



# Article What Causes the M&A Performance of High-Tech Firms?

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**Abstract:** We perform an event study on 2824 cases of domestic mergers and acquisitions (M&A) that were disclosed in the Korean domestic stock exchange and took effect between 2002 and 2015. We focus on Korean capital markets to define the factor variables affecting the disclosure effect of M&A in high-tech industries and the effect of disclosure on long-term performance. We find the following. First, the disclosure effect of M&A benefits acquirers' shareholder wealth; this effect is more pronounced for high-tech firms than for non-high-tech firms. Second, M&A of high- and non-high-tech firms harm acquirers' shareholder wealth via the disclosure effect. Finally, M&A between high- and non-high-tech firms negatively affect long-term firm performance. However, acquirers that are mature high-tech firms have a positive effect on long-term performance. This result affirms that organizationally mature firms adapt better to highly specialized technologies and knowledge that are not yet internalized as corporate routines owing to their learned capabilities and breadth of experience. This study provides a significant novel perspective on high-tech M&A by emphasizing the financial performance of firms involved in them.

Keywords: Korea; M&A; high-tech; disclosure effect; long-term performance



Citation: Cho, S.-w.; Jung, J.-y.; Kim, B.-J.; Song, H. What Causes the M&A Performance of High-Tech Firms? *Sustainability* **2022**, *14*, 2820. https://doi.org/10.3390/su14052820

Academic Editors: Min-Kyu Lee and Christian Vandenberghe

Received: 4 December 2021 Accepted: 15 February 2022 Published: 28 February 2022

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# 1. Introduction

It is virtually impossible for high-tech industries—which rely heavily on innovation and complex and specialized technologies—to build every capacity they need for growth and innovation on their own in today's fast-paced business climate. Major economies compete intensely to formulate policies conducive to cutting-edge industries. Such strategies are expected to create high value added through initiatives such as the "High-Tech Strategy 2020" launched by Germany in 2010, "National Strategic Plan for Advanced Manufacturing" launched by the United States in 2012, "Manufacturing Reform 3.0" launched by the Republic of Korea in 2014, and "Made in China 2025" launched by China in 2015.

Definitions of "high-tech sector" differ across countries, but the term typically refers to an industry based on highly advanced technologies. However, "highly advanced technologies" is a subjective notion, and its definition and subcategories may vary by era and situation. Therefore, the Organization for Economic Cooperation and Development (OECD) uses the level of R&D intensity in an industry (R&D expenditure/output) as a proxy index to determine whether the industry is high-tech. The OECD criteria for high-tech sectors focus on manufacturing industries with a relatively heavy dependence on technologies. According to the OECD criteria, high-tech sectors include the pharmaceutical industry (ISIC Rev. 4 code 21), computer/electronics/optical industry (ISIC Rev. 4 code 26), and aerospace industry (Rev. 4 code 303) [1]. Following these criteria, between 2002 and 2015 (the focal period of this study), R&D expenditures in Korea's high-tech sectors accounted for approximately 50% of total corporate R&D expenditures in Korea for each year during the period, which is considered high (OECD Main Science and Technology Indicators, 2017). Under such conditions, high-tech industries can no longer afford R&D expenditures and achieve technological convergence on their own by relying solely on their internal innovative capacity to maintain outstanding performance. This situation induces the need to seek capacities externally through technological partnerships and mergers and acquisitions (M&A) with other firms [2].

M&A allow high-tech firms to obtain resources and capacities, and human resources with specific kinds of experience [3]. Technological partnerships can also serve as an important means of expanding firms' knowledge horizons through joint development or the exchange of products, technologies, and services. Nevertheless, most research on M&A and strategic technology partnerships in high-tech industries has focused on how to transfer and incorporate innovative technologies and knowledge. Only a few studies have examined the effects of M&A on long-term performance, and they often confine their samples to cases where either the target firms are in high-tech sectors or both the acquirers and targets are high-tech firms, which has been pointed out as a limitation [4,5].

Moreover, the recent global trend is that service sectors and manufacturing sectors actively take part in innovative activities. In China, policy formulation is now based on a definition of "high-tech firms" that has broadened beyond the manufacturing sector to include firms in the service sector. Greater emphasis is also placed on a more comprehensive, coordinated, and high-level "going out" process, which will further promote the going out of Chinese services and technology by increasing foreign investment [6]. However, the aforementioned criteria by the OECD to define high-tech sectors worked well for the manufacturing sector, and they suffice less for the service sector. This study, therefore, classifies high-tech sectors into biotechnology, telecommunications, computer equipment, electronics, and general technology groups. We examine samples that comprise 2824 domestic M&A cases that were disclosed and took effect on the Korean domestic stock exchange between 2002 and 2015. We focus on Korean capital markets, which have drawn attention in the high-tech field, and perform an event study to examine the disclosure effect of high-tech industry M&A and the effect of disclosure on their long-term performance.

