed from fiscal year 1995 to fiscal year 1999. We decide the beginning year considering that JBSA has been published annually since 1994 and that we use one-year pre-merger characteristics of firms. The ending year is set so that we use JBSA of fiscal year 2002 and examine the post-merger performance up to three years after mergers.

We could match JBSA and MARR for 141 mergers for which acquirers' data were available for one year before mergers and three years after mergers. On the other hand, the number of acquired firms for which we could match JBSA and MARR was as small as 55. Consequently, we focus only on the acquiring firms in this paper.

Tables 2A and 2B show the numbers of mergers by year and by industry, respectively. Table 2C classifies merger types into four. Theoretically, mergers can

be classified into horizontal, vertical, and diversifying ones. Unfortunately, we cannot distinguish the vertical and diversifying mergers given that only the industries of the acquiring and acquired firms are available. Mergers in which acquiring and acquired firms belong to the same industry are classified as intra-industrial mergers and others as inter-industrial mergers here. Using the industry classification adopted by MARR (40 industries), we find that 56 percent of mergers are intra-industrial. We also classify mergers according to whether they are within the same business group or not. We define the within-group merger, following the definition of MARR, as a merger between a parent company and its subsidiary or between the largest shareholder and its affiliated companies.[2] We find that 91 percent of mergers occurred within the same business group.

5. Acquirers' Pre-merger Characteristics

In this section, we investigate the pre-merger characteristics of acquirers. The main purpose of this analysis is to obtain a suitable control group to be compared with acquirers, which we use in the following sections. It will also be useful to examine the validity of the hypotheses presented in Section 2. Specifically, we perform the following logistic regression:

$$\ln\left(\frac{p_{i,t}}{1-p_{i,t}}\right) = \beta' X_{i,t-1} + Industry_i + Year_t + \varepsilon_{i,t} \qquad (1),$$

where $p_{i,t}$ is the probability of a firm *i*'s being an acquirer in year *t*. $X_{i,t-1}$ is a vector of the firm *i*'s characteristics in year *t-1*. We add industry and year dummies. As the firm characteristics, we choose total factor productivity (TFP), R&D expenditures as a proportion of sales (R&D intensity, hereafter), cash flow-to-asset ratio, logarithm of total assets, logarithm of firm age, cost-to-asset ratio, and debt-to-asset ratio. See Appendix for the construction of the TFP measure. The sample firms are all manufacturing firms compiled in JBSA.

Table 3 shows the estimation result. The coefficient on TFP is positive and significant at the 10 percent level, which is consistent with the value-creating hypothesis positing that efficient firms acquire inefficient firms to spread their superior management skills,. The cost ratio has a positive and significant coefficient, while the cash flow ratio has a negative and significant coefficient. Though these results do not seem to be consistent with the value-creating hypothesis, inefficient firms may conduct mergers to improve their efficiency by taking advantage of the

targets resources or by reaping the gains from synergy effects. The negative coefficient on cash flow is not consistent with the free cash flow hypothesis (Jensen, 1986) or the financial constraint hypothesis, either. The coefficient on the logarithm of total assets is positive and significant. A larger firm may acquire a smaller one to gain control of the integrated firm and to minimize the integration costs. The coefficients on the R&D intensity and the debt-to-asset ratio are insignificant.

6. Post-merger Performance

6.1 Approach

To examine the effects of mergers, we have to avoid the endogeneity problem of the merger decision. If, for example, a growing firm tends to be an acquirer, we may mistakenly attribute the improvement of its performance to the effect of mergers. To deal with this problem, we select a control group adoping the propensity score matching method. Specifically, we adopt the following two steps procedures. First, based on the result of Table 3, we select a control sample using the one-to-one nearest matching. Second, we estimate the effects of mergers on the acquirer's TFP and R&D for up to three years after merger using the following difference-in-difference approach:

$$\hat{\alpha}_{ATT,s} = \frac{1}{n}\sum_{1}^{n}\left(y_{t+s}^{treated} - y_{t+s}^{control}\right) - \frac{1}{n}\sum_{1}^{n}\left(y_{t-1}^{treated} - y_{t-1}^{control}\right), \qquad s = \{1, 2, 3\}, \qquad (2),$$

, where n is the number of observations, i.e., acquirers, t is the acquisition year, s is a post-merger year, and y is a measure of firm performance. We look at the post-merger performance up to three years after mergers. As measures of firm performance, we choose TFP and R&D intensity. In addition, we also choose returns on assets (ROA) and debt-to-asset ratio to examine the post-merger changes in profitability and leverage. The superscripts "treated" and "control" denote acquirers and their matched firms, respectively.

