

Can Cross-Listing Mitigate the Impact of an Information Security Breach Announcement on a Firm's Values?

Yong Chen^{1,a}, Feng Dong^{1,b}, Hong Chen^{1,c} and Li Xu

Old Dominion University, USA

E-mail: ^ay7chen@odu.edu, ^bfdong@odu.edu, ^chchen001@odu.edu, lxu@odu.edu

Abstract. The increase in globalization in the markets has driven firms to adopt online technologies and to cross-list their stocks. Recent studies have consistently found that the announcements of information security breaches (ISBs) are negatively associated with the market values of the announcing firms during the days surrounding the breach announcements. Given the improvement in firms' information environments and the better protection for investors generated by cross-listing, does cross-listing help firms to reduce the negative impacts caused by their announcements of ISBs? This paper conducts an event study of 120 publicly traded firms (among which 25 cross-list and 95 do not), in order to explore the answer. The results indicate that the impact of ISB announcements on a firm's stock prices shows no difference between cross-listing firms and non-cross-listing firms. Cross-listing does not mitigate the impact of ISBs announcement on a firm's market value.

1. Introduction

In the past two decades, globalization has driven the use of online technology and the spread of Internet connectivity around the world (Garg, Curtis, & Halper, 2003). The rapid growth of e-business, built on the Internet, makes information security a great concern for firms (Garg, Curtis, & Halper, 2003; Hovav & D'Arcy, 2003). The Internet offers convenience and business for firms, but security issues can be serious. In a 2006 survey that examined privacy policies of 47 U.S. and E.U. multinational companies, 94 percent of the E.U. companies reported that they had experienced an information security breach (ISB) in the prior three years. That number can be compared with 86 percent of their American counterparts who reported experiencing a similar breach (Cline, 2006).

Firms are usually reluctant to release information about ISBs for fear of embarrassment, increased expense, information provided to competitors and to hackers, the possible dropping of their stock prices and values as well as their profits and dividends, and the diminishment of their customers' confidence in them (Cavusoglu, Mishra, & Raghunathan, 2004; Garg, Curtis, & Halper, 2003; Goel & Shawky, 2009; Gordon & Loeb, 2002; Hoffer & Straub, 1989; Power, 2001; Power, 2003). Recent studies have consistently found that the announcements of ISBs are negatively associated with the market values of the announcing firms during the days surrounding the announcements (e.g., Acquisti, Friedman, & Telang, 2006; Campbell, Gordon, Loeb, & Zhou, 2003; Cavusoglu, Mishra, & Raghunathan, 2004; Garg, Curtis, & Halper, 2003; Goel & Shawky, 2009; Hovav, & D'Arcy, 2003; Kannan, Rees, & Sridhar, 2007; Telang & Wattal, 2007). The decline in market value of breached firms reflects investors' concerns about possible financial damage caused by the announcements of ISBs.



The globalization in the financial markets drives firms to choose to cross-list their stocks on exchanges outside of their domestic markets (Baker, Nofsinger, & Weaver, 2002). Cross-listed firms aim to have higher valuations, a lower cost of capital, and increased liquidity (King & Segal, 2009). By cross-listing, firms can increase their liquidity, since their shares become more accessible to investors (Baker, 1992; Euromoney, 1986; Fanto & Karmel, 1997; Mittoo, 1992; Sarkissian & Schill, 2009). Furthermore, cross-listing can increase investor recognition by widening cross-listed firms' shareholder bases and improving their information environments (Baker, 1992; Euromoney, 1986; Fanto & Karmel, 1997; Merton, 1987; Mittoo, 1992). In addition, cross-listing provides better investor protection (Coffee, 1999; Coffee, 2002; Stulz, 1999). As Doidge, Karolyi, and Stulz (2004) point out, cross-listing helps controlling shareholders commit to limiting their expropriation from minority shareholders and increases the ability of firms to take advantage of growth opportunities. Given the improvement in firms' information environments and the better protection for investors generated by cross-listing, does cross-listing help firms to reduce the negative impact caused by announcements of ISBs? The answer remains unknown. In order to explore the impact of ISBs on the market value of publicly traded firms, this paper conducts an event study of 120 firms which suffered ISBs between 2005 and 2014. Among them, 25 cross-list and 95 do not. The stock prices of these firms are compared between a 120-day pre-event period and a six-day event window. The results show that the impact of an ISB announcement on firm's stock price shows no difference between those firms that have chosen to cross-list those firms that do not cross-list. Cross-listing does not mitigate the impact of the announcement of an ISB on a firm's market value.

