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Investigating the Impact of IT Security Investments on Competitor's Market Value: Evidence from Korea Stock Market

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ABSTRACT

If a firm announces an investment in IT security, how the market value of its competitors reacts to the announcement? We try to shed light on this question through an event study design. To test the relationship, we collected 143 announcements on cybersecurity investment and measured the subsequent impact on 533 competitors' abnormal returns, spanning from 2000 to 2019. Our estimation results present that, on average, the announcements have no observable impact on the market value of announcing firms and competitors as well, which is consistent with findings of a prior study. Interestingly, however, the impact becomes evident when we classify our samples by industries (Finance vs. non-Finance or ICT vs. non-ICT) and firm size (Big vs. Small). We interpret our empirical findings through the lenses of *contagion effect* and *competition effect* between announcing firms and their competitors. Key finding of our study is that, for financial service firms, the effect resulting from the announcement on cybersecurity investment transfers to competitors in the same direction (i.e., contagion effect).

Keywords: IT Security Investment, Competitors, Market Reaction, Event Study, Information Transfer Theory, Korea Stock Market

Ⅰ. Introduction

Without a doubt, firms have created value by utilizing information more than ever before. The importance of protecting the information from outer exploiters has also been growing unprecedentedly. Indeed, the economic damage and crushed reputation resulting from the infiltrations by hackers have facilitated firms to adopt defensive measures for potential security attack.

The real-world example of the Facebook scandal[1)] represents how crucial for firms to manage well their

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data. Last year, Facebook experienced enormously plummeted market value after the announcement that there was an exposure of personal information up to 87 million people. Even though Facebook recovered its market value after the incident, a myriad of investors loses their money, causing gigantic economic damage to the firm and plummeted reputation as well. The case of the Marriott security incident[2] also demonstrates the relationship between security breach announcement and subsequent market reactions to it. To be more specific, Marriott announced the outbreak of being taken 500 million personal information away, then the market value of Marriott decreased by 5%. The reason why Marriot's breach was taken more seriously by investors was because the subject of the breach was unclear. Since Marriott's acquisition of Starwood, the question arises as to whether the security systems between the two companies have been properly integrated. The ambiguity of these victims was also a problem for Under Armour's acquisition of MyFitnessPal[3] and FedEx's acquisition of TNT Express[4]. In other words, the information security incident is very fatal to the company because its damage size and the cause of the damage are unclear.

As such, information security incidents have a very negative effect from the perspective of society as a whole, not only affecting individual firms Cyberattacks are the fastest growing crime in the United States, and the costs used to prevent them are growing exponentially. Robert Herjavec, founder and CEO at Herjavec group, mentioned that "This dramatic rise in damage costs only reinforces the sharp increase in the number of organizations unprepared for a cyberattack." ding to Gartner's 2019 forecast, global information security investments in 2019 will reach $ 124 billion, an increase of 12.4% compared to 2018's 114 billion dollars (Herjavec Report, 2019).

Most previous studies (Garvey et al., 2013; Gordon et al., 2015; Nagurney et al., 2017) regarding investment in information security were conducted with respect to measuring optimal amount of budget for information security. Nagurney et al. (2017) introduced three cybersecurity investment model, employing a Nash equilibrium concept. They computed the optimal point where the expected utilities of investing in cybersecurity is maximized in cooperative and competitive situations. Garvey et al. (2013) introduced an approach by which firms can prioritize cybersecurity measures among other investment options to strengthen cyber defense. Interestingly, they suggested a set of Pareto efficient investments based on cost-benefit function. From the perspective of real options, Gordon et al. (2015) argued that information sharing between market participants would encourage firms to investment sooner than otherwise, mitigating market's overall underinvestment in cybersecurity.

Likewise, majority of prior studies have considered information security investment as a cost and measured its benefits, but only a few studies (Chai et al., 2011; Jeong et al., 2019) on how a company's information security investment disclosure affects its market value. As mentioned earlier, companies' investment in information security is increasing rapidly, and externally, it is necessary to understand how the relevant disclosures cause following market reactions as the information security investment is rec-

1) https://www.nytimes.com/2018/07/25/technology/facebook-revenue-scandals.html
2) https://www.cnbc.com/2018/11/30/marriott-hack-raises-questions-about-merger-diligence-tools-in-use.html
3) https://www.cnbc.com/2018/03/29/under-armour-stock-falls-after-company-admits-data-breach.html
4) https://www.cnbc.com/2017/06/28/fedex-warns-of-possible-material-impact-after-subsidiary-hit-bit-cyberattack.html

ognized as a prioritized investment.

Our research question arises in this context, and following are our research questions: *In which direction does announcement on cybersecurity investment influence the announcing firm's market value (i.e., abnormal returns)? If so, do the market investors also react to the announcement by buying/selling competitors' stock share?* To empirically investigate theses questions, we collected 143 announcements on cybersecurity investments in Korea media and measured the subsequent impact on stock market reaction, employing event study as our observational lens.

For the observational period from 2000 to 2019, interestingly, we found empirical evidence that contagion effect existed when financial service firms announced investment in cybersecurity. That is, the market value of the announcing firms increased along with the increases in competitors' market value. Also, we identified that ICT (Information and communications Technology) firms experienced decrease in their market value after the announcement. We interpreted our results based on information transfer theory Michael (1996) used in the context of financial industry.

Ⅱ. Literature Review

2.1. Prior Studies on IT Investment

We carefully reviewed the variables, measurements, outcomes and some other crucial elements about IT investment literature because there were few studies implemented about information security investment. <Table 1> describes concise references with variables used, main findings. Hayes et al. (2000) discovered that information system outsourcing announcement positively affects market reaction the day after announcement date, especially for small firms and service firms. Oh et al. (2006) found that contract size was negatively related with market response, whereas IT vendor size was positively related with market response. Chatterjee et al. (2002) found the increased market value of announcing firms after announcement for IT investment. And, they found firms size has negative relationship with market reaction corresponding to the findings of Im et al. (2001). Im et al. (2001) empirically measured the impact of investing in information technology using event study methodology and found significant positive impact on small firms and finance firms.

Taken sum, on average, firms' announcements for investment on IT give the stock market investors positive signal who would infer their investments as positive action. We built our theoretical foundation upon this fact.

The Prior studies on the impact of IT investment announcement on investing firm have their theoretical foundation on the fact that the amount of expected losses resulting from incidents such as data breaches or systems hacked by outer exploiters are much larger than costs by which firms can build up preventive information protection systems. (Purser, 2004) Large body of literature that investigated information security breaches and cybersecurity investments are viewed through the lens of Net Present Value (NPV) analysis to measure cost and expected benefit resulting from security investment decisions (Gordon and Loeb, 2006; Hoo, 2001; Kim and Lee, 2005). Gordon and Loeb (2006) made a contingency table which was based on survey responses and strongly suggested that analyzing expected losses and probability of expected security breaches is an important issue when a firm is in the stage of planning budget for information security.