Our findings are as follows. First, the disclosure effect of domestic M&A in Korean capital markets has a positive effect on acquirers' shareholder wealth, and the positive effect is more pronounced for high-tech firms than for non-high-tech firms. This scenario seems to occur because investors have a higher expectation of a synergistic effect in high-tech industries, given their nature. Second, M&A disclosure negatively affects acquirers' shareholder wealth when non-high-tech firms acquire or merge with high-tech firms. This result supports the findings of Nelson and Winter [7], who show that investors rely heavily on acquirers' existing corporate routines rather than uncertain and new knowledge-based resources if the acquirers are non-high-tech firms. Third, M&A negatively affect the long-term performance of high-tech acquirers when high-tech firms engage in M&As with non-high-tech firms. However, the effect on long-term performance is positive when high-tech firms mature in organizational age are engaged in M&A. This appears to suggest that firms that are organizationally mature can adapt better to highly specialized technologies and knowledge that are not yet part of their corporate routines because of their learned organizational capacity and breadth of experiences.

The remainder of this paper is organized as follows. Section 2 reviews prior studies and derives hypotheses. Section 3 describes the methodology and data. Section 4 presents the results of the empirical findings. Finally, Section 5 summarizes the study and presents its conclusions.

#### 2. Literature Review and Hypotheses

#### 2.1. Review of Studies

M&A in high-tech sectors are knowledge-intensive; they are known to expand the pool of new knowledge-based resources [3]. However, they produce an intriguing dilemma in how acquirers internalize the newly obtained knowledge and capacities. In M&A, acquirers absorb target firms' knowledge bases to expand their own and merge them with their internally accumulated capacities to ultimately create high value added [8,9]. However,

firms may not succeed in absorbing the knowledge base through M&A or may even suffer a performance decline owing to the excessive costs associated with them [10–12].

Most studies that view high-tech industry M&A positively emphasize technological connections, internalization, and the propagation of knowledge. Technological connection is the most critical factor driving the result of innovation obtained from knowledge acquisition via M&A; it plays a key role when acquirers put the knowledge into use, as this integrated knowledge base leads to innovative high-value added [13–15]. Horizontal M&A enhance the scale economy, whereas vertical M&A increase investments in technological innovation owing to transaction cost savings [16].

Studies on acquirers' internalization of specialized and innovative knowledge report that organizational adequacy and the share of R&D expenditures significantly affect performance. Hagedoorn and Duysters [17] state that organizational adequacy brings about positive firm performance after M&A. Firm size determines organizational types, so differences in firm size account for a significant part of organizational adequacy, and a marriage between firms of divergent sizes is better for integrating functions such as marketing, operation, and manufacturing [11,18,19].

On the contrary, several studies regard M&A in high-tech sectors negatively. Ahuja and Katila [3] report that acquirers and target firms with similar knowledge bases enjoy active exchanges between their knowledge bases; however, if the similarity is too high, M&A fail to yield much benefit. Cohen and Levinthal [20] find that, when highly complex and specialized knowledge is introduced to firms, it complicates organizational integration by incorporating knowledge as an innovative activity that has yet to become a part of the corporate routines, thereby exerting a negative effect on acquirers. Furthermore, new technologies have a relatively uncertain probability of success and may be imitated by competitors owing to the knowledge ripple effect. Therefore, high-tech companies may be passive in investing in the development of new technologies, even though they may strengthen their innovation capabilities [21,22]. Therefore, Freeman and Soete [23] and Henderson and Cockburn [24] argue in their respective studies that R&D capacity is a significant factor in firms' growth in high-tech sectors. Thus, mergers with firms with a low emphasis on R&D may decrease the R&D activities of the target firms and their technological capacity, ultimately resulting in poor technological performance.

Research on M&A in high-tech industries focuses on the transfer of high-tech knowledge and its incorporation into the corporate structure [16,25]. Few studies have examined the effects of M&A on long-term performance. They are limited because their samples are confined to cases where either the target firms are in high-tech sectors or both the acquirers and target firms are in high-tech sectors [4,5]. This study examines how M&A in the high-tech industries affect firm performance in the short and long terms.

As mentioned, we focus on Korean capital markets, where the share of R&D expenditures in high-tech industries is high, at around 50% among all Korean firms between of 2002 and 2015. Table 1 shows the trends in the international trade balance of high-tech companies in major countries. The Korean high-tech industry is drawing much attention from the world because it has the world's largest international trade surplus.

Table 1. Trends in international trade balance of high-tech companies in major countries<sup>1</sup>.

Year Country	2007	2008	2009	2010	2011	2012	2013	2014	2015
Korea	55,822	52,063	52,379	66,220	57,735	56,110	66,670	65,571	
USA	-77,954	-78,493	-73,547	-111,198	-119,298	-115,349	-111,259	-120,162	-139,194
Japan	25,686	21,302	6257	5505	-3092	-17,908	-31,114	-34,489	-33,101
Germany	21,109	24,068	15,985	8818	16,138	36,456	40,680	36,439	37,574
France	5595	11,624	8454	9074	8487	13,366	18,435	16,644	11,567
UK	-22,741	-19,937	-13,304	-19,651	-6823	-11,848	-17,635	-27,456	-22,505

<sup>1</sup> Unit: Million US dollars. Source: OECD, Main Science and Technology Indicators 2016-1, 2016-6.

