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How M&As Impact Acquirers' R&D: Japanese Pharmaceutical Industry

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Abstract

This study aims to examine the impact of pharmaceutical industry mergers and acquisitions (M&A) on research and development (R&D) investment in Japan. Employing appropriate difference-in-difference (DID) estimation techniques associated with a propensity score-matching procedure, this study focuses on two main indicators of performance: R&D-related variables and profit variables. This study finds that after five years, R&D investment increases but profit performance declines. These findings suggest that a synergy effect exists between M&As and R&D investment, and the financial burden of an M&A and a large increase in R&D investment or problems merging distinct corporate cultures may possibly cause a decline in corporate performance in the long run. This study is the first to examine the impact of M&As on R&D in the Japanese market. Using the propensity-score-matching procedure to control for these simultaneous bias problems, this study succeeds in elucidating the cause and effect between M&A and R&D. The results provide quantitative support for the establishment of certain laws in Japan about M&As and the design of policies within the pharmaceutical industry.

Key Words: *M&A, R&D, Pharmaceutical Industry, DID, Propensity-Score-Matching.*

Introduction

The Japanese pharmaceutical industry is currently facing severe economic difficulties. For example, the "2010 problem," which led to widespread patent expiration on blockbuster drugs in 2010 as well as reduction in medicine prices, has hindered the development of new medicines. Pharmaceutical firms in Europe and America also face the same situation. Because markets in developed countries have already matured, firms are searching for new sources of profits. To this end, markets in emerging countries are particularly promising. As such, international competition in these markets has grown increasingly intense. Given these developments, the Japanese government has protected the domestic pharmaceutical industry. However, when accounting for the necessity of international consolidation in the pharmaceutical industry, the Japanese Ministry of Health, Labour and Welfare has released an international strategy for strengthening Japanese firms' international competitiveness. In light of this strategy, the Japanese pharmaceutical industry has entered a new phase of international consolidation. To compete in global markets, it is necessary to scale merit for firms. Therefore, it is reasonable to expect that the consolidation of not only domestic Japanese firms but also international firms will continue to increase. Thus, it is critical to explore the influence of M&As in the pharmaceutical industry.

Since the global rise in M&As has drawn scholarly interest, literature on the effects of M&As is growing fast among European and American counties. Some studies analyze the impact of M&As on financial and economic performance, while others focus on the relationship between M&As and innovative performances measured through factors such as R&D-related and patent-related indicators.[1]

Literature Review

The most notable and seminal studies examining the relation between M&As and R&D are those by Hall (1988, 1990). Hall explored the determinants of the probability that a firm will engage in an M&A using a sample of 2,500 US manufacturing firms (1967–87). Hall found some negative correlation between M&A and R&D intensity. However, after accounting for the fact that a small decline in R&D intensity after an M&A is associated with increased leverage rather than the M&A itself, Hall's conclusion is not decisive.

Hitt et al. (1991) investigated the effects of acquisitions on both R&D inputs and outputs. The results provide strong support for the negative effects stemming from acquisitions on R&D investment and the number of patents. These findings thus suggest that firms achieve a synergy based on economies of scale, scope, or both, and managers may use acquisitions as a substitute for innovation.

Blonigen and Taylor (2000) examined empirical evidence on the relation between M&As and R&D intensity in electronic and electrical equipment industries. The results show a strong negative correlation; in other words, in these industries, firms with a relatively low R&D are more likely to engage in M&As. Lehto and Lehtoranta (2004) investigated the manner in which R&D affects the likelihood of M&As in Finland. The researchers found that a high level of R&D increases the probability of engaging in M&As. Despite the evidence presented by these two studies, however, the causal link may also run in the opposite direction, i.e., from M&As to R&D.

Bertrand and Zuniga (2006) investigated the effects of national and cross-border M&As on OECD countries' R&D investment in the 1990s. This study found that cross-border M&As had no significant effect on domestic R&D intensity but did exert a positive impact on R&D intensity in medium-tech industries. Bertrand and Zitouna (2008) further examined the effects of horizontal acquisitions on the performance of target firms. These researchers found that M&A do not increase the profit of French target firms, even in the long run, but clearly raise the productivity. Bertrand (2009) investigated the causal effect of foreign acquisitions on R&D activities of domestic French target firms. Bertrand found that the acquisition of French firms by foreign companies boosted R&D spending.[2] Stiebale (2013) found that cross-border acquisition raises the average domestic R&D-to-sales ratio in acquiring firms. In terms of negative effects, Stiebale and Reize (2011) found that foreign acquisition has a negative impact on average R&D expenditures in innovative German firms. Desyllas and Hughes (2010) found that acquisitions bring about a negative effect on both R&D intensity and R&D productivity in the first year following an acquisition, but for R&D-intensity, the effect turns positive in the third year. Martin and Alvarez (2009) found that M&As undertaken by foreign-owned firms in Spain have a negative impact on acquirers' innovation activities, but M&As undertaken by domestically owned firms demonstrated no significant influence.[3] Cloodt, Hagedoorn, and Kranenburg (2006) examined the post-M&A performance of acquiring