<Table 1> Prior Studies on the Impact of IT Investment Announcement on Market Value

Authors	Sample size (periods)	Main findings
Tony et al. (2016)	40 (2010-2015)	Big data investment announcements did not have significant impact on the U.S. stock market reaction.
Son et al. (2014)	212 (2006-2011)	Market investors positively react to the announcements on cloud computing initiatives. Also, resource-specific, firm-specific, and resource-specific factors influence on the magnitude of the market reaction.
Oh et al. (2006)	87 (1995-2003)	IT outsourcing announcements positively affect announcing firms' market value for 0.47%, 0.54%, 0.47%, 0.39% at the even windows, (-1, +1), (0, +1), (0, +2), (-2, +2), respectively. Contract size is negatively related with the market reaction.
Dehning et al. (2003)	353 (1981-1996)	Transformational IT investment: market value increased by 1.51%. Industry IT strategic role*IT investment strategic role yields market value increase by 1.66%.
Chatterjee et al. (2002)	112 (1992-1995)	Market value increased by 1.99% at (0, +1) with full sample. Announcement for infrastructure (0,1): 2.02% Announcement for application (-2, +2): 1.74% Firm size is negatively related with the market response. No evidence for the relation between market reaction with growth, diversity, and industry.
Im et al. (2001)	238 (1981-1996)	Significant market value increase by 0.269% for small firms. Significant market value increase by 0.630% for finance firms.
Hayes et al. (2000)	76 (1990-1997)	IT outsourcing announcements positively affect market value. Abnormal return for the day after announcement is over 80% larger than the announcement day. Small firms experienced marginally significant positive market reaction. Service firms have significant positive abnormal return for Day +1.
Dos Santos et al. (1993)	97 (1981-1988)	Insignificant outcome for the change in market value with full sample. Positive market reaction for the announcement on innovative IT investment. Industry effect does not exist.

2.2. Prior Studies on IT Security Investment

According to Roztocki and Weistroffer (2008), prior studies that examined the impact of investment in information systems can be categorized into three topics: Information Technology Investments, Security and Assurance, and Information Technology Outsourcing Initiatives. They counted the number of papers that used event study methodology to measure the impact of IT investment and explained that twenty-seven of forty-six papers had investigate the IT investment. Even though this proportion (27/46) seems relatively huge amount, none of them was about measuring impact of information security investment on the changes in market value of announcing firm.

Small but growing body of literature has focused on the economic impact of announcement on IT security. As shown in <Table 2>, Sangmi Chai et al. (2011) also found that announcing firms experienced significant increase in market value about 3% ~ 4%. To the best of my knowledge, Jeong et al. (2019) is the most recent study that measure the impact of announcement on IT security, in terms of announcing firms and their competitors as well. Interestingly, they found empirical evidence that competitors of firms who experience cybersecurity

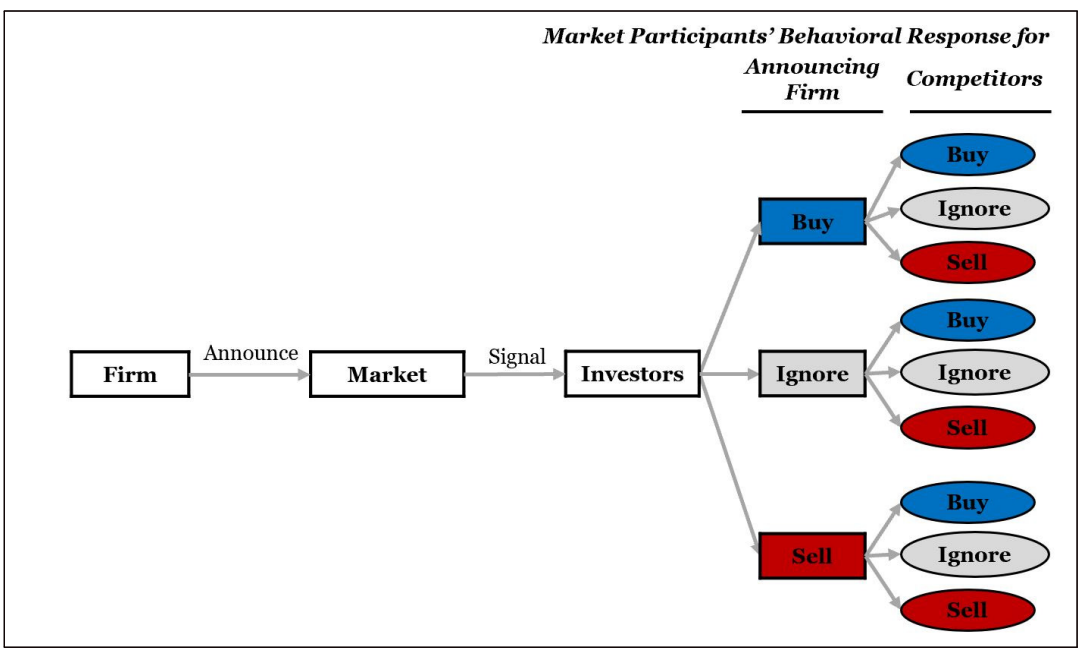
<Table 2> Prior Studies on Security Investment Announcement and Market Value

Authors	Sample size (periods)	Main findings
Jeong et al. (2019)	98 (2010-2017)	No observable impact on investing firms and competitors as well. Cybersecurity incident after cybersecurity investment brings significantly positive impact on competitors of investing firm.
Chai et al. (2011)	101 (1997-2006)	Announcement on cybersecurity investment increased market value for all event windows ranging from 1.01% to 1.89%. After the legislation of SOX (Sarbanes-Oxley Act), the effect increased distinctively.

breach after investment in cybersecurity increased in market value about 0.23% ~ 0.60%. This outcome reveals that the effect of announcement on IT security investment spreads out to intra industry firms.

Ⅲ. Hypotheses Development

<Figure 1> is a simplified illustration of the market participants' behavioral response for the announcement. When a firm makes an announcement of cybersecurity investment, stock market investors would appreciate and react to the new information based on their own valuation: buy, sell or ignore. Market value of the announcing firm would also change depending on their decisions. We hypothesize our arguments based on these mechanisms. Moreover, market participants' behavioral response for the announcement might vary by industries (i.e., finance vs. non-finance and ICT vs. non-ICT) and firm size. Below is the process of hypothesis development of our study.