Though $\hat{\alpha}_{ATT}$ is an appropriate measure of the effects of mergers, it contains some impacts of acquired firms at least in the short run. For example, if the performance of the acquired firm was poor prior to mergers, it may take a considerable time to integrate the business in an efficient way. In this case, $\hat{\alpha}_{ATT}$ shows a negative effect of the merger, even if the merger has synergy effects in the long run. To eliminate the short-run impact of the acquired firm, we also measure changes in TFP and R&D intensity from one year after mergers:

$$\hat{\beta}_{ATT,s} = \frac{1}{n}\sum_{1}^{n}\left(y_{t+s}^{treated} - y_{t+s}^{control}\right) - \frac{1}{n}\sum_{1}^{n}\left(y_{t+1}^{treated} - y_{t+1}^{control}\right), \qquad s = \{2, 3\}, \qquad (3).$$

6.2 Baseline Results

Table 4A presents the estimates of $\hat{\alpha}_{ATT}$, changes from the pre-merger level. It shows that TFP decreases significantly just after mergers and does not recover to the pre-merger level up to three years after mergers. On the other hand, R&D intensity does not show a significant change up to three years after mergers. The increased leverage after mergers does not significantly constrain R&D. A decrease in TFP may suggest that some managerial costs of business integration are required to acquire firms. A temporary decrease in ROA, which is negative and significant one year after mergers, also suggests some managerial costs of integration.

Table 4B presents the estimates of $\hat{\beta}_{ATT}$, changes from one year after mergers. It shows that the change in TFP is not significant. Scale or scope economy is not working at least up to three years after mergers. The change in the R&D intensity is not significant, either. Yeh and Hoshino (2002), who examined the productivity of the merging firms that completed mergers from 1970 to 1995 using the industry median as a control group, also found no significant recovery in the post-merger years (Table 4, pp. 355), though their sample period and control group are different from ours. .

What do the results concerning the post-merger performance suggest concerning the hypotheses in Section 2. First, considering a significant post-merger decrease in TFP, we may safely say that integration costs are huge and persistent at least up to three years, even though mergers may bring about an efficiency gain on acquired assets. Second, given that R&D did not significantly increase after mergers, managers did not conduct mergers to expand their private benefits from nonproductive R&D. Finally, judging from the fact that R&D did not significantly decrease after mergers, we may conclude that external finance did not constrain R&D activities, though firms significantly increased leverage after mergers..

6.3 Results by Merger Type

The post-merger performance may depend on various merger types: whether merging firms are within the same industry (intra-industry) or across different industries (inter-industry), or whether merging firms are within the same business group or not. Intra-industrial mergers may be easier to save the duplication of R&D investment. Efficiency improvement through synergy effects may also be different

between intra-industrial mergers and inter-industrial mergers. Merging firms within a business group may share sufficient information prior to mergers and an unambiguous power balance between the acquiring and acquired firms, which may contribute to the reduction in the conflicts of interests and integration costs (Iwaki, 2006). On the other hand, A firm affiliated with a business group may tend to bailout financially distressed firms within the group, and hence its post-merger productivity may be negatively affected by the merger (Yeh and Hoshino, 2002).

Table 5A shows the post-merger performance of mergers for the intra-industrial and inter-industrial mergers. Looking at the changes from one-year post-merger, we see that a significant recovery of TFP after mergers can be observed only for inter-industrial mergers. ROA also increases during the two years beginning from one-year post-merger in the case of inter-industrial mergers. Synergy effects seem to be significant for inter-industrial mergers. The changes in R&D are not significant either for intra-industrial mergers or for inter-industrial mergers.