# 2.2. Hypotheses

Higgins and Rodriguez [26] argue that firms complement their internal R&D efforts with external advanced technologies obtained through high-technology-focused M&A. Bertrand and Zuniga [27] state that high-technology-centric M&A help firms re-establish their R&D activities. Thus, high-technology-centric M&A boost acquiring firms' R&D efficiency, which serves as a basis on which the market receives high-technology-centric M&A positively. The empirical study of Canace and Mann [28] confirms that the disclosure of M&A designed to obtain high-technology results in significantly positive abnormal returns (AR) for acquiring firms' shareholders. Therefore, M&A in high-tech industries are borne out of a strong motivation to acquire highly specialized technologies and knowledge, and M&A in high-tech sectors are expected to result in greater disclosure effects than those in non-high-tech sectors in Korean capital markets as well. This study proposes Hypothesis 1 to empirically test that expectation.

# **Hypothesis 1.** Acquirers in high-tech sectors enjoy a greater positive effect on their shareholder wealth from the disclosure effect of M&A than do acquirers in non-high-tech sectors.

Many studies discuss why it is difficult to implement high-technology-centric M&A successfully. De Man and Duysters [29] argue that, even when the firms' R&D divisions manage to come together as one after M&A, the process can be trickier for other divisions, which, in turn, depresses the firm's overall performance. Kallunki et al. [30] also state that, failure to properly internalize the knowledge acquired through M&A can negatively affect firm performance. A supporting empirical study by Ornaghi [31] finds, based on an analysis of pharmaceutical firms, that those that went through M&A performed worse for several years following the process than those that did not. Canace and Mann [28] also establish that M&A executed to acquire innovative technologies result in significantly negative performance for the merged entities in the long run. Hitt et al. [32] conducted a case study on M&A success and failure among U.S. firms and hold that, for two-thirds of successful M&A cases, either just the acquiring firms or both the acquiring and target firms already had significant experience in implementing changes before the M&A, which boosted firms' adaptability and ability to respond more flexibly to changes. Zollo and Singh [33] argue that the more systemized the knowledge gained from prior M&A experiences, the better the financial performance of M&A. Fowler and Schmidt [34] also aver that firms with previous M&A experience and that are organizationally mature show better financial performance after M&A.

Given these findings, we can assume that M&A in high-tech sectors generally affect long-term performance negatively, while acquirers who are organizationally mature are better at adapting to highly specialized technologies and knowledge that are not yet part of the organization's routine because of their learned organizational capabilities and breadth of experiences. This aspect, in turn, has a positive effect on shareholder wealth. The following hypothesis is proposed to test this expectation empirically:

**Hypothesis 2.** *M&A involving high-tech acquirers that are organizationally mature have a positive effect on the acquirers' shareholder wealth.* 

# 3. Materials and Methods

# 3.1. Methodology

This study classifies high-tech industries into biotechnology, telecommunications, computer equipment, electronics, and general technology groups to examine how M&A in high-tech industries impact the disclosure effects and long-term performance. To this end, we select 2824 domestic M&A cases that were disclosed in the domestic stock exchange and took effect between 2002 and 2015. We focus on Korean capital markets and use the market-adjusted model for AR, and calculate cumulative abnormal returns (CAR) by adding up the AR during the event period. We use a single-sample *t*-test to test the validity

of AR and CAR, and conduct a difference analysis comparing the CAR of high-tech sectors to that of non-high-tech sectors through a *t*-test on the independent samples, where CAR serves as the test variable.

To examine the disclosure effect of M&A in high-tech and non-high-tech industries in Korean capital markets, we perform a multiple regression analysis where  $CAR_{(t_{-n},t_n)} = \sum_{t=t_{-n}}^{t_n} AR_t$ ,  $(t_{-1}: -5, t_n: 1)$  serves as a dependent variable, which is calculated by adding up AR from the market-adjusted model throughout the event period; A\_High\_D and T\_High\_D are the explanatory variables; and A\_Year, T\_List\_D, SameG\_D, D/E\_r, Size, Ind\_D, and Year\_D serve as control variables (see Section 3.1.3 for details on these variables).

To examine the effect of M&A disclosure on long-term performance, we perform a *t*-test as a difference analysis on the independent samples where  $AROCF_{(t_{-n}, t_n)}$ ,  $(t_{-n} : -1, -2, t_n : +1, +2, +3)$  serve as test variables and high-tech and non-high-tech groups serve as group variables. To analyze the effect on the long-term performance of high-tech acquirers, we perform a multiple regression analysis where AROCF (-2, +1) serves as a dependent variable; A\_High\_D, T\_High\_D, A\_Year, and A\_Year × A\_High\_D serve as the explanatory variables; and T\_List\_D, SameG\_D, D/E\_r, Size, Ind\_D, and Year\_D serve as the control variables (see Section 3.1.3 for details on these variables).

#### 3.1.1. Measuring AR

We use the market-adjusted model to calculate the AR for this study to minimize bias in the parameter estimation. Bouwman et al. [35] recommend the market-adjusted model for event studies on M&A as firms with multiple M&A disclosures may experience a bias in their estimation results, because another M&A disclosure may overlap with the parameter estimation period for the market model. Thus,

$$AR_{i,t} = R_{i,t} - R_{m,t},\tag{1}$$

where

 $AR_{i,t}$ : AR of individual stock *i* on day *t*.  $R_{i,t}$ : Actual return of individual stock *i* on day *t*.  $R_{m,t}$ : Market index returns on day *t*.