[1] Veugelers (2006) reviewed studies examining the relation between M&As and R&D mainly covering the period up to 2000.

[2] Guadalupe et al. (2012) also found positive effects of foreign acquisition on innovation. However, in this study, strictly speaking, innovation includes process innovation that introduces new machinery and/or new methods to organize production, not R&D activity.

[3] Controlling by industry, M&As for foreign firms show a positive impact on R&D expenditures in high-tech industries, while M&As for domestic firms have a positive effect in medium-high-technology

firms in four major high-tech sectors. The study found that non-technological M&As have a negative impact on the acquiring firm's innovative performance. In addition, Szücs (2014) investigated the impact of M&As on R&D activities of both acquiring and target firms. The results show that target firms decrease their R&D efforts after a merger, but the R&D intensity of acquiring firms drops due to a sharp increase in sales.

Finally, some works have focused on the pharmaceutical industry. Ornaghi (2009) examined the effects of mergers on R&D activity of consolidated firms using data from the pharmaceutical industry. He found that merged companies perform, on average, worse than the group of non-merging firms. Danzon et al. (2007) analyzed the determinants and effects of M&A activity in the pharmaceutical and biotech industries and found that large firms that merged experienced slower operating profit growth in the third year after merger compared with similar firms that did not merge. In addition, small firms that merged experience relatively slow R&D growth in the first year compared with non-merging firms. Such evidence suggests that mergers may be a response to trouble but are not necessarily a solution.

While extensive research has investigated the effects of M&As on R&D activities, findings in the literature are quite mixed and no scholarly consensus has been formed. The aim of this study is to examine the impact of pharmaceutical industry M&As on R&D investment in Japan.

Compared with these previous studies, this study would be the first to exclusively focus on the pharmaceutical industry in Japanese market. Although each industry is characterized by its own unique elements, many other industries in Japan face problems similar to those of the pharmaceutical industry. Therefore, the findings and implications of this study may be generalizable to other industries.

In addition, Ravenscraft and Long (2000) and Higgins and Rodriguez (2006) performed event studies of pharmaceutical M&As. However, the event study method, at best, captures expectations measured by stock prices at the time of an M&A's announcements, not addressing the long-term effects of M&A. In contrast, this study seeks to measure long-term firm performances after M&As using financial data rather than an event study.

To examine the impact of M&As on R&D, this study first needs to remove the reverse causal link running from R&D to M&A. Unless this study distinguishes both these relations, it will only obtain evidence on correlations rather than on causal links. Therefore, this study uses the propensity-score-matching procedure to control for these simultaneous bias problems. Therefore, this study can clearly sort out cause and effect between M&As and R&D.

This study is organized as follows. Section 2 briefly discusses the theoretical background. Section 3 presents the data sets, model, and results of the regression analysis. Section 4 presents a summary and conclusion.

Theoretical Background

Theory suggests that M&As exert both positive and negative effects on R&D investment. According to industrial organization framework, positive effects arising from M&As are mainly (1) an increasing market share or strengthening market power, (2) improving efficiency, and (3) complementarity of technology assets.[4]

industries. Moreover, the reduction in R&D investment in low-tech industries is also significant for both foreign-owned and domestic acquirers.

[4] A more detailed description of the motivation for M&As is provided by Odagiri and Hase (1989).

First, an increasing market share or strengthening market power may bring sales growth or higher price effects. Accordingly, profitability or cash flows may improve, leading to increased R&D investment.

Second, improving efficiency through (1) synergistic gains and (2) economies of scale and scope in production and distribution may lead to a high incentive to invest in R&D. Also, M&As could bring R&D efficiency to firms by eliminating duplicated R&D-related employment or equipment if the overlap between the R&D activities of the acquirer and the target is large.