Table 5B shows the post-merger performance of mergers for the within-group mergers and non-within-group mergers. The recovery of TFP after mergers is significant only for within-group mergers. This is consistent with Iwaki (2006), suggesting that the integration costs are relatively small in the case of mergers within a business group. The changes in R&D intensity are not significant for either type of mergers. The change of debt-to-asset ratio from the one-year pre-merger is positive and significant only for within-group, which may suggest that merges are undertaken to bailout a financially distressed firm within the same group. However, a financial constraint effect on R&D investment cannot be observed.

7. Pre-merger Characteristics, Merger Type, and Post-merger Performance

7.1 Approach

In this section, we investigate how pre-merger characteristics of an acquirer and merger types have impacts on its post-merger performance. Specifically, we first measure the effects of mergers on TFP and R&D intensity as

$$\Delta y_{i,t+3} \equiv \left(y_{t+3}^{treated} - y_{t+3}^{control}\right) - \left(y_{t-1}^{treated} - y_{t-1}^{control}\right) \quad (4),$$

, where y denotes either TFP or R&D intensity. Note that we adopt a four-year window. Next, we regress the change in TFP or R&D intensity on the pre-merger characteristics of the acquirer.

$$\Delta y_{i,t+3} = \beta_1' X_{i,t-1} + \beta_2' Type_i + \varepsilon_{i,t} \quad (5),$$

where $X_{i,t-1}$ is the vector of the pre-merger characteristics of acquirer i and $Type_i$ is the vector of merger types. $X_{i,t-1}$ includes the TFP level, ROA, R&D intensity, debt-to-asset ratio, and the average age of the industry the acquirer belongs to. We try to capture the maturity of the industry by the industry-level age. If the free cash flow hypothesis is valid, mergers in matured industries do not improve TFP. $Type_i$ consists of the two variables. One is the intra-industry merger dummy and the other is the within-group merger dummy.

7.2 Results

The first two columns of Table 6 show the estimation results of TFP and the last two columns show those of R&D intensity.

Looking at the results of TFP, we find that the initial R&D intensity has a positive and marginally significant effect on the change in TFP. The finding that mergers by an R&D intensive acquirer are likely to improve its TFP is consistent with the value maximization hypothesis. The initial TFP has a negative impact on the change in TFP, suggesting its mean reverting property. The industry-level age is not significant. Column 1, with only the intra-industry dummy and the group dummy, shows that neither of the merger type dummies is significant. In Column 2, we classify mergers into four types: intra-industry and within-group (type A), intra-industry and non-within-group (type B), inter-industry and within-group (type C), and inter-industry and non-within-group (type D). Given type D as a benchmark, all the other three type dummies are positive and significant with almost the same coefficients, suggesting that type D underperforms the other three types in terms of TFP. Type D may involve quite a high managerial cost for business integration.

Turning to the results of R&D intensity, we find that the initial R&D intensity is negative and significant, suggesting its mean reverting movement. The debt-to-asset ratio is not significant. If mergers tightened the financial constraint faced by the acquirer, such effects would be stronger for the acquirers whose pre-merger debt level was high. Our result suggests that the financial constraint does not have a negative impact on the post-merger R&D intensity. The industry-level age dummy is positive but not significant. The managerial private motive hypothesis is not supported. Column 3, including two merger types of

dummies, the intra-industry dummy and the group dummy, shows that the group dummy is negative and significant at the 10 percent level. The finding that within-group mergers reduce R&D intensity but not TFP level suggests that firms within a group may have substitutable technology and therefore acquirers can save duplication of R&D within-groups, though this effect is only marginally significant. In column 4, we include four merger type dummies and find that none of the merger type dummies is significant.

8. Conclusion

We investigate the impact of merger on innovation and efficiency using a micro dataset of Japanese manufacturing firms including unlisted firms during the merger wave period of 1995-1999. We find that the acquirer's total factor productivity (TFP) decreases immediately after mergers and does not significantly recover to the pre-merger level within three years after mergers. We also find that the R&D intensity does not significantly change after mergers despite a significant increase in the debt-to-asset ratio. Our results suggest that the costs of business integration are large and persistent.

Considering a large integration cost, we also analyze the post-merger performance from one year after mergers, finding no significant increase in TFP or R&D intensity up to three years after mergers.

