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국내 제약산업의 합병효과 분석

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Efficiency Effects of Mergers in the Korean Pharmaceutical Industry

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■ Abstract ■

The main objective of this paper is to empirically analyze the efficiency effects of mergers on Korean pharmaceutical firms and suggests managerial or policy implications for managers or policy makers. This study selects non-merging control firms close to the size of merging firms, as well as a set of merging firms, and measures the effects of mergers on efficiency three years before and after the merger using the non-parametric data envelopment analysis (DEA) method. To compare the differences of efficiency means among several groups, Wilcoxon rank sum test or Wilcoxon signed rank test is used. It showed that the long-term effects after the merger appeared partially. Furthermore, it was observed that there was no difference statistically in the efficiency between merging and non-merging firms. Also, there was no difference statistically in the efficiency between the pre- and post-merger periods. In conclusion, there was not any observed synergy effect through group (or affiliated) mergers between affiliates or related mergers for Korean pharmaceutical firms.

Keywords : Pharmaceutical Industry, Merger, Efficiency Effect, DEA

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1. Introduction

The structure of the global pharmaceutical industry has been reorganized with multinational Big Pharma as the center through a huge wave of mergers and acquisitions (M&A) since the mid-1990s. For example, Pfizer acquired both Warner-Lambert and Pharmacia, Astra and Zeneca merged, Glaxo Wellcome joined with SmithKline Beecham, and Sanofi combined with Aventis. As a result, global shares for top ten firms increased to 48.3% by 2004, compared with 28.3% in 1989 and, in fact, currently these firms have been leading the market [21].

On the other hand, the Korean pharmaceutical industry is centered on the production of domestic and finished products through the synthesis of raw materials, and 72.4% of the pharmaceutical companies have shown a small industrial structure of less than 10 billion Korean Won (KRW) based on production records in 2014 [25]. Furthermore, small Korean pharmaceutical firms have been facing a difficult situation with growing competition against global pharmaceutical firms caused by the Korea-US FTA and the Korea-EU FTA, as well as high approval barriers, such as CGMP and EU GMP, and large-scale reduction of drug prices for medical costs savings. This vulnerable competitiveness of the Korean pharmaceutical industry and changing global environment imposes a limit on growth for Korean pharmaceutical firms. Consequently, the necessity of M&A to enlarge its scale and strengthen competitiveness between pharmaceutical firms has been constantly raised in Korea.

The M&A of global pharmaceutical firms has been used as growth and survival strategies from various angles, whereas M&A in Korea has not yet started and taken place in significant ways. Above all, the most common causes of this Korean situation are considered to be the ownership-oriented conservative management style and lack of synergy effect because of their business structure, thereby leading to the absence of differences with a focus on small industrial structure and copying drugs [50].

When all the M&A studies are synthesized and analyzed, despite its importance, the effects of M&A remain in dispute. This study aims to empirically analyze the effects of mergers concerning the merger cases of Korean pharmaceutical firms. Many previous studies on mergers has approached this issue in terms of long-term performance, such as profitability or stock returns measures, whereas this study differs from previous studies in that it analyzes using efficiency measure the effects of mergers by taking into consideration inputs and outputs simultaneously, by the data envelopment analysis (DEA) methodology. DEA is suitable for comparing and evaluating the efficiency of different production units or decision making units (DMUs), having been widely used for analyzing efficiency in various fields [26, 30, 31, 32, 33, 35, 36]. Countries, industries, companies, programs, projects, or other comparable sets may serve as such units. In particular, DEA has been used for analyzing merger efficiency in the sectors such as hospitals, electric power, banks, etc., whereas the pharmaceutical industry has been an exception thus far.

The rest of the paper proceeds as follows. Section 2 is the theories of motives for merger and reviews the available research on the effects of mergers and the effects of merger types. Section 3 outlines the research design and me-

thods used in the analysis. Section 4 presents the empirical results of the study. Finally, section 5 includes the findings and implications of this study, and research limitations and directions for future research.

2. Theoretical Background and Literature Review

2.1 Merger Types and Motives

In general, a merger is the combination of two or more companies to legally form a new company. There are various types of classification criteria for merger. First, a merger may take either of the two forms, by absorption or establishment. Second, according to combination forms, in general, mergers can be classified as horizontal, vertical, and conglomerate. Horizontal or vertical mergers can be classified as related mergers; whereas and conglomerate mergers can also be referred to as unrelated mergers [3].