Third, firms may be able to obtain technology more effectively through M&As. In the pharmaceutical industry, long-term investment is needed before results emerge. Moreover, the risks associated with a firm's own research rise every year. In this case, M&As are preferred because the methods employed under M&As are less risky and faster in obtaining technology and know-how from a firm that has already succeeded in R&D. In addition, the Schumpeter hypothesis, which stresses the efficiency gains in R&D investment due to firm size and market power, can be applied. The complementarity of merging partners' technology assets not only improves R&D efficiency but also motivates them further increase R&D investment. Considering these economic channel effects described above, M&As may bring about high performance effects and increase the incentive to invest in R&D.

On the other hand, counter-arguments can be made regarding the effects of M&As on acquiring firm's R&D activities. M&As can have negative effects, including (1) substituting for R&D, (2) reducing duplicate R&D activities, (3) reducing the incentive to invest in R&D, (4) reducing corporate performance due to higher debt, and (5) increased organizational complexity.

First, when resources available for allocation are scarce or constrained, managers are obliged to forgo other investment opportunities. In such cases, one opportunity to be foregone may be investment in R&D.[5] Second, when the acquirer can eliminate wasteful R&D duplication from the target's R&D activities, given improved R&D efficiency, this may result into reduced R&D activities. Third, an M&A may reduce the incentive to compete with rivals and acquire new technology, which may lead to decreased R&D investment. Fourth, M&As are often associated with increasing levels of debt, leading to reductions in corporate performance. The increased financial risk associated with debt may also make managers more risk-averse and less willing to invest in R&D.[6] Finally, M&As may entail higher organizational costs arising due to the need to integrate the merging firms. Distinct corporate cultures may hamper mutual communication, leading to drops in R&D activities and corporate performance. Considering these effects, a negative correlation can arise between M&A and R&D-related variables.

To clear whether M&As bring more benefits than drawbacks to R&D, this study mainly examines the effects of M&As on R&D-related variables as well as on profit variables.

Empirical Analysis

This section examines the effect of M&As on the outcome by using the propensity-score-matching difference-in-difference (PSM-DID) estimator proposed by Rosenbaum and Rubin (1983). That is, this study assumes that counterfactual performance can be defined by a control group of non-M&A-conducting firms with observable characteristics similar to those of a treatment group of M&A-conducting firms. An M&A is measured by the difference in performance between a control group and a treatment group, which can be attributed to the M&A event only.

[5] See Hitt et al. (1990, 1991).
[6] See Hitt et al. (1996, 1998).

The M&A data used are obtained from the *M&A Databook of Japanese firm* and *marr* (February 2004). M&A activities are broadly defined to include not only M&As of entire firms but also the transfer of businesses and capital participation. This study worked with balance sheet data obtained from the Development Bank of Japan (DBJ) for the period between 1999 and 2008. This study focuses on firms listed in the securities exchange.

This study's basic regression for firm i at time t is as follows:

$$Y_{it} = \beta_0 + \beta_1 T + \beta_2 M \,\&\, ADummy_{it} + \varepsilon_{it} \qquad (1)$$

where Y_{it} indicates outcome (e.g., performance indicator such as R&D intensity, ordinary profit to sales ratio, etc.), β_0 is firm-specific fixed effect, T is a set of time trends, and ε_{it} is a random disturbance term. $M \,\&\, ADummy_{it}$ takes a value of 1 if the firm i first conducts an M&A in period t.

The first step of our estimation strategy consists in finding a well-suited control group. Using the panel data of 63 pharmaceutical firms, 157 samples from 1999 to 2007 and a probit model, this study conducted an empirical analysis. Table 1 reports descriptive statistics for variables.

This study estimates the following regression:

Table 1. Descriptive statistics for the variables of a probit model

Variable	Mean	Median	Maximum	Minimum	Std. Dev.	Observations
R&D intensity	0.319	0.318	0.996	0.000	0.204	157
Log(SALES)	11.096	11.063	13.608	8.890	1.232	157
Log(CASHFLOW)	8.392	8.437	11.859	4.454	1.722	157
DEBTRATIO	0.396	0.352	0.886	0.141	0.190	157