To take into consideration the heterogeneity of mergers, we analyze the post-merger performance by classifying merger types. We find that the recovery of TFP after mergers is significant for mergers across different industries or within the same business group, suggesting that a synergy effect works well and integration costs are small for those types of mergers

Though our sample is broad in that it includes both listed and non-listed firms, our sample period, fiscal year 1995 to1999, is relatively short, which coincides with the severe banking crisis in Japan and a major part of which covers the downturn of business cycle (1997:II through 1999:I), mainly due to the limited availability of dataset. Would the results change if we could extend the sample period to cover a more "normal" period? We conjecture that our results that mergers within a group or across industries relatively perform better than other types would still hold. On the other hand, the overall post-merger performance might depend on how many mergers are for the purpose of rescuing distressed firms and how many are for more strategic business purposes. The exact answer to the question has to be waited until

more recent data becomes available.

Appendix: Construction of the TFP measure

The dataset employed in this paper was obtained from *Basic Survey of Japanese Business Structure and Activities* for the period from 1994-2002, which is conducted annually by the Ministry of Economy, Trade and Industry (METI).

We define the productivity level of firm i in year t in a certain industry in comparison with the productivity level of a hypothetical representative firm in base year 0 in that industry. This TFP measure was developed by Caves, Christensen, and Diewert (1982) and extended by Good, Nadiri, Roller, and Sickles (1983).

The TFP level is defined as follows:

$$\begin{aligned} \ln TFP_{i,t} &= (\ln Q_{i,t} - \overline{\ln Q_t}) - \sum_{f=1}^{n} \frac{1}{2}(S_{f,i,t} + \overline{S_{f,t}})(\ln X_{f,i,t} - \overline{\ln X_{f,t}}) \\ &+ \sum_{s=1}^{t}(\overline{\ln Q_s} - \overline{\ln Q_{s-1}}) - \sum_{s=1}^{t}\sum_{f=1}^{n}\frac{1}{2}(\overline{S_{f,s}} + \overline{S_{f,s-1}})(\overline{\ln X_{f,s}} - \overline{\ln X_{f,s-1}})] \end{aligned} \tag{A1}$$

where $Q_{i,t}$, $S_{f,i,t}$, and $X_{f,i,t}$ denote the output of firm i in year t, the cost share of factor f for firm i in year t, and firm i's input of factor f in year t, respectively. Variables with an upper bar denote the industry averages of those variables.

We drop from our sample all firms for which data on total sales, total number of workers, tangible fixed assets, total wages and intermediate inputs are zero or negative value at least for one year. If firm i switches industries, we classify firm i into an industry by entry date.

Output

Except for the commerce sector, gross output is defined as firms' total sales. For the commerce sector, gross output is measured as sales minus expenses for purchased materials. Gross output is deflated by the output deflator derived from *Japan Industrial Productivity Database* 2006 (JIP 2006) compiled by Research Institute of Economy, Trade and Industry.

Intermediate inputs

For the commerce sector, intermediate inputs are calculated as (Cost of sales + Operating costs) – (Wages + Depreciation costs + Expenses for purchased materials). The intermediate inputs of other sectors are defined as (Cost of sales + Operating costs) – (Wages + Depreciation costs). Intermediate inputs are deflated by the intermediate input deflator provided by JIP 2006.

Labor input

As labor input, we used each firm's total number of workers multiplied by the sectoral working hours from JIP 2006.

Capital Stock

For capital stock, the only data available are the nominal book values of tangible fixed assets. Using these data, we calculated the net capital stock of firm *i* in industry *j* in constant 1995 prices as follows:

$$K_{it} = BV_{it} * (INK_{jt} / IBV_{jt})$$

where BV_{it} represents the book value of firm *i*'s tangible fixed capital in year *t*, INK_{jt} stands for the net capital stock of industry *j* in constant 1995 prices, and IBV_{jt} denotes the book value of industry *j*'s capital. INK_{jt} was calculated as follows. First, as a benchmark, we took the data on the book value of tangible fixed assets in 1975 from the *Financial Statements Statistics of Corporations* published by MOF. We then converted the book value of year 1975 into the real value in constant 1995 prices using the investment deflator provided by JIP 2006. Second, the net capital stock of industry *j*, INK_{jt}, for succeeding years was calculated using the perpetual inventory method. We used the investment deflator in JIP 2006. The sectoral depreciation rates used are taken from JIP 2006.