<Figure 1> Simplified Decision Tree of Market Reaction to Unexpected Announcement

3.1. Announcement and Subsequent Effect on Announcing Firm

Majority of prior studies that investigate in which direction had the announcement on IT investment influenced stock market reaction concurred that, on the whole, market participants appreciate the information about investment in IT (Chatterjee et al., 2002; Dehning et al., 2003; Hayes et al., 2000; Oh et al., 2006). This finding supports the argument of Purser (2004) that the expected losses from the security breach is greater than the expected costs to build security defensive measures. That is, market investors regard the announcement of security investment as a positive signal, believing that the announcing firm would try to mitigate a potential damage by security breach.

Moreover, there have been discrepancies between academic studies that examined the impact of announcement of IT security investment on the announcing firm's market value. Specifically, Chai et al. (2011) studied the market reaction for the announcement on IT security and found that, on average, firms who announce their investment experience significant increase in market value. On the contrary, the empirical finding of Jeong et al. (2019) demonstrated that the announcement had no impact on the market value of announcing firm.

Jeong et al. (2019) described as follows: "In our case, unlike the time of the study of Chai et al. (2011), investors already started to recognize that IT security investment is a must-do thing rather than optional strategy." The logic behind this argument is that the observation period of Jeong et al. (2019) is from 2010 to 2017, but Chai et al. (2011) is from 1997 to 2006. However, according to a number of previous studies (e.g., Chai et al., 2011; Dos Santos et al., 1993; Im et al., 2001), disclosures of IT security investments, including IT investments, generally have a positive abnormal return to the announcing firms. In addition, the observation period of this study was from 2000 to 2019, which covers Chai et al. (2011) and Jeong et al. (2019). Therefore, we hypothesize our argument based on the common findings of previous studies. We tried to reexamine the impact based on the context of Korea stock market with Korean firms.

H1: Firms who announce investment in cybersecurity would experience increases in market value.

3.2. Announcement and Subsequent Effect on Competitors

The term '*information transfer effect*' refers to the market reaction for an announcement where a firm's unexpected dividend announcement affects intra-industry firms' market valuation change (Michael, 1996). They found empirical evidence that the announcing firms experienced an increase of market value by 2.63% whereas the similar-type firms experienced an increase of market value by 0.37%, respectively. The term '*contagion effect*' has been widely-used as a synonym of information transfer effect and occurs when a non-announcing firm's change in market value is in line with that of the announcing firm (Laux et al., 1998). On the other hand, '*competition effect*' occurs when rivals react opposite direction as that of announcer firms' announcement, especially when the market is oligopoly. For example, Lang and Stulz (1992) found that rivals react positively to announcer's bankruptcy announcement.

In our study, we tried to capture market value changes of announcing firm and the competitors, respectively, after the announcement on investment in IT security. And we assumed that we could infer the investors' reaction to those announcements by

observing investing firms' and competitors' market value change.

H2: Cybersecurity investment announcement would change the market value of intra-industry firms who are closely related to the announcing firm.

3.3. Heterogenous Impact by Industry - Finance vs. non-Finance

We looked at whether industry-specific effect affects the abnormal return for both announcing firms and their competitors. Among various types of industry, financial industry is known to be likely target for the exploiters who cause security breach for their own sake. Based on this fact, Im et al. (2001) found that there was significant positive abnormal return for financial firms who announced investment in IT. Likewise, Hayes et al. (2000) provided evidence that service firms experienced significant positive abnormal return a day after announcement date. Given that, on average, financial firms are closely related with dealing with highly private information (Flannery, 1986), thus investors are more sensitive about the data breach of the financial firms than about other industries, we can possibly set up hypothesis 3-a.

Moreover, it is hard to forecast in which direction will "contagion effect" or "competition effect" determine the abnormal returns of competitors of announcing firms. Therefore, we posit that financial firms' announcement on cybersecurity investment would affect market value of their competitors, rather than making an unidirectional hypothesis.

H3-a: Announcement on cybersecurity investment would increase market value of financial firms compared to non-financial firms.

H3-b: Financial firms' announcement on cybersecurity investment would affect abnormal return of their competitors.

3.4. Heterogenous Impact by Industry - ICT vs. non-ICT

A number of previous studies analyzing the effects of IT investments (Chai et al., 2011; Chatterjee et al., 2002; Hayes et al., 2000) have shown that IT investment disclosures from service firms that deal with vast customer data might be positively linked to the stock market investors. Hayes et al. (2000) found that fact empirically. Therefore, we hypothesize that Korean ICT firms would benefit from their announcement on cybersecurity investment more than non-ICT firms could possibly did.

Interestingly Jeong et al. (2019) investigated the impact of information-intensive firms' announcement on IT security on their competitors' market value and found that "competition effect" existed. That is, when an information-based firm announces data breach, in turn, its competitors take advantage of the event through gaining abnormal returns. Based on this finding, we posit that competitors of ICT firms would be affected by announcing firms' announcement, in terms of market value change.

H4-a: Announcement on cybersecurity investment would increase market value of ICT firms compared to non-financial firms.

H4-b: ICT firms' announcement on cybersecurity investment would affect abnormal return of their competitors.

3.5. Heterogenous Impact by Firm Size

We viewed firm size as a main variable which differently affects abnormal returns for each firm assuming investors would have differentiated expect-

ation spectrum for firms by size. Moreover, the relative importance of announcements would vary by size of the firm because big firms relatively reveal more announcements in regards to investment decisions than small firms. Im et al. (2001) classified firm size into large, medium, and small, whereas Hayes et al. (2000) measured firm size as big versus small. Also, Chatterjee et al. (2002) and Dehning et al. (2003) looked at size effect for investing firms. The difference between these prior studies and our study is that they measured firm size based on total assets, whereas this paper collected market value of each firm for fiscal year of investing period.

Following the finding of Im et al. (2001) that small firms benefit more from announcement on IT investment than big firms, we posit that small firms announcing cybersecurity investment would benefit more than big firms. Jeong et al. (2019) found that relatively big firms' announcement on security breach increases competitors market value, confirming the existence of competition effect. Therefore, we argue the existence of heterogenous impact of firms' announcement on cybersecurity investment on competitors' market value by firm size.

H5-a: Announcement on cybersecurity investment would increase market value of small firms compared to big firms.

H5-b: Relatively big firms' announcement on cybersecurity investment would affect abnormal return of their competitors.

Ⅳ. Theoretical Underpinnings

4.1. Efficient Market Hypothesis

The theoretical core of efficient market theory is under assumption that all available information is fully reflected in publicly-traded securities' prices (Malkiel and Fama, 1970). That is, the impact of newly-revealed announcements from specific firm is not applied to present market value of the firm. When the unexpected announcements reach stock market, all present or potential investors would appreciate (or depreciate) the following influence alongside of that exposures. If a market is efficient, investors would notice the unanticipated news and direct them to their subsequent reactions, revaluing the firms' difference between before and after of the announcements (Im et al., 2001). Then, we would be able to discern whether the investments improve their market value. The fundamental basis of event study methodology is based upon this theory and is applicable to test empirical study.