Using Formula (1), we calculate the average AR (AAR) by measuring the simple mean of the daily AR as follows:

$$AAR_t = \sum_{i=1}^{N} AR_{i,t} / N, \qquad (2)$$

where

N: Number of sample firms.

Using Formula (2), we calculate the cumulative average abnormal returns (CAAR; hereafter, CAAR is treated as CAR) from t - n before the disclosure date to tn after the disclosure date, as follows:

$$CAAR_{(t_{-n},t_n)} = \sum_{t=t_{-n}}^{t_n} AAR_t,$$
(3)

### 3.1.2. Measuring Long-Term Operating Performance

We now measure changes in acquiring firms' return on operating cash flow (ROCF) before and after M&A by referring to the study methodologies adopted by Healy et al. [36] and Loughran and Ritter [37]. To measure ROCF, we use the EBITDA (earnings before interest, tax, depreciation, and amortization), which is then divided by total assets. By deducting the benchmark ROCF from the measured ROCF, we arrive at an AR for operating cash flow (AROCF). Adjustment is made to the operating performance of acquiring firms based on benchmark operating performance using the industry-adjusted method. According to the industry-adjusted method, AROCF is calculated by deducting the median value of ROCF for firms that belong to the same sector as the sample acquiring firms (in this study, these are defined as cases in which firms share the first two digits of the Korea

Standard Industry Classification Code) in a given year from the ROCF of the acquiring firms for the same year. To measure long-term operating performance, we analyze changes in acquiring firms' AROCF over an extended period before and after M&A. The formulas and statistics for the difference analysis are as follows:

$$ROCF = \frac{Acquirers'EBITDA}{Book Value of Acquirers' Total Assets'}$$
(4)

$$AROCF = Acquirers' ROCF - Benchmark ROCF, and$$
 (5)

 $\Delta$ AROCF = Changes in AROCF before and after the year of M&A disclosure. (6)

Test statistics on difference analysis:

$$\frac{\Delta AROCF_{(t_{-n},t_n),\mu_1} - \Delta AROCF_{(t_{-n},t_n),\mu_2}}{\sqrt{\frac{Var(\Delta AROCF_{(t_{-n},t_n),\mu_1})}{n_1} - \frac{Var(\Delta AROCF_{(t_{-n},t_n),\mu_2})}{n_2}},$$
(7)

where

 $n_1$ : Number of high-tech firms.

*n*<sub>2</sub>: Number of non-high-tech firms.

 $\mu_1$ : Mean of  $\triangle$ AROCF for the high-tech firms.

 $\mu_2$ : Mean of  $\triangle$ AROCF for the non -high-tech firms.

# 3.1.3. Multiple Regression Analysis Model

We perform multiple regression analysis on the samples comprising 2824 cases of domestic M&A that are disclosed in the domestic stock exchange and took effect between 2002 and 2015 to examine the disclosure effect of M&A in the high-tech sectors and the effect of disclosure on long-term performance in Korean capital markets.

Model 1 is a multiple regression model formula devised to examine the disclosure effect of M&A in high-tech industries where the dependent variable is  $CAR_{(t_{-n},t_n)} = \sum_{t=t_{-n}}^{t_n} AR_t$ ,  $(t_{-n}: -5, t_n: 1)$ , which is calculated by adding up AR during the event period using the market-adjusted model; the explanatory variables are A\_High\_D and T\_High\_D, while the control variables are A\_Year, T\_List\_D, SameG\_D, D/E\_r, Size, Ind\_D, and Year\_D.

Model 2 is a multiple regression model formula devised to examine the effect of disclosure on long-term performance after M&A in high-tech industries where the dependent variable is AROCF (-2, +1); the explanatory variables are A\_High\_D, T\_High\_D, A\_Year, and A\_Year X A\_High\_D; and the control variables are T\_List\_D, SameG\_D, D/E\_r, Size, Ind\_D, and Year\_D:

Model 1:

$$CAR_{i} = \alpha_{i} + \beta_{1}A_{High_{D}} + \beta_{2}T_{High_{D}} + \beta_{3}A_{Year} + \beta_{4}T_{List_{D}} + \beta_{5}SameG_{D} + \beta_{6}D/E_{r} + \beta_{7}Size + \sum Ind_{D} + \sum Year_{D} + \varepsilon_{i},$$
(8)

Model 2:

$$AROCF_{i} = \alpha_{i} + \beta_{1}A_{High_{D}} + \beta_{2}T_{High_{D}} + \beta_{3}A_{Year} + \beta_{4}A_{Year} \times A_{High_{D}} + \beta_{5}T_{List_{D}} + \beta_{6}SameG_{D} + \beta_{7}D/E_{r} + \beta_{8}Size + \sum Ind_{D} + \sum Year_{D} + \varepsilon_{i},$$
(9)

where

- A\_High\_D: Dummy variable indicating whether an acquiring firm is a high-tech firm; the assigned value is 1 if the acquiring firm is a high-tech firm and 0 otherwise. Hightech acquiring firms are defined as firms whose main business is in biotechnology, telecommunications, computer equipment, electronics, and general technologies.
- *T\_High\_D*: Dummy variable indicating whether a target firm is a high-tech firm; the assigned valus is 1 if a target firm is a high-tech firm and 0 otherwise.