Cost Shares

Total cost of labor is measured as total wages. We used nominal intermediate input as the intermediate input cost. Capital cost was calculated by multiplying the real net capital stock with the user cost of capital. The latter was estimated as follows:

$$c_k = \frac{1-z}{1-u} p_k \{\lambda r + (1-u)(1-\lambda)i + \delta_i - (\frac{\dot{p}_k}{p_k})\}$$

where $p_k, i, \delta, u, \lambda$ and z are the price of investment goods, the interest rate (newly issued government bonds yield (10 years)), the depreciation rate, the corporate tax rate, the equity ratio, and the present value of depreciation deduction on a unit of nominal investment, respectively. Data on investment goods prices, interest rates, and corporate tax rates were taken from JIP 2006, the Bank of Japan's website, and the *Ministry of Finance Statistics Monthly*, respectively. The

depreciation rate for each sector (δ_i) was taken from JIP 2006. We calculated the cost shares of each factor by dividing the cost of each factor by total costs, which consist of the sum of labor costs, intermediate inputs costs, and capital costs. z was estimated as follows:

$$z = (u\delta_i) / [\{\lambda r + (1-u)(1-\lambda)i\} + \delta_i].$$

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Table 1. Hypotheses of the Characteristics and Performance of Acquirers

Motives	Pre-merger Characteristics		Post-Merger Performance	
	TFP	R&D	Change in TFP	Change in R&D
Value-Creation	High	–	Increase (Synergy) Decrease (Integration Costs)	Increase (Complementary) Decrease (Substitutable)
Managerial Private Motive	Low	High	Decrease (Empire-Building) Increase (Discipline by Debt)	Increase (Empire-Building) Decrease (Discipline by Debt)
Financial Constraint	–	–	Decrease	Decrease (Debt Overhang)

Table 2. Number of Mergers

A. By Year

Fiscal Year	
1995	1
1996	26
1997	26
1998	41
1999	46
Total	140

B. By Industry of Acquirers

Food products and beverages	10
Textiles	4
Pulp ,paper and paper products	2
Chemicals	17
Petroleum and coal products	1
Non-metallic mineral products	9
Iron, steel, and non-ferrous metals	19
Fabricated metal products	11
Machinery	19
lectrical machinery ,equipment and supplie	16
Transport equipment	15
Precision instruments	6
Others	11
Total	140

C. By Type

	Within Group	Others	Total
Within Industry	68	11	79
Across Industries	59	2	61
Total	127	13	140

Table 3. Decision of Being an Acquirer

TFP	0.736	*
	(1.71)	
Cash Flow / Asset	−0.395	***
	(−4.24)	
Log (Asset)	0.542	***
	(16.25)	
Log (Age)	−0.080	
	(−0.53)	
R&D / Sales	−1.463	
	(−0.62)	
Cost / Asset	0.176	***
	(3.16)	
Debt / Asset	−0.156	
	(−0.63)	
Constant	−9.570	***
	(−12.97)	
No. of Obs.	62072	
Pseudo R2	0.095	

1 Logit estimate for the probability of being an acquirer is presented.
2. All the explanatory variables are one-year lagged variables.
Year dummies and industry dummies are included in the explanatory variables.
3. Numbers in the parentheses are z-values.
4. ***, **, * stand for the significance levels of 1%, 5% and 10%, respectively.

Table 4. Post-merger Performance

A. Changes from one year before mergers

years after mergers	TFP		R&D Intensity	ROA		Debt-to-Asset Ratio	
1 year	−0.025	***	−0.001	−0.009	**	0.012	*
	(214)		(214)	(214)		(214)	
2 years	−0.026	***	0.000	−0.007		0.014	*
	(199)		(199)	(199)		(199)	
3 years	−0.031	***	−0.002	−0.005		0.032	**
	(140)		(140)	(140)		(140)	

B. Changes from one year after mergers

years after mergers	TFP	R&D Intensity	ROA	Debt-to-Asset Ratio
2 years	−0.001	0.000	−0.001	0.001
	(183)	(183)	(183)	(183)
3 years	0.011	−0.003	0.002	0.003
	(122)	(122)	(122)	(122)

1. Changes from one year after mergers are shown.
2. Numbers in the parentheses are numbers of observations.
3. ***, **, * stand for the significance levels of 1%, 5% and 10%, respectively.