The most common motives for merger are synergy and growth [7, 19]. According to efficiency theory, mergers are planned and executed to achieve synergies [48]. The synergy motive creates greater value for the new entity than two firms operating separately. The two main types of synergy are operating synergy and financial synergy. While the operating synergy is achieved through economies of scale and economies of scope; the financial synergy is achieved through consolidation of firms with different cash flows and investment opportunities [12]. And one of the most fundamental motives for mergers is growth. There are two types of firm growth strategies: internal and external. Merger is an external growth strategy using existing other firms or businesses rather than an internal growth strategy through the company's own resources utilization [13, 19, 27, 38]. Through merger, firms may easily and quickly dominate the market, increase the market share, and beat the competitors [11].

2.2 Effects of Mergers and Merger Types

The study on effects of mergers has been one of the key topics in the area of strategic management, organization, and finance for decades. Merger performance can be classified into long-term and short-term measures [28, 52]. Researchers have attempted to measure merger performance using various approaches. Two commonly used approaches are classified into event studies and accounting studies. Event studies examine whether shareholders achieve abnormal returns around the merger announcement date, in terms of short-run or long-run. But, it is not easy to measure the actual performance of mergers because approaches using event studies reflect only stock market responses to events [37, 38]. The majority of previous empirical studies related to pharmaceutical M&A have focused on short- and long-term performance using event studies to analyze abnormal stock returns [22, 40, 46].

Accounting studies evaluate how the operating performance has changed pre- and post-merger by researching the reported financial results, such as profitability, of the merging firms [28, 38]. Many studies widely used financial results (e.g., return on investment (ROI), enterprise value, profit ratio or margins, sales, return on equity (ROE), net earning) for analyzing pharmaceutical mergers' performance [9, 10, 34, 42]. One of the key measures used for analyzing mergers' long-

term operating performance is efficiency. Previous studies used DEA or Malmquist index to examine impact of mergers. Ferrier and Valdmanis [18] found that mergers did result in improvements in terms of certain aspects of efficiency compared with non-merged hospitals, but merged hospitals did not appear to have sustained improvements in performance. Kwoka and Pollitt [29] showed that electric firm mergers were not consistent with improved performance. Jayaraman et al. [23] indicated that the efficiency of merged banks was decreased during the initial phase of the merger but increased after the initial three years. Bogetoft and Wang [6] discussed in detail the decomposition of the potential gains from merging agricultural extension offices in Denmark into technical efficiency, scale, and harmony gains.

M&A performance is primarily affected by specific M&A characteristics [1]. This means that types of mergers can influence post-merger performance of the merging firms. Unrelated mergers are less likely to succeed when compared to related mergers because of the non-familiarity between the acquiring and the target firms [14, 17, 39, 45]. However, related mergers do not always create positive performance either [4, 41, 47]. Group (or affiliated) mergers appear to be very specific to some countries such as Japan given their culture and business environments. The study examining the mergers of Japanese firms reported that *Keiretsu* mergers were negative to the merging firms' post-merger performance [49]. Besides, Arvanitis and Stucki [1] examined Switzerland M&As, and found that M&As within the same group of firms (internal M&As) had significantly lower synergy than external M&As with respect to economic performance.

3. Methodology and Research Design

3.1 Efficiency Measurement

We employ DEA for measuring the effects of mergers on efficiency. DEA is a linear programming methodology to measure the relative efficiency of DMUs, which is a non-parametric method for the estimation of production frontiers and has the benefit of not assuming a particular functional form for the frontier. Production frontier is an efficient state in which it is no longer possible to reduce inputs or enlarge outputs. The efficiency scores of DMUs are measured by their distance to an estimated production frontier [15, 16, 44].

The CCR (named after Charnes, Cooper, and Rhodes) and BCC (named after Banker, Charnes, and Cooper) are one of the most representative DEA models. Charnes, Cooper, and Rhodes [8] developed the CCR model under a constant return to scale (CRS), whereas the BCC model, which was developed by Banker, Charnes, and Cooper [2], is a model under variable returns to scale (VRS). The DEA method can be applied by using either an output-based or an input-based approach. An input-based approach is intended to measure the efficiency by comparing the actual inputs with the minimum inputs, whereas an output-based approach aims to compare the actual outputs with the maximum outputs.