- *A\_Year*: Variable for acquiring firms' organizational age; this variable indicates acquiring firms' organizational age at the time of M&A disclosure, measured by subtracting the year when the acquiring firms were founded from the year of their M&A disclosure.
- *T\_List\_D*: Dummy variable indicating whether a target firm is listed; 1 if a target firm is listed, and 0 otherwise.
- SameG\_D: Dummy variable indicating whether an M&A is executed between affiliated firms; 1 if an acquiring firm and a target firm are affiliated, and 0 if they are not. "Affiliation" means that the acquirers and target firms share the same ultimate parent ticker symbol (provided by SDC Platinum).
- D/E\_r: Year-end debt ratio of acquiring firms for the year immediately preceding M&A disclosure = (borrowed capital/equity) × 100.
- *Size*: Variable representing acquiring firms' size; it is the natural log value of the mean market capitalization of acquiring firms' common stocks for the year immediately preceding M&A disclosure.
- *Ind\_D*: Dummy variable indicating the acquiring firms' industrial classification based on the first digit of the Standard Industry Classification code.
- *Year\_D*: Dummy variable for the year of M&A disclosure.

# 3.2. Samples

# 3.2.1. Sample Composition

We account for the effect of the Asian financial crisis and to include the most recent M&A cases by setting the sample period from 2002 to 2015. Of the M&A cases between Korean firms that were disclosed and took effect between January 2002 and December 2015 (i.e., the sample period), we verify 8063 firms on SDC Platinum, a database exclusively for M&A cases. Of these 8063 cases, only those that satisfied the following conditions are selected as the final samples for the study: (1) The acquiring firm is listed on the domestic stock exchange; (2) the acquiring firm does not belong to the financial sector; (3) the acquiring firm's fiscal year ends in December; and (4) all the financial and stock data required for the analysis are available without missing values. Table 2 lists the composition of the samples.

Table 2. Composition of samples.

<b>M&amp;</b> A	A Cases between Korean Firms from 2002 to 2015	8063 Cases
Samp	ple conditions:	
<ol> <li>(1)</li> <li>(2)</li> <li>(3)</li> <li>(4)</li> </ol>	acquiring firm is listed on the domestic stock exchange acquiring firm does not belong to the financial sector acquiring firm's fiscal year ends in December	
(4)	all financial and stock data required for the analysis are availa	able without missing values
Final	sample size	2824 cases

Ultimately, 2824 M&A cases that met all these requirements are selected for analysis. The M&A-related data required for the analysis are obtained from SDC Platinum, and stock and financial data were obtained from FnGuide.

Table 3 shows the distribution of the entire sample of high-tech and non-high-tech firms by year of M&A disclosure. As Table 3 shows, the acquiring firms that mainly engaged in biotechnology, telecommunications, computer equipment, electronics, and general technologies are classified as high-tech firms. Table 3 indicates that M&A were sluggish between 2002 and 2005 and then increased in 2006. This situation may have occurred because M&A were pursued vigorously worldwide in 2006 owing to the economic recovery in Europe, booming raw material sectors, low interest rates, and growth in the private equity sector. After 2006, the yearly distribution of M&A did not change drastically.

Year	Total		Group with Acqui	High-Tech rers	Group with Non-High-Tech Acquirers	
	# of Cases	%	# of Cases	%	# of Cases	%
2002	53	1.9	20	1.5	33	2.2
2003	37	1.3	13	1.0	24	1.6
2004	40	1.4	13	1.0	27	1.8
2005	50	1.8	16	1.2	33	2.2
2006	293	10.4	154	11.5	138	9.3
2007	260	9.2	137	10.2	120	8.1
2008	359	12.7	183	13.7	174	11.8
2009	332	11.8	167	12.5	165	11.2
2010	298	10.6	147	11.0	149	10.1
2011	249	8.8	127	9.5	122	8.3
2012	231	8.2	103	7.7	128	8.7
2013	171	6.1	62	4.6	109	7.4
2014	176	6.2	70	5.2	106	7.2
2015	275	9.7	125	9.3	149	10.1
Total	2824	100	1337	100	1477	100

Table 3. Distribution of M&A cases by year.

# 3.2.2. Descriptive Statistics of Variables

Table 4 summarizes the descriptive statistics of the key variables used in the multiple regression analysis. It contains the descriptive statistics for the entire sample and the results for each group to allow us to check for differences in descriptive statistics between the groups with high-tech and non-high-tech acquiring firms.

Table 4. Descriptive statistics by group.