4.2. Announcement and Abnormal Return

Abnormal returns are values resulting from unexpected events and unbiased estimates of changed market value to the firms within event period. The abnormal return for the firms which unexpectedly reveal announcements is calculated as follows:

$$AR_{i,t} = R_{i,t} - R_{i,t}^{*} \qquad (1)$$

$AR_{i,t}$: abnoramal return for firm i on day t

$R_{i,t}$: actual return for firm i on day t

$R_{i,t}^{*}$: normal return for firm i on day t

To estimate normal return for specific firm, which is denoted by R*, the most frequently-used model is the market model (Chai et al., 2011; Chatterjee et al., 2002; Dehning et al., 2003; Dos Santos et al., 1993; Hayes et al., 2000; Im et al., 2011; Oh et al., 2006) and there is another alternative model such as a market-adjusted model. In our study, we basically

used market model to estimate normal return. The equation for the actual return is described below:

$$R_{i,t} = a_i + \beta_i R_{m,t} + \varepsilon_{i,t} \quad (2)$$

a_i : intercept term (measure of risk-adjusted value)

β_i : systematic risk for firm i

$R_{m,t}$: actual return of marker portfolio

There is another question for which market index to be used as an appropriate market estimator: equally-weighted index and value-weighted index. We set equally-weighted index because this option is well known to capture abnormal security returns (Dann and Mikkelson, 1984).

$$CAR_{(t1,t2)} = \sum_{i=t_1}^{t2} AR_i \quad (3)$$

$$CAAR_N = \frac{1}{N}\sum_{i=1}^{N} CAR_i \quad (4)$$

The cumulative abnormal return (CAR) for period t1 through t2 is a summation of all abnormal returns (AR) for each event period. If we assume that there is no iterative effect on each event period, the abnormal returns, accordingly, would become independent for each other. So, the equation above is set. To make this assumption and following equation valid, adequate length of event window should be employed.

Ⅴ. Methodology

5.1. Event Study

We adopted event study methodology to observe tangible impact of investing in information security on investing firms' market value change by themselves and on competitors. This methodology has its foundation on efficient market theory (Malkiel and Fama, 1970). We used this methodology to effectively and intuitively capture the market investors' behavior response. This methodology has been widely used in various scientifically-investigated academic field not only being applied for the finance literature (Dyckman, 1984; Shah and Arora, 2014), but also for the information literature. More specifically, many prior studies regarding information breaches (Anthony et al., 2006; Campbell et al., 2003; Kannan et al., 2007) or investment have been conducted through the lenses of event study methodology.

Furthermore, prior studies that investigated IT investment using this method can be classified into many areas including E-commerce initiatives (Dehning et al., 2004; Dewan and Ren 2007; Subramani and Walden, 2001), IT investments in Human resources (Chattergee et al., 2001; Khallaf and Skantz, 2007), and IT outsourcing initiatives (Hayes et al., 2000; Oh et al., 2006; Peak et al., 2002). However, few studies have been implemented that observe the changes in market value of the announcement firm who invests in IT security (Chai et al., 2011; Jeong et al., 2019) We expect that it is an evident way of measuring market reaction between investing firms and competitors when they are observed by event study methodology.

5.2. Data

We gathered samples of announcements based on searching from news.naver.com, because this channel is the most frequently-visited source for investors. We collected related articles that were most prompt and recent ones. Following Jeong et al. (2019), we did not consider duplicated news articles after the initial one because an event we try to capture should have unexpected influence on stock market. If we consider the subsequent news articles, we would end up in estimating confounding effects resulting

<Table 3> Data Summary

Classification	Investing Firms (n = 143)	Competitors (n = 533)
(a) Announcements by Years		
2000	1	4
2001	4	13
2002	11	40
2003	11	41
2004	8	29
2005	6	24
2006	8	32
2007	2	5
2008	7	28
2009	9	36
2010	14	53
2011	4	16
2012	7	28
2013	3	12
2014	10	33
2015	11	44
2016	8	26
2017	8	31
2018	6	21
2019	5	17
(b) Industry classification 1		
Finance	64	256
Non-finance	79	277
(c) Industry classification 2		
ICT	55	184
Non-ICT	88	349
(d) Size		
Big	48	159
Small	48	192

from mixed events. We only gathered firms that are publicly-traded in Korea and excluded privately-held firms that we cannot capture the market investors' responses. We searched news articles based on keywords such as 'Data security purchase', 'Information security acquisition', 'mobile security investment'. Initially, we collected 148 samples of investing firms but 5 of those samples turned out to be missing when using FnGuide package. <Table 3> presents announcements by years, industry classifications, and firm size division by samples.

We collected samples of competitors based on 'related companies' category from the 'news.naver.com' Finally, the total samples came out as 143 for investing firms and 533 for competitors, respectively. The observation period is 2000 through 2019, covering the most recent announcement on IT security investment. We collected every possible announcement on IT security within the observation period.

5.3. Measure

5.3.1. Measurement

Industry - Finance vs. non-Finance. The standards of ICT companies are based on the ICT integrated classification system of the Korea Information and Communications Promotion Association (KAIT) 2017 ICT Survey and the Korea Standard Industrial Classification linkage table. Following the classification of KAIT, the numbers starting from 20231 is classified into Finance firms. Detailed classification for the individual firm is presented at <Appendix> section.

Industry - ICT vs. non-ICT. Following the classification of KAIT, the numbers starting from 26 (Communication equipment manufacturing), 582 (software development and supply), 62 (computer programming, system integration and management), and 63 (information service) are classified into ICT firms, as shown in <Table 4>. Accordingly, for example, the firms, Actozsoft and NCSoft are classified as ICT.

Firm Size - Big vs. Small. In our samples, the firms are classified into three categories, small, medium, and big. To highlight the differential impact, we analyzed the impact of announcement, only based on small versus. big firms. Jeong et al. (2019) classified event firm sizes into small and big, and we followed their criteria. Specifically, small firms are defined as firms that have market value below 3 trillion won. Big firms are defined as firms that have market value over 12 trillion won. By following this criterion, we match the number of small (i.e., 48) and big (i.e., 48) firms within our samples. For example, the sample firms, Actozsoft, NCSoft, and Shinhan Bank are classified as small, medium and big firm, respectively.