The CCR model is appropriate to use when the DMUs are operating at an optimal scale, but this model calculates the overall technical efficiency or simply technical efficiency (TE) for each unit and has the disadvantage of not being decomposed into pure technical efficiency (PTE) and scale efficiency (SE). The BCC model, on the

other hand, assumes VRS and adds a convexity condition to overcome the disadvantage of the CCR model. PTE can be calculated by the BCC model, SE is computed as a ratio of its TE score (measured by the CCR model) and PTE score (measured by the BCC model).

The input-based DEA model used in this research can be defined as follows. The input-based CCR model under CRS:

$$Min \quad \theta^k \tag{1}$$

subject to

$$\theta^k x_m^k \geq \Sigma_{j=1}^J x_m^j \lambda^j \ (m=1, 2, \cdots, M);$$
$$y_n^k \leq \Sigma_{j=1}^J y_n^j \lambda^j \ (n=1, 2, \cdots, n);$$
$$\lambda^j \geq 0 \ (j=1, 2, \cdots, J)$$

and the input-based BCC model under VRS:

$$Min \quad \theta^k \tag{2}$$

subject to

$$\theta^k x_m^k \geq \Sigma_{j=1}^J x_m^j \lambda^j \ (m=1, 2, \cdots, M);$$
$$y_n^k \leq \Sigma_{j=1}^J y_n^j \lambda^j \ (n=1, 2, \cdots, N);$$
$$\Sigma_{j=1}^J \lambda^j = 1 \ (j=1, 2, \cdots, J);$$
$$\lambda^j \geq 0$$

Where, θ is the efficiency scores of DMUs, λ is the weights given to DMUs, and x and y are the data of inputs and outputs. Furthermore, j is the number of DMUs, m is the number of input variables, and n is the number of output variables.

The efficiency value is always bounded between zero (or 0%) and one (or 100%). This means that if the efficiency has a value close to one, then the DMU lies on the frontier and is more efficient, and if the efficiency has a value close to zero, then the DMU is far from the frontier and is more inefficient.

The discrimination of DEA analysis has properties being in inverse proportion to the numbers of input and output variables, and being in proportion to the numbers of DMUs. If the numbers of DMUs are too small, then the ratio of efficient DMU appears relatively high. Namely, researchers have suggested that the numbers of DMUs are more than three times as many as the sum of the numbers of inputs and outputs to have a sufficient degree of freedom [2].

DEA has already been used for analyzing merger efficiency. In particular, DEA is suitable for comparing and evaluating the efficiency of merging firms during the pre- and post-merger periods in the pharmaceutical industry. TE, PTE, and SE can all be calculated by using the CCR and BCC models. Furthermore, it is possible to identify whether the cause of the inefficiency is due to pure technical factors or scale effects.

3.2 Research Design

The main objective of this study is to empirically analyze the efficiency effects of mergers on Korean pharmaceutical firms and suggests managerial or policy implications for managers or policy makers. In order to accomplish this objective, this paper aims to answer the following three research questions:

1) What are the long-term effects, if any, of mergers?
2) Do efficiency differences exist between merging and non-merging firms?
3) Are there efficiency improvements during the post-merger compared with the pre-merger period?

The major approaches used in this study to validate these research questions are as follows. First, we selected non-merging control firms

close to the size of merging firms, as well as a set of merging firms to analyze the effects of mergers. There was a limitation for measuring the effects only with merging firms as any other event besides the merger would have a possibility of affecting the performance after the merger.

Second, we analyzed the effects of mergers using an input-based DEA model because minimizing inputs is a major decision-making problem in the business world in general. DEA is suitable for evaluating the efficiency of different production units (or decision making units; DMUs), and, in particular is a good way to help decision makers by comparing the efficiency, pre- and post-merger [5]. To analyze these effects, we denoted the measured efficiency of each operating unit by merger years t, pre-merger years $t-i$, and post-merger years $t+i$.

Third, we tested the differences of efficiency means among several groups using the Wilcoxon rank sum test or the Wilcoxon signed rank test. These methods are to be used in the case of an independent sample and a matching sample, respectively. We use a non-parametric method because efficiency scores by DEA are not extracted from a particular statistical distribution and are calculated from the data only.