$$\Pr(M \,\&\, A_{it} = 1 \mid X_{it-1}) = \Phi(X_{it-1}) \qquad (2)$$

Where $M \,\&\, A_{it}$ takes a value of 1 if the firm i conducts an M&A in period t and 0 otherwise, the vector X_{it} representing the firm characteristics are as follows. $R \,\&\, D \text{int} ensity_{it}$ is R&D intensity calculated as the ratio of a firm's R&D investment to tangible assets. When synergistic gains are expected from an M&A or when high R&D intensity induces a high-capacity announcement effect to acquire technology, the expected sign is positive. On the other hand, if the firm engages in different strategies (e.g., "make or buy" strategy), the expected sign is negative. $Log(SALES_{it})$ is the logarithm of sales, serving as a proxy for firm size. $Log(CASHFLOW_{it})$ is the logarithm of cash flow calculated as retained earnings plus depreciation divided by the domestic corporate goods price index. Jensen's (1988) free cash flow hypothesis suggested that firms with higher free cash flow are likely to engage in M&As. $DEBTRATIO_{it}$ is debt ratio calculated as total debt divided by total assets. Considering capital constraints, the debt ratio exerts a negative effect on M&A activity. To reduce the simultaneity bias problem, explanatory variables are lagged. In addition to these variables, the regression also includes $dummy_t$ indicating time dummy variables (2001–2003 fiscal years).

Then, the propensity-score-matching method is utilized to re-establish the conditions of a natural experiment with non-experimental data. The aim is to construct an appropriate counterfactual by matching

each M&A-conducting firm (treatment group) with one based on similar characteristics drawn from a sample of non-M&A-conducting ones (control group). This study measures the probability of a firm conducting an M&A according to estimated coefficients of Equation (2). This study uses the nearest-neighbor matching method to select the control firm. This study can control for self-selection based on endogeneity bias.

The second step is to use the difference-in-difference method to examine the effect of M&As.[7] Taking the first differences of equation (1) removes the firm-specific fixed effect (β_0).

$$Y_{it} - Y_{it-1} = \beta_1 + \beta_2 M \,\&\, ADummy_{it} + (\varepsilon_{it} - \varepsilon_{it-1}) \quad (3)$$

Table 2. Results for the propensity score estimation (probit model)

	Coefficient
Constant	−9.294 ***
	(2.050)
R&D intensity	−2.655 **
	(1.054)
Log(SALES)	0.382 *
	(0.204)
Log(CASHFLOW)	0.491 **
	(0.201)
DEBTRATIO	1.319
	(1.067)
Sample size	157
Log-likelihood	−53.991

Notes:
Standard errors are in parentheses.
Year dummies are included.
*** Significant at the 1% level, ** significant at the 5% level, and * significant at the 10% level.

This study employs the Ordinary Least Squares (OLS) method by regressing data pooled across the treatment and control groups. As it avoids the problem of endogeneity and bias in estimation with the fixed effects model, the estimator of β_2 is unbiased and consistent.

Empirical Results

Results in Table 2 summarize the estimated coefficients for Equation (2) for a probit model. The estimated coefficients of $R\&D\text{int}ensity_{it}$ is negative and statistically significant. This suggests that firms engage in different strategies (e.g., "make or buy" strategy). The estimated coefficient on $Log(SALES_{it})$ is positive and statistically significant, indicating that a firm's probability of engaging in an M&A increased as firm size increased. The estimated coefficients of $Log(CASHFLOW_{it})$ is positive and statistically significant,

[7] see. Heckman (1997).

supporting Jensen's (1988) free cash flow hypothesis. Finally, the estimated coefficients on $DEBTRATIO_{it}$ are not statistically significant.

By using these probit model results, this study conducts propensity-score-matching. The method measures the probability of conducting M&As and constructs an appropriate counterfactual by matching M&A-conducting firms (treatment group) to non-M&A-conducting ones (control group) based on propensity scores. Table 3 reports means for both a treatment group and control group after matching, and t-tests are performed to determine the equality of means for both groups. As can be seen, no significant difference exists in these variables between two groups. This result indicates the efficacy of the propensity-score-matching method.[8]

Table 3. Balancing test

	Means after matching		t-value
	Treatment Group	Control Group	
Log(R&D Investment)	9.687	8.970	−1.47
R&D intensity	0.342	0.298	−0.71
Log(SALES)	12.055	11.759	−1.18
Log(CASHFLOW)	9.576	9.299	−0.68
DEBTRATIO	0.392	0.434	0.70

Notes:

t-value of the difference between mean values.

Finally, the effects of M&As are estimated using the DID method. As displayed in Table 4, for four performance indicators, the study tracked DID for each year from the year of an M&A to five years later. It revealed that M&As have a positive and significant impact on R&D-related variables—both R&D intensity and R&D growth five years after the M&A occurred. Because the complementarity of merging partners' technology assets not only improves R&D efficiency but also makes the involved firms increase their R&D investment further, these results may suggest that a synergy effect exists between M&As and R&D investment levels. These findings support those of Bertrand and Zuniga (2006), Bertrand (2009), Stiebale (2013), and Desyllas and Hughes (2010), but contradict those of Hitt et al. (1991), Stiebale and Reize (2011), Martin and Alvarez (2009), and Cloodt, Hagedoorn, and Kranenburg (2006).