Variable	To	tal	Group with	Group with High-Tech		Group with Non-High-Tech	
	(N =	2824)	Acquirers	Acquirers (N = 1337)		Acquirers (N = 1447)	
	Mean	Median	Mean	Median	Mean	Median	
LN Market cap	11.8278	11.2574	11.5602	10.8827	12.0701	11.5981	
Debt ratio	188.6181	96.3750	161.0180	79.2900	213.6021	115.5100	
Organizational age	26.2043	22.0000	20.5079	16.0000	31.3609	31.0000	

The natural log values of acquiring firms' market capitalization for the year immediately preceding M&A disclosure shown in Table 4 represent the size of the acquiring firms [38]. The values are roughly the same across the entire sample (i.e., high-tech and non-high-tech acquiring firms). The mean and median values for the year-end debt ratio of acquiring firms for the year immediately preceding M&A disclosure show significant differences for the entire sample and for both groups, apparently due to several extreme values. The debt ratio is lower for the group of high-tech acquiring firms than for the entire sample and the group of non-high-tech acquiring firms. Thus, high-tech acquiring firms are generally more financially sound than non-high-tech acquiring firms. Regarding organizational age, high-tech acquiring firms engage in M&A 20 years after their establishment on average, whereas non-high-tech acquiring firms engage in M&A 31 years after their establishment on average. This state of affairs suggests that high-tech firms engage in M&A sooner after their establishment than non-high-tech firms do.

### 4. Findings

### 4.1. Results of the Validity Test on AR at the Time of M&A Disclosure

For our final sample, we consider 2824 M&A cases. Of all cases between domestic firms that were disclosed and took effect between January 2002 and December 2015, we

select only the 2824 cases that we can verify on the SDC Platinum, where acquiring firms are listed on the domestic stock exchange, belong to the non-financial sector, end their fiscal year in December, and have all required financial data available without missing values. Table 5 shows the AR from 10 days prior to the disclosure date to one day after the disclosure date, and the univariate *t*-test results associated with it for the entire sample (i.e., high-tech and non-high-tech acquiring firms).

Disclosure Timeframe (Days)	Ta (N =	otal 2824)	High-Tech Group (N = 1337)		Non-High-Tech Group (N = 1447)		
-	Mean	T-Value	Mean	T-Value	Mean	T-Value	
-10AR	0.002	2.241 **	0.001	1.245	0.002	1.887 **	
-9AR	0.000	0.245	0.001	0.743	0.000	-0.451	
-8AR	0.001	1.294	0.001	0.671	0.001	1.191	
-7AR	0.002	2.857 ***	0.001	1.137	0.003	2.987 ***	
-6AR	0.003	2.958 ***	0.002	1.750 *	0.003	2.404 **	
-5AR	0.002	1.950 *	0.003	2.651 ***	0.000	-0.002	
-4AR	0.002	2.877 ***	0.003	2.285 **	0.002	1.775 *	
-3AR	0.003	4.203 ***	0.005	3.981 ***	0.002	1.774 *	
-2AR	0.002	2.909 ***	0.003	2.342 **	0.002	1.749 *	
-1AR	0.008	8.792 ***	0.009	6.949 ***	0.006	5.425 ***	
0AR	0.010	9.484 ***	0.012	7.635 ***	0.008	5.794 ***	
1AR	0.005	4.220 ***	0.004	2.355 **	0.005	3.666 ***	

Table 5. Validity test of AR at the time of M&A disclosure.

Note: \* *p* < 0.1, \*\* *p* < 0.05, \*\*\* *p* < 0.01.

The results for the entire sample are shown in Table 5. Acquiring firms' AR consistently shows significantly positive values from seven days prior to the disclosure date to one day after the disclosure date. This fact indicates that the disclosure of M&A in the domestic stock market results in growth in the acquirers' shareholder wealth. The positive disclosure effect echoes the results of numerous domestic studies [39,40].

# 4.2. Results of Difference Analysis on CAR between High-Tech Group and Non-High-Tech Group

Table 6 shows the results of an independent sample *t*-test, where CAR by disclosure period is a test variable and a dummy variable for whether acquiring firms belong to the high-tech sector is a group variable. This test examines whether acquiring firms in high-tech sectors have a significant effect on the value of CAR. According to the t-test results, except for the disclosure period from one day prior to the M&A disclosure date to one day after it, the CAR of the group with high-tech acquiring firms is significantly greater than that of the group with non-high-tech acquiring firms for the entire disclosure period.

Throughout the M&A disclosure period, the CAR of high-tech firms' shares is approximately 1.1% greater on average than that of non-high-tech firms' shares. The results in Table 6 indicate that M&A disclosures are generally received favorably in the Korean domestic stock exchange, and disclosures of high-tech firms' M&A are more positively perceived in the market than those of non-high-tech firms' M&A. This finding supports Hypothesis 1 of the study, that is, regarding the disclosure effect of M&A, acquirers in high-tech sectors enjoy a greater positive effect on their shareholder wealth than acquirers in non-high-tech sectors.

Given the high value-added nature of high-tech sectors, this situation may have resulted from investors' expectation that acquiring firms in high-tech sectors will enjoy a greater synergistic effect of M&A.

	High-Tech Group (N = 1337)	Non-High-Tech Group (N = 1447)	Difference in Mean	T-Value
CAR(-1,+1)	0.0251 ***	0.0193 ***	0.0058	1.5908
CAR(-2,+1)	0.0281 ***	0.0212 ***	0.0069	1.6975*
CAR(-3,+1)	0.0333 ***	0.0229 ***	0.0104	2.3025 **
CAR(-4,+1)	0.0362 ***	0.0248 ***	0.0114	2.3174 **
CAR(-5,+1)	0.0395 ***	0.0248 ***	0.0147	2.7732 ***
CAR(-10,+1)	0.0461 ***	0.0338 ***	0.0123	1.9116 *

Table 6. Difference analysis of CAR by group.