3.3 Sample Selection

The merger cases in the Korean pharmaceutical industry could be classified by the types as shown in <Table 1>. There are 32 merger cases between years 2003 and 2013; the annual average being 2.9. Of these 32 cases, 18 cases (56.2%) involved pharmaceutical firms and 14 cases (43.8%) were off non-pharmaceutical firms in terms of the subjects of mergers; in short, it seems that non-pharmaceutical firms have high expectations for pharmaceutical firms. In addition, the number of merger cases between pharmaceutical and non-pharmaceutical firms was higher than those between pharmaceutical firms, and one of the most obvious features, the ratio of merger between affiliates was higher by 56.2%. Furthermore, most mergers of pharmaceutical firms were merger by absorption.

This study selected the final sample among all merging cases once they satisfied the following conditions: 1) be listed among pharmaceutical companies; 2) be able to collect data from for six years around the year of the merger; and 3) any case with mergers more than twice was excluded. Five merger firms were eventually selected as the sample for this study (2 cases in 2006, 1 case in 2007, 1 case in 2010, and 1 case in 2011). All five sample cases were the mergers of affiliated companies, four cases among the five cases were mergers between pharmaceutical firms, and one case was a merger between a pharmaceutical firm and a non-pharmaceutical firm.

This paper also selected a set of control firms (or non-merging firms) on the basis of the following criteria. First, they had to be equivalent

〈Table 1〉 Mergers of Korean Pharmaceutical Firms, 2003~2013

	Subjects of mergers		Types of mergers			
	Pharmaceutical firms	Non-Pharmaceutical firms	Related mergers	Unrelated mergers	Group mergers	Non-group mergers
Number of merger cases	18	14	14	18	18	14
Ratio(%)	56.2	43.8	43.8	56.2	56.2	43.8

Source: DART (data analysis, retrieval, and transfer system).

listed pharmaceutical companies like the merging firms. Second, they had to be not involved in the merger and their size (e.g., assets, number of employees, and sales) had to be close to that of the merging firms during the previous year of the merger.

This study utilized the data from a seven-year period including the year of the merger (t), three years before the merger ($t-3 \sim t-1$), and three years after the merger ($t+1 \sim t+3$) to analyze the long-term merger effects. We employed a balanced panel in order to compare efficiency consistently among DMUs across years.

The data used in the study have been collected from business reports of DART (data analysis, retrieval and transfer system) provided by the Financial supervisory service and KIS-VALUE database in Korea. This paper used a free software R version 3.2.1 for data analysis.

3.4 Definition of Input and Output Variables

Based on previous studies [20, 24, 43, 51], the following set of variables are frequently used in different combinations to estimate the efficiency in the pharmaceutical sector, which are the sales as the output variable and assets, employees (or labor costs), or intermediate inputs (material costs, cost of sales, or selling and administrative expenses) as the input variables.

We selected four input variables and one output variable after considering variables being frequently used in previous studies and the practical possibility of obtaining data. The input and output variables used in this study are defined as follows:

- Assets include tangible and intangible assets owned by the firm, and exclude investment assets from total assets.
- Cost of sales is the sum of material and labor costs and other expenses used in the manufacture of products.
- Selling and administrative expenses are all operating expenses not belong to cost of sales.
- Employees are workers employed in a company and participating in production and management activities on the basis of the end of the year.
- Sales are total revenues earned by a company for selling its goods and services during the time period.

For increased accuracy with analysis and to eliminate any possible effects because of inflation, all cost variables were deflated by a GDP deflator and converted to the year 2010 prices. There was no problem in terms of the discrimination of the DEA analysis, as the following were used in this study: 70 DMUs (10 firms× 7 years), four input variables, and one output variable.

4. Empirical Results

4.1 Descriptive Statistics of the Data

The results are presented in <Table 2> about testing the differences of the means of inputs and outputs between merging and non-merging firms, based on pre- and post-merger using the Wilcoxon rank sum test. In this study, a non-parametric testing method was applied as the sample size was not enough.

We found no statistically significant difference on any of the inputs and outputs between merging and non-merging firms, thereby indicating that merging firms and non-merging firms selected as control firms were closely similar to one another.