In addition, M&As have a significantly negative impact on profit variables—both operating profit to sales ratio and ordinary profit to sales ratio—five years after an M&A. One interpretation of these negative impacts can ascribe them to a financial burden arising from the M&A itself or to a substantial increase in R&D investment.[9] Since M&As are often associated with increasing levels of debt, the increased financial risk associated with debt may also make managers more risk averse, leading to reductions in corporate performance. Another interpretation is that since an M&A entails higher organizational costs due to the need to integrate formerly separate firms, distinct corporate cultures may hamper mutual communication, leading to reductions in corporate performance.

[8] The parts of these matching results are also used in Miyazaki (2015). While Miyazaki (2015) analyzes the effects of M&A on stock price performance, this study examines M&As by using financial data. These two studies are greatly different in analytical methods.

[9] The impact of debt is discussed in Hall (1988, 1990) and Hitt et al. (1996, 1998).

Table 4. Effects of M&As

A. R&D intensity

Post−merger period	t	t + 1	t + 2	t + 3	t + 4	t + 5
Constant	0.174	0.289	−0.056	0.187	0.870 **	−0.485
Standard errors	0.345	0.250	0.247	0.298	0.341	0.712
M&A Dummy	0.337	0.042	0.327	0.298095	−0.280	1.844 *
Standard errors	0.472	0.350	0.350	0.421993	0.500	1.051
No.of observations	45	47	46	42	43	37
R^2	0.012	0.000	0.020	0.012	0.008	0.081

B. R&D growth

Post−merger period	t	t + 1	t + 2	t + 3	t + 4	t + 5
Constant	4.857 **	4.500 **	3.209	7.591	9.239 **	−2.375
Standard errors	2.405	1.781	2.127	8.110	3.574	6.891
M&A Dummy	2.514	−0.413	−0.535	13.547	−1.784	23.740 **
Standard errors	3.366	2.493	3.008	11.605	5.240	10.167
No. of observations	47	47	46	43	43	37
R^2	0.012	0.001	0.001	0.032	0.003	0.135

C. Operating profit to sales ratio

Post−merger period	t	t + 1	t + 2	t + 3	t + 4	t + 5
Constant	−0.911	−0.013	−0.031	0.484	−0.221	1.725 *
Standard errors	0.615	0.449	0.486	0.588	0.695	0.946
M&A Dummy	0.078	−0.297	1.136	−0.306	0.493	−2.705 **
Standard errors	0.860	0.628	0.687	0.841	1.019	1.395
No. of observations	47	47	46	43	43	37
R^2	0.000	0.005	0.058	0.003	0.006	0.097

D. Ordinary profit to sales ratio

Post−merger period	t	t + 1	t + 2	t + 3	t + 4	t + 5
Constant	−0.943	−0.236	0.197	0.508	−0.154	2.067 **
Standard errors	0.620	0.463	0.539	0.592	0.742	0.987
M&A Dummy	0.147	−0.336	0.800	−0.172	0.693	−3.111 **
Standard errors	0.868	0.648	0.763	0.848	1.088	1.457
No. of observations	47	47	46	43	43	37
R^2	0.001	0.006	0.024	0.001	0.010	0.115

Notes:
Standard errors are in parentheses.
*** Significant at the 1% level, ** significant at the 5% level, and * significant at the 10% level.

Concluding Remarks

This study investigated the impact of M&As on R&D investment in the Japanese pharmaceutical industry. Employing appropriate DID estimation techniques associated with a propensity-score-matching procedure, this study focuses on two main indicators of performance: R&D-related variables and profit variables. This

study finds that R&D investment increases but profit performance declines within five years after an M&A. These findings suggest that a mutually reinforcing effect exists between M&As and R&D investment, and the financial burden imposed by M&As and a substantial increase in R&D investment or distinct corporate cultures associated with firms brought together through an M&A may possibly cause corporate performance to deteriorate in the long run.

The empirical results provide quantitative support for the establishment of certain laws in Japan regarding M&As and a policy addressing the pharmaceutical industry. However, despite the study's empirical reliability, further investigation is warranted before generalizing its results.

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