The remainder of this paper is organized as follows. Section 2 reviews the relationship between ISBs and firms' value and discusses the benefits of cross-listing. Based on the review, a hypothesis is developed. Section 3 describes the data and methodology, and presents the empirical results of the event study. Section 4 discusses the findings based on the results and concludes the paper.

2. Background and hypothesis development

ISBs and firm value

An ISB is defined as "a malicious attempt to interfere with a company's business and its information" (Cavusoglu, Mishra, & Raghunathan, 2004, p72). ISBs often include theft or modification of computer programs, embezzlement or modification of data, unauthorized use of computer services, purposeful interruption of computer services, unauthorized access to passwords, and destruction of data by computer viruses (Ettredge & Richardson, 2001; Garg, Curtis, & Halper, 2003; Straub, 1990).

Even though firms have gradually realized the importance of information security, making an assessment of the value of information technology security is challenging because of the difficulty of measuring the cost of ISBs (Cavusoglu, Mishra, & Raghunathan, 2004; Garg, Curtis, & Halper, 2003). The costs associated with ISBs include transitory costs, permanent costs, tangible costs, and intangible costs (Cavusoglu, Mishra, & Raghunathan, 2004; Goel & Shawky, 2009). Transitory costs include lost business and decreased productivity due to the unavailability of the breached resources; labor and material costs required to detect, contain, repair, and reconstitute breached resources; costs associated with evidence collection and prosecution of attackers; government sanctions; and the cost (in media coverage) of providing information to customers and to the public (D'Amico, 2000; Garg, Curtis, & Halper, 2003; Goel & Shawky, 2009). In contrast, permanent costs, which can have far-reaching effects on a breached firm's future cash flow, include the loss of customers who switch to competitors, the loss of ability to attract new customers due to perceived poor security, the loss of trust of a firm's customers and business partners, the loss of competitive edge, legal liabilities arising from the breach, the cost of attackers' access to confidential or proprietary information, possible increased insurance costs, and higher capital costs in debt and equity markets (Cavusoglu, Mishra, & Raghunathan, 2004; Goel & Shawky, 2009). Tangible costs include the cost of lost sales, material and labor, and insurance, whereas intangible costs include costs related to trust. ISBs damage customers' trust and confidence about the breached firm. They are harmful for long-term relationship building. Once an ISB occurs,

investors will doubt if a firm is not concerned enough about its customers' privacy and may assume that the firm's internal security practices are poor. They tend to question firms' long-term performance (Cavusoglu, Mishra, & Raghunathan, 2004; Fama, Fisher, Jensen, & Roll, 1969). ISBs also negatively impact investors' expectation of the value of a firm. For example, immediately following the February 2000 denial of service (DOS) attack, Yahoo, eBay, and buy.com lost 15 percent, 24 percent, and 44 percent, respectively, of their market values (Atomic Tangerine).