〈Table 2〉 Descriptive Statistics of Merging and Non-Merging Firms

Variables	Merging mean (N = 5)	Merging std. dev.	Non-merging mean (N = 5)	Non-merging std. dev.	Wilcoxon rank sum test statistic	Z-test statistic	*p*-value
Assets (million KRW)							
Pre-merger	77,735.40	40,073.73	82,810.13	40,453.89	243.00	0.4355	0.6632
Post-merger	108,317.80	32,863.85	94,887.87	46,517.99	201.00	-1.3066	0.1914
Cost of Sales (million KRW)							
Pre-merger	34,157.07	19,386.41	33,471.87	21,027.24	244.00	0.4770	0.6334
Post-merger	45,602.20	15,568.56	42,303.53	23,380.82	201.00	-1.3066	0.1914
Selling and admin. expenses (million KRW)							
Pre-merger	28,710.60	17,159.44	22,897.53	17,390.22	196.00	-1.5141	0.1300
Post-merger	32,318.33	11,620.43	25,692.33	11,667.96	199.00	-1.3895	0.1647
Number of employees							
Pre-merger	352.93	156.82	333.27	142.07	230.00	-0.1037	0.9174
Post-merger	353.87	113.53	368.80	109.77	241.00	0.3526	0.7244
Sales (million KRW)							
Pre-merger	68,147.20	35,343.37	62,545.80	29,887.45	221.00	-0.4770	0.6334
Post-merger	81,190.13	23,364.53	76,416.93	26,647.98	224.00	-0.3526	0.7244

4.2 Analysis of Long-term Effects After the Merger

<Table 3> reports the efficiency results by the year for before and after the merger, including the year of the merger. For all of the sample firms, our tests found no significant changes after the merger with respect to technical efficiency (by the CCR model), pure technical efficiency (by the BCC model) and scale efficiency means. In the case of the merging firms, the efficiency of the year of the merger declined compared with the previous year of the merger, indicating that the decline in efficiency is caused by integration for the merger. The average of TE was increased from the first year to the second year during the post-merger period but was decreased in the third year. The average of PTE was increased continuously after the merger. We assessed it as a result of making an effort to improve their technological capabilities. In the case of the average of SE, it was increased in the first year during the post-merger period, showing the effect of scale economies through the merger, but it was decreased gradually starting from after the second year, thereby not showing the effect of scale economies.

〈Table 3〉 Efficiency Scores by Merger Period

Efficiency measures	t-3	t-2	t-1	t	t+1	t+2	t+3
Technical efficiency							
Full sample (N = 10)	0.8820	0.6988	0.6396	0.7177	0.6832	0.6984	0.6965
Merging firms (N = 5)	0.8761	0.7656	0.5856	0.5237	0.6963	0.7219	0.6788
Non-merging firms (N = 5)	0.8878	0.6319	0.6936	0.9177	0.6701	0.6748	0.7142
Pure Technical efficiency							
Full sample (N = 10)	0.9580	0.8664	0.8919	0.8699	0.8482	0.8580	0.8577
Merging firms (N = 5)	0.9631	0.8866	0.8782	0.8101	0.8238	0.8606	0.8774
Non-merging firms (N = 5)	0.9530	0.8461	0.9055	0.9297	0.8726	0.8554	0.8379
Scale efficiency							
Full sample (N = 10)	0.9209	0.7787	0.6946	0.7995	0.7814	0.7989	0.7984
Merging firms (N = 5)	0.9109	0.8199	0.6274	0.6186	0.8092	0.7883	0.7629
Non-merging firms (N = 5)	0.9309	0.7375	0.7618	0.9803	0.7536	0.8095	0.8339

4.3 Efficiency Comparisons of Merging Firms vs. Non-Merging Firms

Efficiency results for the period before the merger are presented in <Table 4a> and <Table 4b>. For the sample firms, the TE mean was 0.7401, although the PTE mean appears to be relatively high at 0.9054, but the SE mean appears to be relatively low at 0.7981. The average of TE and PTE was slightly higher for the merging firms than the non-merging firms, but there were no significant differences between the two groups. The average of SE was slightly higher for the non-merging firms than for the merging firms (see <Table 4a>).

Through testing the differences of efficiency means between the merging and the non-merging firms, we found no significant differences with regard to TE, PTE, and SE between the two groups (see <Table 4b>). It was considered that no significant difference in efficiency would be found because there were no pre-merger differences between the mean inputs and the outputs of the merging firms versus the non-merging firms, as shown in <Table 2>.