Table 5. Post-merger Performance by Merger Type

A. Within-industry versus across-industry

Within-industry

Changes	TFP		R&D Intensity	ROA		Debt-to-Asset Ratio	
from (t-1) to (t+3)	-0.037	***	-0.002	-0.015	**	0.037	**
	(79)		(79)	(79)		(79)	
from (t+1) to (t+3)	0.001		-0.003	-0.006		0.011	
	(68)		(68)	(68)		(68)	

Across-industry

Changes	TFP		R&D Intensity	ROA		Debt-to-Asset Ratio	
from (t-1) to (t+3)	-0.024		-0.002	0.007		0.025	
	(61)		(61)	(61)		(61)	
from (t+1) to (t+3)	0.024	**	-0.004	0.011	*	-0.007	
	(54)		(54)	(54)		(54)	

B. Within-group versus Not-within group

Within-group

Changes	TFP		R&D Intensity	ROA		Debt-to-Asset Ratio	
from (t-1) to (t+3)	-0.027	**	-0.002	-0.003		0.031	**
	(127)		(127)	(127)		(127)	
from (t+1) to (t+3)	0.017	*	-0.003	0.003		0.006	
	(110)		(110)	(110)		(110)	

Non-within-group

Changes	TFP		R&D Intensity	ROA		Debt-to-Asset Ratio	
from (t-1) to (t+3)	-0.075	*	0.002	-0.026	*	0.046	
	(13)		(13)	(13)		(13)	
from (t+1) to (t+3)	-0.035		-0.002	-0.010		-0.031	
	(12)		(12)	(12)		(12)	

1. Year t denotes the merger year.
2. Changes from one year after mergers are shown.
3. Numbers in the parentheses are numbers of observations.
4. ***, **, * stand for the significance levels of 1%, 5% and 10%, respectively.

Table 6. Pre-merger Characteristics and Post-merger Performance

Dependent Variable	TFP	TFP	R&D intensity	R&D intensity
Column No.	1	2	3	4
TFP level	−0.678 ***	−0.705 ***		
	(−8.69)	(−9.05)		
ROA	0.293	0.328	−0.028	−0.027
	(1.28)	(1.46)	(−1.06)	(−1.03)
R&D intensity	0.780 *	0.775 *	−0.755 ***	−0.756 ***
	(1.85)	(1.87)	(−14.90)	(−14.89)
Debt-to-asset ratio	−0.019	−0.015	−0.003	−0.003
	(−0.43)	(−0.35)	(−0.64)	(−0.60)
Intra-industry dummy	−0.002		−0.003	
	(−0.07)		(−1.19)	
Group dummy	0.029		−0.008 *	
	(0.73)		(−1.66)	
TypeA dummy		0.190 **		−0.004
(within-industry and within-group dummy)		(2.11)		(−0.35)
TypeB dummy		0.202 **		0.006
(within-industry and non-within-group dummy)		(2.07)		(0.49)
TypeC dummy		0.204 **		0.000
(across-industry and within-group dummy)		(2.26)		(0.00)
TypeD dummy		(dropped)		(dropped)
(across-industry and non-within-group dummy)				
Industry-level age	0.001	0.002	0.001	0.001
	(0.50)	(0.61)	(1.47)	(1.49)
Constant	−0.114	−0.294 **	−0.013	−0.021
	(−0.94)	(−2.01)	(−0.91)	(−1.20)
Obs.	128	128	128	128
R-squared	0.399	0.421	0.682	0.683

1 Dependent variables are changes from one year before mergers to three years after mergers.
2. All the explanatory variables are one-year before mergers.
3. Numbers in the parentheses are t-values.

Footnotes

[1] Iwaki (2007) excludes the so-called "equal mergers" from her sample firms.

[2] As for the definition of the Japanese business group, diversified groups consisting of a bank and a range of large manufacturing firms that cross-share stocks and often accept directors from the bank is defined as keiretsu (e.g., Hoshi et al., 1990), Keiretsu has sometimes another meaning of a vertical grouping of manufacturing firms. Our definition does not necessarily imply such a bank-centered group or a vertical tie.