5.3.2. Computation of Mean Cumulative Abnormal Return (CAAR)

We used FnGuide package to find out parameters for market index and cumulative abnormal return for each firm setting estimation period t = -190 to t = -30, subsequently the gap between last day of estimation period and event window was fixed to

<Table 4> Examples of Firm Classification

Firm (Announcement)	Contents of Announcement	Classification
Actozsoft (20120917)	Actozsoft has converted its email service from its internal server to the cloud through Microsoft Office 365 (hereafter Office 365).	ICT
	Actozsoft explains that the transition has taken the cloud as a fundamental way to combat e-mail breaches that are becoming more sophisticated.	Small
Shinhan Bank (20160127)	Shinhan Bank announced on the 27th that it will provide fingerprint authentication login service with enhanced security to existing simple login method for customers using SUNNY Bank.	Finance
	Fingerprint authentication applied to Sunny Bank was established in accordance with FIDO standard, which is an international standard for biometric authentication.	Big
NCSoft (20000718)	NcSoft (CEO Kim Taek-jin) announced on the 18th that it has signed an agreement with Hauri (CEO Seok-cheol Kwon) to provide anti-hacking and anti-virus services, and to end information hacking between the Lineage users.	ICT
	With this agreement, NcSoft has integrated a system that can block back-offices and other hacking in-game. In addition, virus scanning, treatment, and hacking blocking system were introduced on the Lineage homepage to ensure customer information protection.	Medium

30 days. To use this package, we extracted stock market index codes available from finance.naver.com and applied those codes to firm identifiers. And, we adopted equally-weighted market indices as benchmark option. As benchmark option within FnGuide package allowed us to select market model or market-adjusted model, we selected the market-model option as our baseline estimation criterion.

The major concern when conducting event study is to confine confounding effects brought by overlapping multiple announcements. For instance, a firm may announce a new product a day after they have exposed surprising earnings or dividends. The impact of these announcements will make iterative effect negatively or positively for each other. To avoid this effect, we tried to eliminate overlapping observations adopting short-term event windows for calculating CAAR. (Elberse, 2007; Sood and Tellis, 2009).

After defining estimation model and selecting estimation options, we chose event windows (-1, +1), (0, +1), (0, +2), (-1, +2) and finalized the process to observe outcome. The criteria for selecting event windows are as follows: First, according to findings of Roztocki and Weistroffer (2009) where they studied prior IT investment literature that had used event methodology from 1993 to 2008, those event windows are most frequently-used ones consisting of 25/46 for (-1, +1), 13/46 for (-1, 0), and 9/46 for (0,+1), respectively. Second, since a huge gap between announcement date and period of event windows would dilute what we want to measure, short event window would more reliably capture abnormal return than the long event windows. (Armitage, 1995).

Ⅵ. Results

We adopted conventionally-used event windows, (-1, +1), (0, +1), (0, +2), (-1, +2), and the result are presented in the following tables.

6.1. CAAR Results - Announcing Firm and Competitors

<Table 5> is presented to test our hypothesis H1 and H2. Being consistent with the finding of Jeong et al (2019) and contrary to the Chai et al. (2011), the estimation results show that announcement on cybersecurity investment has no observable impact on the market value of announcing firms. That is, on the whole, market investors did not react to the announcement. All the event windows we employed show statistically insignificant abnormal returns, hence *we can reject the H1*. These results demonstrate that, unlike the finding of Chat et al. (2011), announcement on cybersecurity investment itself is not

<Table 5> Impact on Announcing Firm and Competitors (H1, H2)

	Announcing Firm (*N* = 143)		**Competitors (*N* = 533)**	
Event Window	CAAR (%)	*t*-Value	CAAR (%)	*t*-Value
(-1, +1)	-0.01	0.29	-0.073	0.269
(0, +1)	0.114	0.422	0.189	0.882
(0, +2)	0.056	0.14	0.358	1.463
(-1, +2)	-0.167	0.377	0.091	0.309

Note: * Significant at 0.10. ** Significant at 0.05.

provocative in the context of Korea stock market. The possible explanations for these results are that, investment in cybersecurity has been perceived as one of the priorities for market participants (Jeong et al., 2019) or, on the contrary, a negligible investment.

For competitors of announcing firms, we cannot observe the 'information transfer effect' for the total samples, which means, on average, the announcement on cybersecurity investment has no impact on the market value of closely-related firms. Hence, *we can reject the H2*. This outcome is consistent with the finding of Jeong et al. (2019) who looked at the U.S. stock market reaction. By all accounts, when investigating on the total sample, we could identify that announcement on cybersecurity investment does not bring abnormal returns for the announcing firm and competitors was as well, similar to the U.S. stock market reaction.

6.2. CAAR Results - Finance vs. non-Finance

To examine the industry effect coupled with announcement on investment in cybersecurity, we focused on identifying the difference between financial firms versus non-finance firms. As shown in <Table 6>, the estimation results present that the financial firms took advantage of the announcement on cybersecurity investment, which is denoted by the statistically significant abnormal returns (i.e., CAAR: 0.925%, $p < 0.1$) at the event window (0, +2). Also, the mean difference between the financial firms and non-financial firms is also statistically different, highlighting the heterogenous impact of the announcement on each sample firms. Hence, *we can accept the H3-a*. This result is consistent with the finding of Im et al. (2001). Through this analysis, we reconfirm that the earlier finding can be applied to the context of Korea stock market.

Interestingly, the timing of market value change of competitors' exactly corresponds to that of announcing firm. At the same event window (0, +2), competitors of the anncouncing fiancial firm experienced increases in market value, but with less magnitude (CAAR: 0.588%). Therefore, *we can accept the H3-b*. Mean difference for CAAR between financial firms and non-financial firms also statistically significant.

We interpreted this results that, as Laux et al. (1998) identified, the 'contagion effect' pecuiliar to the announcement on cybersecurity investment causes the unidirectional movement of abnormal returns for announcing firms and their competiors as well. What is important to note is that, unlike the prevalent understanding about the relationship between the financial firms, stock market participants regard the financial entities as a collectivity, in terms of cybersecurity, throught which other financial firms (i.e., com-

<Table 6> Heterogenous Impact on Announcing Firm by Industry (H3-a)

Announcing Firm					
	Finance (*N* = 64)		**Non-finance (*N* = 79)**		
Event Window	CAAR (%)	*t*-Value	CAAR (%)	*t*-Value	Difference
(-1, +1)	0.138	0.299	-0.164	0.316	0.435
(0, +1)	0.649	1.621	-0.151	0.414	1.477
(0, +2)	**0.925**	**1.914***	-0.38	0.653	**1.725***
(-1, +2)	0.414	0.801	-0.402	0.609	0.973

Note: * Significant at 0.10. ** Significant at 0.05.

<Table 7> Heterogenous Impact on Competitors by Industry (H3-b)

Competitors					
	Finance (*N* = 256)		Non-finance (*N* = 277)		
Event Window	CAAR (%)	*t*-Value	CAAR (%)	*t*-Value	Difference
(-1, +1)	-0.146	0.56	0.011	0.024	0.298
(0, +1)	0.362	1.565	0.048	0.135	0.740
(0, +2)	**0.588**	**2.002****	0.017	0.457	**1.928***
(-1, +2)	0.075	0.242	0.137	0.276	0.106

Note:* Significant at 0.10. ** Significant at 0.05.

petitors) could take advantage of positive externalities.