Note: \* *p* < 0.1, \*\* *p* < 0.05, \*\*\* *p* < 0.01.

# 4.3. Results of Univariate Analysis on Post-M&A Long-Term Performance between High-Tech Group and Non-High-Tech Group

Table 7 presents the results of the univariate analysis on the long-term performance of the high-tech and non-high-tech groups from two to three years after the year of M&A disclosure. The samples used for the analysis of long-term performance consist of M&A cases between 2002 and 2012 only, as the financial data needed to measure AROCF were not available for the years 2013 through 2015.

### Table 7. Univariate analysis of post-M&A long-term performance.

(N	Total (N = 1865)		ech Group = 892)	Non-High-Tech Group (N = 973)	
Mean	T-Value	Mean	<b>T-Value</b>	Mean	T-Value
AROCF(-1,+1) -0.008	-2.242 **	-0.006	-1.013	-0.011	-2.235 **
AROCF(-1,+2) -0.003	-0.947	0.002	0.308	-0.007	-1.949 *
AROCF(-1,+3) -0.017	-2.291 **	-0.016	-1.091	-0.018	-3.645 ***
AROCF(-2,+1) -0.013	-3.136 ***	-0.018	-2.875 ***	-0.008	-1.530
AROCF(-2,+2) -0.007	-2.135 **	-0.010	-1.891 *	-0.005	-1.093
AROCF(-2,+3) -0.021	-2.823 ***	-0.027	-1.893 *	-0.015	-2.875 ***

Note: \* *p* < 0.1, \*\* *p* < 0.05, \*\*\* *p* < 0.01.

The results for the entire sample reveal that acquiring firms' operating performance deteriorates significantly after M&A in all periods except for AROCF (-1, +2).

In addition, for the group with high-tech acquiring firms, the acquiring firms' AROCF decreases significantly after M&A. This trend is pronounced when AROCF for the two years prior to the year of disclosure and AROCF for one year are compared. In addition, long-term operating performance is significantly negative for non-high-tech acquiring firms.

The results in Table 7 indicate that many firms have a hard time tapping into the synergistic effect of M&A after the fact, but the reason for such low performance in the long run is yet to be clearly identified. Therefore, we conduct multiple regression analysis to analyze the effects of variables expected to affect the long-term performance gains that acquiring firms enjoy through M&A by focusing on the variable for high-tech acquiring firms' organizational age, a hypothetical variable in this study.

# 4.4. Results of Multiple Regression Analysis

Table 8 presents the results of the multiple regression analysis on Model 1, a multiple regression model formula devised to examine the M&A disclosure effect of the high-tech sectors on long-term performance, and Model 2, a multiple regression model devised to examine the effect of the high-tech acquirers' organizational age on long-term performance.

¥7	Model 1	Мос	del 2
Variables –	(1)	(2)	(3)
A High D	0.014 **		-0.028 *
A_High_D	(2.192)		(-1.655)
T High D	-0.013 **		-0.002
1_11igh_D	(2.167)		(-0.189)
A Year $\times$ A High D			0.001 *
			(1.781)
AHTH		0.001	
		(0.163)	
ALTH		-0.021 **	
		(-2.229)	
AHTL		0.009	
	0.000	(1.132)	0.000
A_Year	(0.000)	(0.000)	(1 288)
	-0.007	(-0.041) -0.007	(1.200) -0.016 *
T_List_D	(-1, 207)	(-1.267)	(-1811)
	-0.002	-0.003	-0.011
SameG_D	(-0.319)	(-0.437)	(-1.107)
D (D		0.000	0.000 ***
D/E_r	0.000(-0.017)	(-0.009)	(3.839)
Ci	-0.009 ***	-0.009 ***	-0.003
Size	(-6.010)	(-6.071)	(-1.322)
Intercent	0.170 ***	0.173 ***	-0.030
intercept	(8.307)	(8.379)	(-0.324)
Ind_D	Yes	Yes	Yes
Year_D	Yes	Yes	Yes
F-value	3.830	3.736	2.931
(p-value)	(0.001)	(0.001)	(0.001)
Adj. R <sup>2</sup>	0.026	0.027	0.026

Table 8. Analysis of market reaction to M&A disclosures and effect on long-term performance.

Notes: 1. We report heteroskedasticity-robust t-values in parentheses. 2. \* p < 0.1, \*\* p < 0.05, \*\*\* p < 0.01.

The results in column (1) indicate that the dummy variable reflecting whether an acquirer is a high-tech firm has a significantly positive effect on long-term performance. However, the dummy variable reflecting whether the target firm is a high-tech firm has a significantly negative effect on long-term performance. Therefore, further analysis is required to understand if the positive effect on the long-term performance of the dummy variable indicating whether an acquirer is a high-tech firm is due to its attributes or to the fact that it has acquired a non-high-tech target firm.

Column (2) presents the results of the analysis. All the conditions are kept identical to those of the earlier multiple regression model except that, instead of the dummy variable indicating whether a target firm or acquiring firm is a high-tech firm, four dummy variables are introduced for the regression analysis: AHTH (1 if both an acquiring firm and a target firm are high-tech firms, and 0 otherwise), AHTL (1 if the acquiring firm is a high-tech firm but a target firm is not, and 0 otherwise), ALTH (1 if an acquiring firm is a non-high-tech firm and a target firm are non-high-tech firm, and 0 otherwise).