The results for the post-merger efficiency for the period after the merger are presented in <Table 5a> and <Table 5b>. For the sample firms, the averages of TE, PTE, and SE were 0.6927, 0.8546, and 0.7929, respectively. There was no significant difference between the merging firms and the non-merging firms. The average TE was slightly higher for the merging firms than for the non-merging firms, and the averages PTE and SE were slightly higher for the non-merging firms than for the merging firms, but there were no significant differences between the two groups (see <Table 5a>).

〈Table 4a〉 Efficiency Scores for the Pre-Merger Period

Efficiency measures	Mean	Std. dev.	Min	Max
Technical efficiency				
Full sample (N = 10)	0.7401	0.3319	0.0166	1.0000
Merging firms (N = 5)	0.7425	0.3659	0.0166	1.0000
Non-merging firms (N = 5)	0.7378	0.3070	0.0294	1.0000
Pure technical efficiency				
Full sample (N = 10)	0.9054	0.1185	0.5250	1.0000
Merging firms (N = 5)	0.9093	0.1483	0.5250	1.0000
Non-merging firms (N = 5)	0.9016	0.0841	0.7643	1.0000
Scale efficiency				
Full sample (N = 10)	0.7981	0.3341	0.0173	1.0000
Merging firms (N = 5)	0.7861	0.3585	0.0173	1.0000
Non-merging firms (N = 5)	0.8101	0.3200	0.0364	1.0000

〈Table 4b〉 Statistical Tests between Merging and Non-Merging Firms for the Pre-Merger Period

Efficiency measures	Wilcoxon rank sum test statistic	Z-test statistic	*p*-value
Technical efficiency	216.0000	-0.7018	0.4828
Pure technical efficiency	213.0000	-0.8437	0.3988
Scale efficiency	220.0000	-0.5316	0.5950

〈Table 5a〉 Efficiency Scores for the Post-Merger Period

Efficiency measures	Mean	Std. dev.	Min	Max
Technical efficiency				
Full sample (N = 10)	0.6927	0.3085	0.0370	1.0000
Merging firms (N = 5)	0.6990	0.3366	0.0370	1.0000
Non-merging firms (N = 5)	0.6864	0.2893	0.0771	1.0000
Pure technical efficiency				
Full sample (N = 10)	0.8546	0.1289	0.5933	1.0000
Merging firms (N = 5)	0.8539	0.1449	0.6332	1.0000
Non-merging firms (N = 5)	0.8553	0.1158	0.5933	1.0000
Scale efficiency				
Full sample (N = 10)	0.7929	0.3226	0.0584	1.0000
Merging firms (N = 5)	0.7868	0.3413	0.0584	1.0000
Non-merging firms (N = 5)	0.7990	0.3146	0.0980	1.0000

〈Table 5b〉 Statistical Tests between Merging and Non-Merging Firms for the Post-Merger Period

Efficiency measures	Wilcoxon rank sum test statistic	Z-test statistic	p-value
Technical efficiency	226.0000	-0.2697	0.7874
Pure technical efficiency	233.5000	0.0417	0.9667
Scale efficiency	228.0000	-0.1867	0.8519

As a result of testing the differences of efficiency means between the merging firms and the non-merging firms post-merger, we found no significant differences with regard to TE, PTE, and SE between the two groups (see <Table 5b>). It was considered that no significant difference in efficiency were found as there were no post-merger differences between the mean inputs and the outputs of the merging firms versus the non-merging firms, as shown in <Table 2>.

4.4 Efficiency Comparisons of before the Merger vs. After the Merger for the Merging Firms

<Table 6a> and <Table 6b> provide the results of the analysis on the efficiency means for pre-merger and post-merger. For the merging firms, the averages of TE, PTE, and SE were 0.7208, 0.8816, and 0.7864, respectively. We concluded that the cause of inefficiency resulted from the scale rather than purely technical factors. The efficiency of the merging firms appears to have declined on the whole after the merger rather than before; PTE appears to have especially declined more than SE, being considered as a result of making a weak effort to improve technological capabilities (see <Table 6a>). Mergers typically happen through the integration of two or more companies and help to increase return to scale. We found that inefficiency caused by increasing return to scale didn't occur, which was attributable to no change in SE.

We tested the differences of the efficiency means of pre-merger and post-merger on the merging firms using the Wilcoxon signed rank test. The results showed that there were no significant differences with regard to TE, PTE, and SE between the two groups (see <Table 6b>).