One interesting point is that both investing firms and competitors experience positive CAAR only when the event window is (0, +2). As can be seen in both <Table 6> and <Table 7>, the statistically significant CAAR could not be observed based on the (0. +1) event window. Chai et al. (2011) shows that market investors respond more heavily to information security investments two days after the disclosure date. Similarly, this study found that the occurrence of abnormal returns on the disclosure of information security investments by finance companies increased over time. It is interesting that finance firms' competitorss also experienced similar effects over the same period.

6.3. CAAR Results - ICT vs. non-ICT

The CAAR results for ICT firms are worth looking at in that they suggest us to reconsider the rejection for the hypothesis 1 (H1). Interestingly, when we divide our full samples (n = 143) into ICT (n = 55) and non-ICT (n = 88) firms, we can observe that announcement on cybersecurity investment increases market value of announcing firm at all event window, (-1, +1), (0, +1), (0, +2), (-1, +2). We therefore argue that, on average, ordinary firms, other than ICT firms, experience increases in market value after they announced investment in cybersecurity. Furthermore, the mean difference between ICT and non-ICT firms' CAARs are statistically significant, at least, at 5% level. We consider these empirical findings as evidence that supports the argument of Chai et al. (2011) even in the context of Korea stock market.

The interesting to note is that ICT firms' announcement on cybersecurity investment even decreases their market value when measured by the event window (0, +1), contrasting the difference of the results for the financial firms. Hence, *the H4-a is not supported*. What drives the contrasting outcomes between financial firms and ICT firms? Both industries are well-known to be information-intensive field. Our cautious interpretations are as follow:

On the one hand, stock market investors consider the financial firms' announcement on cybersecurity investment as positive signal that they care cybersecurity and try to take defensive measures to prevent themselves from being exploited by hackers, which lures the investors to think the investment as an unexpected event such as surprise earnings or dividend. On the other hand, stock market investors usually set higher standard for ICT firms to invest in cybersecurity than non-ICT firms or, even, financial firms. This differentiated expectation leads to disparate response to the investment announcement.

As shown in <Table 9>, we found that competitors

<Table 8> Heterogenous Impact on Announcing Firm by Industry (H4-a)

Announcing Firm					
	ICT (*N* = 55)		non-ICT (*N* = 88)		
Event Window	CAAR (%)	*t*-Value	CAAR (%)	*t*-Value	Difference
(-1, +1)	-1.01	1.538	**0.665**	**1.667***	**2.179****
(0, +1)	**-0.793**	**1.766***	**0.852**	**2.629*****	**2.970*****
(0, +2)	-1.051	1.363	**0.951**	**2.375****	**2.304****
(-1, +2)	-1.283	1.463	**0.767**	**1.776***	**2.097****

Note: * Significant at 0.10. ** Significant at 0.05.

<Table 9> Heterogenous Impact on Competitors by Industry (H4-b)

Competitors					
	ICT (*N* = 184)		non-ICT (*N* = 349)		
Event Window	CAAR (%)	*t*-Value	CAAR (%)	*t*-Value	Difference
(-1, +1)	0.001	0.004	-0.1	0.411	0.290
(0, +1)	0.004	0.085	0.281	1.415	1.357
(0, +2)	0.261	0.487	**0.435**	**1.738***	0.294
(-1, +2)	0.213	0.319	0.051	0.18	0.223

Note: * Significant at 0.10. ** Significant at 0.05.

of the non-ICT announcers also experienced increases in market value from the event date to two days after the announcement (CAAR: 0.435%). However, we cannot observe any evidence that annoucement of ICT firms positively or negatively affects the competitors' market value. Therefore, *the H4-b is not supported*. Unlike the finding of Lang and Stulz (1992) who identify that rival firms' market value reacts positively to announcer's bankruptcy annoucemet, we can observe a 'contagion effect' by which competitors took advantage of positive externalities, in the case of investment in cybersecurity announcement. Taken sum, our sample firms' (any other than ICT firms) competitors experience increases in market value as same direction as announcing firms experienced.

6.4. CAAR Results - Big vs. Small

The estimation result presented in the <Table 10> shows that size of a firm is not a factor that determines whether a firm announcing investment in cybersecurity experiences abnormal returns (or losses). Being inconsistent with the finding of Im et al. (2001), we found no statistically significant CAARs for all event windows we used. This result also demonstrates that industry effect is the more crucial determiant of whether a firm experiences abnormal returns than size effect. Hence, *H5-a is hardly supported*.

We also looked at the market response for the competitors, from the perspective of size classification. The comparative results are shown in <Table 11>. As all CAAR results for all event windows are statistically insignificant, the *H5-b is also not supported*. This result is in accordance with the finding of Jeong

<Table 10> Heterogenous Impact on Announcing Firm by Firm Size (H5-a)

Announcing Firm					
	Big (N = 48)		Small (N = 48)		
Event Window	CAAR (%)	t-Value	CAAR (%)	t-Value	Difference
(-1, +1)	-0.05	0.092	-0.422	0.454	0.345
(0, +1)	-0.107	0.271	0.13	0.196	0.307
(0, +2)	0.381	0.909	-0.265	0.326	0.706
(-1, +2)	0.433	0.795	-0.82	0.859	1.140

Note: * Significant at 0.10. ** Significant at 0.05.

<Table 11> Heterogenous Impact on Competitors by Firm Size (H5-b)

Competitors					
	Big (N = 159)		Small (N = 192)		
Event Window	CAAR (%)	t-Value	CAAR (%)	t-Value	Difference
(-1, +1)	-0.143	0.368	-0.282	0.668	0.242
(0, +1)	-0.069	0.215	0.054	0.162	0.266
(0, +2)	0.056	0.137	0.119	0.308	0.112
(-1, +2)	-0.022	0.046	-0.219	0.476	0.297

Note: * Significant at 0.10. ** Significant at 0.05.

et al. (2019). That is, the information transfer effect does not apply to the size effect we hypothesized. We can infer from this analysis that Korea stock market investors less sensitively respond to the announcement of investment in cybersecurity by firm size than by industry classification (i.e., financial and ICT industries).