The results in column (2) show that, if the target firm is a high-tech firm, the regression coefficient remains positive, although the results are not statistically significant. However, if the target firm is a high-tech firm and the acquiring firm is not, a significantly negative effect on long-term performance is observed. Therefore, the negative effect on long-term performance when the target firm is a high-tech firm seen in the earlier regression analysis is highly likely to be due to the acquiring firms' attributes, not those of the target firms. In other words, the market reacts unfavorably when non-high-tech firms that lack experience

in high-tech sectors acquire target firms in high-tech sectors. Therefore, Hypothesis 1 (that acquirers in high-tech sectors enjoy a greater positive impact on their shareholder wealth from the disclosure effect of M&A than do acquirers in non-high-tech sectors) is supported.

Column (3) presents the results of the multiple regression analysis on Model 2, a multiple regression model devised to examine the effect of high-tech acquirers' organizational age on long-term performance. The results shown in column (3) indicate that the dummy variable indicating whether an acquiring firm is high-tech has a negative effect on long-term performance. Therefore, we can conjecture that acquiring firms in high-tech sectors make it more difficult to succeed in M&A than acquiring firms in non-high-tech sectors in general. However, the organizational age of high-tech acquiring firms has a significantly positive effect on long-term performance. Thus, Hypothesis 2 (that M&A by high-tech acquirers that are organizationally mature have a positive effect on the acquirers' shareholder wealth) is supported. In view of these two results, high-tech acquirers' long-term low performance is likely attributable to their lack of experience and knowhow. Meanwhile, the dummy variable indicating whether a target firm is listed has a significantly negative effect on acquiring firms' long-term performance in the years following M&A. This result implies that it is harder to merge with a listed firm, whose corporate culture and internal systems are robustly established, than with a non-listed firm, which tends to have a more flexible corporate culture and internal systems. Finally, the debt ratio has a significantly positive effect on long-term performance.

# 5. Conclusions

We conduct an event study on 2824 cases of domestic M&A that were disclosed in the domestic stock exchange and took effect between 2002 and 2015 in Korean capital markets by classifying high-tech sectors into biotechnology, telecommunications, computer equipment, electronics, and general technology groups. We examine the disclosure effect of M&A in high-tech industries and the impact of disclosure on long-term firm performance. The key empirical findings of this study are as follows.

First, the disclosure effect of domestic M&A in Korean capital markets has a positive impact on the acquirer's shareholder wealth; this effect is more pronounced for high-tech firms than for non-high-tech firms. Second, M&A between non-high-tech and high-tech firms negatively affect the acquirer's shareholder wealth in terms of the disclosure effect. This result supports the findings of Nelson and Winter [7], which hold that investors rely heavily on established corporate routines rather than uncertain and newly acquired knowledge-based resources when acquirers belong to the non-high-tech sector. Third, M&A between high-tech and non-high-tech firms have a negative effect on long-term performance, but acquirers that are high-tech and organizationally mature enjoy a positive effect on long-term performance. This result suggests that organizationally mature firms can better adapt themselves to highly specialized technologies and knowledge that have yet to be internalized as part of their corporate routines because of their learned capabilities and breadth of experiences.

Research on M&A in the high-tech industry has focused only on strategic technology alliances, transfers of advanced technology and knowledge, and integration methods [16,24]. Extant studies on long-term performance are limited to cases in which the target companies are high-tech [4,5]. This study empirically analyzes the effect of the acquiring company's high-tech status on the long-term performance of M&A, targeting an entire M&A sample. The results thereby suggest that considering the capabilities of both the target and acquiring companies can contribute to the maximization of corporate value and efficient resource allocation by increasing the speed of innovation. This study can also be used to improve the performance of alliance networking and M&A.

This study is particularly important because its analytical scope is not confined to typical cases of high-tech M&A, wherein the target firms are high-tech or the acquiring and target firms are both high-tech covers the entire spectrum of M&A cases to examine how acquiring high-tech affect the financial performance gains that acquiring firms enjoy

through M&A. This aspect is significant, as it suggests that we have discovered new factors with which to elucidate the changes that may occur in acquirers' short- and long-term performance before and after M&A under ordinary M&A conditions. The study is also crucial in considering the acquirers' organizational age and the target firms' listed status as cues for their depressed performance in the years following M&A in the domestic market.

However, a limitation of the study is that it did not use proxies for long-term performance other than the change in operating cash flow rate of return. This aspect may be addressed in future studies.

Author Contributions: Conceptualization, S.-w.C. and J.-y.J.; methodology, H.S.; software, H.S. and S.-w.C.; validation, H.S., J.-y.J.; formal analysis, H.S.; investigation, H.S.; resources, H.S. and S.-w.C.; data curation, H.S.; writing—original draft preparation, H.S.; writing—review and editing, S.-w.C., J.-y.J. and B.-J.K.; supervision, S.-w.C. and J.-y.J. All authors have read and agreed to the published version of the manuscript.

Funding: This research received no external funding.

Acknowledgments: Jung appreciates support from Inha University.

Conflicts of Interest: The authors declare no conflict of interest.

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