〈Table 6a〉 Efficiency Scores for the Pre- and Post-Merger Periods for the Merging Firms

Efficiency measures	Mean	Std. dev.	Min	Max
Technical efficiency				
Full sample (N = 5)	0.7208	0.3462	0.0166	1.0000
Pre-merger (N = 5)	0.7425	0.3659	0.0166	1.0000
Post-merger (N = 5)	0.6990	0.3366	0.0370	1.0000
Pure technical efficiency				
Full sample (N = 5)	0.8816	0.1468	0.5250	1.0000
Pre-merger (N = 5)	0.9093	0.1483	0.5250	1.0000
Post-merger (N = 5)	0.8539	0.1449	0.6332	1.0000
Scale efficiency				
Full sample (N = 5)	0.7864	0.3439	0.0173	1.0000
Pre-merger (N = 5)	0.7861	0.3585	0.0173	1.0000
Post-merger (N = 5)	0.7868	0.3413	0.0584	1.0000

〈Table 6b〉 Statistical Tests between Pre- and Post-Merger Periods for the Merging Firms

Efficiency measures	Wilcoxon signed rank test statistic	*p*-value
Technical efficiency	37.00	0.3575
Pure technical efficiency	30.00	0.3054
Scale efficiency	32.00	0.2166

These results denote that the synergy effect through mergers didn't appear.

5. Conclusions

This study used the non-parametric DEA method to analyze the effects of mergers, and the Wilcoxon rank sum test or the Wilcoxon signed rank test to compare the differences of efficiency means among several groups in the Korean pharmaceutical industry.

The findings of this study are as follows. It showed that the long-term effects after the merger appeared partially. Furthermore, it was observed that there was no difference statistically in the efficiency between merging and non-merging firms. Also, there was no difference statistically in the efficiency between the pre- and post-merger periods.

In conclusion, no synergy effect was observed from the mergers in the pharmaceutical industry. All sample cases used in our study were group (or affiliated) mergers between affiliates of Korean pharmaceutical firms. As discussed earlier, this means that pharmaceutical mergers in Korea have not taken place in significant ways. This is considered to be contributed mainly by a lack of the synergistic effect due to the ownership-oriented conservative management style and business structures leading to an absence of difference with a focus on small industrial structures and copying drugs. Furthermore, it seems that efficiency gains from mergers are not evident as the majority of merger cases are aimed to increase sales and production volumes, help to serve the needs of the major shareholders, or are carried out as a result of the restructuring pressures from the government rather than to

increase firm value or improve efficiency through restructuring insolvent affiliates. On the other hand, there is a possibility that an appropriate strategy for efficiency gains of the merging firms has not yet been formulated, and, hence, the post-merger efficiency has not improved. The empirical results from this study suggest that if group (or affiliated) mergers between affiliates are misused as a strategic means to delay the exit of insolvent affiliates, given the majority of mergers among pharmaceutical firms in Korea are mergers between affiliates, then the mergers are more likely to hinder the efficiency of the merging firms by counteracting to protect insolvent affiliates.

Theoretical implications of this study are as follows. First, many previous studies on mergers have approached this issue using event studies to analyze abnormal stock returns or long-term performance, such as profitability or growth measures; whereas this study analyzed the effects of mergers by simultaneously taking into consideration multiple indicators, such as input and output variables representing the corporate competitiveness. Second, the other is on the methodology used in this study. The DEA model employed in this study for measuring the efficiency effects of mergers on pharmaceutical firms can guide future empirical research related to this issues. Third, in particular, so far there have been no empirical studies done on the effects of mergers in the Korean pharmaceutical industry. Therefore, this is believed to be the first attempt to investigate empirically the effects of mergers on the Korean pharmaceutical industry. Also, this study contributes to providing evidence that mergers performance depends on the types of mergers. Specially, the value of these results is to alert managers and policy makers considering group mergers and related mergers and what to do about them.

Nevertheless, this study has some limitations. First, this study wasn't able to include more merger cases as there were not many cases available as sample firms. Second, the period for analysis was limited to three years before and after the merger because of the differences in the time of the mergers between the merging firms. Third, it was difficult to comparatively analyze the effects of mergers by the types of mergers as most cases had used mergers between affiliates as samples. Finally, additional input variables, that reflect the characteristics of the Korean pharmaceutical mergers such as sales network and patent-related information, need to be considered. Thus, future large-scale studies are needed to help to validate our findings on the effects of mergers in the Korean pharmaceutical industry.

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