Ⅶ. Discussion

7.1. Discussion of Findings

Cyberattacks have become one of the fastest growing crimes, and companies are increasing their investments in information security to counter them. Many previous studies considered firms' investment in information security as a cost and focused on the return on investment by comparing expected benefits and costs. However, not only does an information security breach cause economic losses, but it also causes various losses that cannot be easily estimated, such as the reputation of a company. Therefore, the purpose of this study is to find out how the announcements of information security investment are perceived by investors in the stock market through the change in the market value of the firm. In addition, this paper analyzes the impact of corporate information security investment disclosures on the market value of competitors. Michael (1996), who studied the impact of a company's dividend disclosures on the market value of competitors based on the information

transfer theory, served as a key paper in terms of conceptual foundation. Following are key findings of our study:

First, in accordance with the finding of Jeong et al. (2019), we confirm that, on average, the announcement on cybersecurity investment has no direct relationship between announcing firms' changes in market value. However, when classifying all sample firms into ICT firms and non-ICT firms, we found that the announcement of information security investments by non-ICT firms increased their market value, ranging from 0.665% (event window: (-1, +1)) to 0.951% (event window: (0, +2)). The mean CAAR difference between the ICT and non-ICT groups was statistically different. We have found that this result is aligned with that of Chai et al. (2011), and therefore, supports the findings. In other words, we found that the effect is also applicable in Korea stock market.

Second, the announcement of information security investments by financial service firms is shown to increase the market value of both the firm and its competitors. In particular, both groups had the same effect in the same period (event window: (0, +2)). More specifically, financial service companies that have announced information security investments have gained market value of 0.925%, while competitors have experienced abnormal returns of 0.588% over the same period. This result is similar to the dividend disclosure effect of Michael (1996) found. In addition, the changes in market value of competing companies are smaller than those of companies that have made information security investments or dividend disclosures. In other words, even though the market value moves in the same direction for both the announcing firm and the competing company, due to the contagion effect, but it is confirmed that the size of effect is more evident for the announcing firms.

Lastly, we found that the effect of announcing on information security investments is not affected by the relative size of the company or its competitors itself, which is consistent with the finding of Jeong et al. (2019). In other words, market participants do not differently discern the size of a company in recognizing the importance of announcement on information security investment. This result is inconsistent with the finding of Im et al. (2001) who found that IT investment announcement from small firms increases the firms' market value. Therefore, this study suggests that the effect of the information security investment announcement is found to be affected by the industry rather than the size of the firm.

7.2. Implication

Along with our findings, this study has the following academic contribution. First of all, this study is meaningful in that it considers both the effect of information security investment announcement in Korea stock market and the subsequent effect on their competitors as well. As a related study, Jeong et al. (2019), which is based on the US stock market, exists, but because the US stock market and the Korean stock market are fundamentally different from each other, it is necessary to study these two markets separately. The findings found in this study partially coincide and inconsistent as well with Jeong et al. (2019). We interpreted the results based on information transfer theory, and it is surprising that the contagion effect in the stock market discovered by Michael (1996) was once again confirmed in the context of information security investment. In addition, samples from this study included 2000 to 2019, and this long observation period enhances the validity of the findings.

Another point we suggest as a main implication of this research is that this study found that the effect of information security investment announcement reflects industry sector characteristics rather than firm size. Although there have been attempts[5] to identify industry effect in regard to the impact of IT investment announcement on market value, none of them found that industry effect matters, especially when the announcement influences the market value of competitors as well.

7.3. Limitation and Future Research Direction

Even though our study sheds more light on the impact of cybersecurity investment announcement on stock market, thus contribute to academic stream, there are a few obstacles that can be viewed as limitations of this research.

First, our observation is implicitly assuming that stock market investors react to the announcement on cybersecurity investment uniformly throughout our observation period, disregarding the differential period effect. Im et al. (2001) could be able to re-examine the finding of Dos Santos (1993) with more sample events, expanding the observation period from 1981 - 1988 to 1981 - 1996. The observation period we use is 2000 - 2019. Therefore, the further study can classify the long period into more granular periods (e.g., before and after the dot-come bubble).

Second, the criterion of setting competitors might be questionable. We determined competitors of announcing firm to be extracted from section of '*related firms*' on the 'news.naver.com'. Even though this route is frequently-visited reference for stock market investors, it cannot be justified as an absolute route to determine the adequate competitors of the announcing firm in our samples.

Lastly, the measurement criteria we used for classifying firm size are under 3 trillion won for 'small firms" and over 12 trillion won for 'big firms', respectively. Therefore, more objective criterion is needed to divide samples firms into big and small, rather than being contingent upon the composition of samples. The future study would become a more fruitful one if it considers these limitations we encountered.

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5) 1) Im et al. (2001) and Dehning et al. (2003) took finance industry account. 2) Hayes et al. (2000) and Chatterjee et al. (2002) took service industry account. 3) Dos Santos et al. (1993) differentiate manufacturing and finance industry.

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<Appendix> Sample Announcements and Corresponding Firm Characteristics (n = 143)

Firm	Announcement	Stock Index	Finance	ICT	Firm Size
NCSoft	20000718	A036570	0	1	Medium
SK Telecom	20010108	A017670	0	1	Big
SK Securities	20011029	A001510	1	0	Small
Kyobo Securities	20011029	A030610	1	0	Small
Shinhan Investment Corp	20011111	A055550	1	0	Big
Korea Information	20020320	A053300	0	1	Small
SK Telecom	20020507	A017670	0	1	Big
Hyundai Motor Company	20020530	A005380	0	0	Big
Hyundai Information Technology	20020618	A026180	0	1	Small
KT	20020711	A030200	0	1	Medium
Hyundai Shipping	20020806	A001450	1	0	Medium
Hyundai Heavy Industries	20020826	A009540	0	0	Medium
Korea Electric Power Corporation	20020901	A015760	0	0	Big
Mirae Asset Daewoo	20021001	A006800	1	0	Medium
Daishin Securities	20021016	A003540	1	0	Small
Hanhwa Securities	20021029	A003530	1	0	Small
Shinhan Bank	20030108	A055550	1	0	Big
Kangwon Land	20030130	A035250	0	0	Medium
Samsung Electronics	20030515	A005930	1	0	Big
KB Financial Group Inc	20030630	A105560	1	0	Big
Dongjin Semichem	20030715	A005290	0	0	Small
Daishin Securities	20030725	A003540	1	0	Small
KT	20030801	A030200	0	1	Medium
Hancom	20030908	A030520	0	1	Small
SK Telecom	20030917	A017670	0	1	Big
LG Chem	20031022	A051910	0	0	Big
Shinsegae Group	20031209	A004170	0	0	Medium
SBS	20040119	A034120	0	0	Small
Daishin Securities	20040401	A003540	1	0	Small
Korea Information	20040414	A053300	0	1	Small
Hyundai Department Store	20040517	A069960	0	0	Small
KT	20040701	A030200	0	1	Medium
Woori Bank	20040722	A000030	1	0	Medium
SK Telecom	20040722	A017670	0	1	Big
Mirae Asset Daewoo	20040804	A006800	1	0	Medium
The Jeonbuk Bank	20050121	A175330	1	0	Small

<Appendix> Sample Announcements and Corresponding Firm Characteristics (n = 143) (Cont.)

Firm	Announcement	Stock Index	Finance	ICT	Firm Size
Interpark	20050428	A108790	0	1	Small
Neowiz	20050518	A095660	0	1	Small
Daegu Bank	20050725	A138930	1	0	Medium
Busan Bank	20050725	A138930	1	0	Medium
KT	20051020	A030200	0	1	Medium
Dongbu Insurance	20060112	A005830	1	0	Medium
Samsung Life Insurance	20060112	A032830	1	0	Big
NCSoft	20060119	A036570	0	1	Medium
Shinhan Bank	20060321	A055550	1	0	Big
Hyundai Home Shopping Network Corporation	20060331	A057050	0	0	Small
KB Financial Group Inc	20060908	A105560	1	0	Big
KT	20060925	A030200	0	1	Medium
NHN Entertainment	20061012	A181710	0	1	Small
SK Telecom	20070730	A017670	0	1	Big
KT	20070904	A030200	0	1	Medium
Woongjin Group	20080124	A016880	0	0	Small
Shinhan Bank	20080611	A055550	1	0	Big
Interpark	20080627	A108790	0	1	Small
Woori Financial Group	20080922	A000030	1	0	Medium
Nexon	20080925	A041140	0	1	Small
WeMade	20081022	A112040	0	1	Small
KB Financial Group Inc	20081208	A105560	1	0	Big
Daegu Bank	20090223	A138930	1	0	Medium
Busan Bank	20090223	A138930	1	0	Medium
KEB Hana Bank	20090223	A086790	1	0	Big
The Jeonbuk Bank	20090330	A175330	1	0	Small
Samsung Electronics	20090427	A005930	1	0	Big
Dong Yang Life Insurance	20090528	A082640	1	0	Small
NCSoft	20090827	A036570	0	1	Medium
Mgame	20091023	A058630	0	1	Small
Busan Bank	20091216	A138930	1	0	Medium
Woori Financial Group	20100118	A000030	1	0	Medium
Sebang	20100324	A004360	0	0	Small
Nexon	20100325	A041140	0	1	Big
YD Online	20100326	A052770	0	1	Small
Digital Chosun	20100329	A033130	0	1	Small

<Appendix> Sample Announcements and Corresponding Firm Characteristics (n = 143) (Cont.)

Firm	Announcement	Stock Index	Finance	ICT	Firm Size
Neowiz	20100331	A095660	0	1	Small
MODETOUR NETWORK Inc.	20100412	A080160	0	0	Small
Hyundai Home Shopping Network Corporation	20100421	A057050	0	0	Small
Korea Investment & Securities Co	20100503	A071050	1	0	Medium
Shinhan Investment Corp	20100503	A055550	1	0	Big
SK Securities	20100503	A001510	1	0	Small
CJ GLS	20100519	A000120	0	0	Medium
SM Entertainment	20100721	A041510	0	1	Small
SK Telecom	20101110	A017670	0	1	Big
GS Retail	20110209	A007070	0	0	Medium
The Jeonbuk Bank	20110214	A175330	1	0	Small
Ezwelfare	20110426	A090850	0	0	Small
Samsung Electronics	20110711	A005930	1	0	Big
Korea Investment & Securities Co	20120103	A071050	1	0	Medium
LG Electronics	20120212	A066570	0	1	Big
Hyundai Department Store	20120227	A069960	0	0	Small
Woori Financial Group	20120312	A000030	1	0	Medium
Nexon	20120329	A041140	0	1	Big
Hanwha Life Insurance	20120705	A088350	1	0	Medium
Actozsoft	20120917	A052790	0	1	Small
Hyundai Hicar Direct Auto Insurance Co	20130103	A001450	1	0	Medium
Hyundai Motor Securities	20130227	A001500	1	0	Small
Shinhan Bank	20130506	A055550	1	0	Big
The Jeonbuk Bank	20140320	A175330	1	0	Small
Woori Investment&Securities	20140326	A000030	1	0	Big
NHN Entertainment	20140430	A181710	0	1	Small
KT	20140804	A030200	0	1	Medium
LG Uplus	20141001	A032640	0	1	Medium
Korea Electric Power Corporation	20141107	A015760	0	0	Big
SK Telecom	20141202	A017670	0	1	Big
Korea Zinc	20141203	A010130	0	0	Medium
Naver	20141217	A035420	0	1	Big
Shinhan Investment Corp	20141230	A055550	1	0	Big
Daishin Securities	20150104	A003540	1	0	Small
NCSoft	20150423	A036570	0	1	Medium
Daum	20150430	A035720	0	1	Medium

<Appendix> Sample Announcements and Corresponding Firm Characteristics (n = 143) (Cont.)

Firm	Announcement	Stock Index	Finance	ICT	Firm Size
Samsung Electronics	20150430	A005930	1	0	Big
KT	20150616	A030200	0	1	Medium
Naver	20150625	A035420	0	1	Big
Hanwha investment&securities	20151007	A003530	1	0	Small
KEB Hana Bank	20151127	A086790	1	0	Big
KB Securities	20151202	A105560	1	0	Big
POSCO	20151204	A005490	0	0	Big
Minwise Co	20151229	A214180	0	1	Small
Shinhan Bank	20160127	A055550	1	0	Big
Samsung Electronics	20160512	A005930	1	0	Big
Naver	20160512	A035420	0	1	Big
Woori Bank	20160714	A000030	1	0	Big
Samsung SDS	20160714	A018260	0	1	Big
NextChip	20160810	A092600	0	1	Small
SK Telecom	20161116	A017670	0	1	Big
Asiana Airlines	20161123	A020560	0	0	Small
Woori Bank	20170515	A000030	1	0	Big
Samsung Electronics	20170515	A005930	1	0	Big
Korea Electric Power Corporation	20170515	A015760	0	0	Big
Kyobo Securities	20170515	A030610	1	0	Small
KT	20170616	A030200	0	1	Medium
Korea Investment & Securities Co	20170627	A071050	1	0	Medium
NH Investment & Securities	20171113	A005490	1	0	Medium
NHN Entertainment	20171221	A181710	0	1	Small
KT	20180116	A030200	0	1	Medium
SK Telecom	20180123	A017670	0	1	Big
Hana Financial Investment Co.	20180516	A086790	1	0	Medium
Samsung SDS	20181001	A018260	0	1	Big
Woori Bank	20181007	A316140	1	0	Medium
Korean Air	20181106	A003490	0	0	Small
Mirae Asset Daewoo	20190219	A006800	1	0	Medium
KT	20190225	A030200	0	1	Medium
Industrial Bank of Korea	20190311	A024110	1	0	Medium
SK Telecom	20190318	A017670	0	1	Big
Hana Financial Investment Co.	20190329	A086790	1	0	Medium

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