Recent studies have consistently found that the announcements of ISBs are negatively associated with the market value of the announcing firms during the days surrounding the announcements (e.g., Acquisti, Friedman, & Telang, 2006; Campbell, Gordon, Loeb, & Zhou, 2003; Cavusoglu, Mishra, & Raghunathan, 2004; Garg, Curtis, & Halper, 2003; Goel & Shawky, 2009; Hovav, & D'Arcy, 2003; Kannan, Rees, & Sridhar, 2007; Telang & Wattal, 2007). For example, Campbell, Gordon, Loeb, and Zhou (2003) document that firms which suffer a breach of confidential information have a five percent drop in their market values over a two-day window. Cavusoglu, Mishra, and Raghunathan (2004) find that the breached firms lose 2.1 percent of their market value within two days of the announcement -- an average loss in market capitalization of \$1.65 billion per breach. Garg, Curtis, and Halper (2003) document that firms' market values suffer a decline of nine to fifteen percent if their customers' credit card information is stolen. Telang and Wattal (2007) find that firms lose about 0.6 percent of their market values when the vulnerabilities of their software vendors are reported. Goel and Shawky (2009) find that the announcements of ISBs cause firms to lose one percent of their market values during the days surrounding the announcement. These studies prove that the decline in market value of breached firms reflects investors' concern about the possible financial damage caused by the announcements of ISBs.

Cross-listing

Cross-listing can help firms to increase their liquidity, can increase investor recognition (Merton, 1987), and can improve investor protection (Coffee, 1999; Coffee, 2002; Stulz, 1999). As Sarkissian and Schill (2009) point out, cross-listing helps firms to overcome capital and informational barriers; to gain market characteristics, such as liquidity, tax treatment, disclosure; and to contain the risk of shareholder expropriation.

More specifically, cross-listed firms can get greater media visibility and analysis following (Baker, Nofsinger, & Weaver, 2002; Foerster & Karolyi, 1999; Lang, Lins, & Miller, 2003). In addition, cross-listing makes shares more accessible to investors. As a result, more investors are attracted, and cross-listed firms' shareholder bases become larger (Bancel & Mittoo, 2001; Fanto & Karmel, 1997; Mittoo, 1992). A broader shareholder base brings cross-listed firms higher volume of liquidity. However, the increased liquidity caused by cross-listing is not the focus of this paper. Instead, this paper concerns itself more with the improvement in investor recognition and investor protection generated by cross-listing.

Other than widening a firm's shareholder base, cross-listing enhances a firm's value by improving its information environment (Lang, Lins, & Miller, 2003). As such, investor recognition is increased. As Lang, Lins, and Miller (2003) point out, cross-listed firms are required to provide more disclosure due to greater regulatory and investor scrutiny, disclosure requirements, and potential legal exposure. Pagano, Roell, and Zechner (2002) also argue that the greater information transparency generated by cross-listing increases the willingness of international and local investors to commit capital. In addition, King and Segal (2009) point out that cross-listing increases the quantity and/or quality of information about firms, because it reduces the shadow cost of incomplete information as well as the information asymmetry between controlling and minority shareholders.

Cross-listing provides better investor protection as well. Coffee (1999), Coffee (2002), and Stulz (1999) argue that when firms from a jurisdiction with weaker investor protection of minority shareholders cross-list in a jurisdiction with reputational intermediaries, tougher regulation, and better enforcement, their valuation will increase. Meanwhile, cross-listing is likely to improve firm-level corporate governance because the greater transparency of a firm required by cross-listing might reduce the potential diversion of that firm's cash flow to managers and to controlling shareholders (Coffee,

1998; Stulz, 1999). In addition, Doidge, Karolyi, and Stulz (2004) point out that cross-listing increases the quality and/or the quantity of information available to minority shareholders and limits the expropriation of controlling shareholders from minority shareholders. They further note that cross-listing increases the ability of firms to take advantage of growth opportunities.

These aforementioned studies indicate that increasing the quality and/or the quantity of information available to minority shareholders is a key requirement of cross-listing. The greater information transparency generated by cross-listing is vital to improving investor recognition and investor protection. If this is the case, the market value of cross-listed firms will not be affected by the announcement of ISBs to the same degree as that of non-cross-listed firms. There are two facets to the reason for this: on one hand, information transparency requires cross-listed firms to routinely release reports about their ISBs. Therefore, it is not easy for their investors to be surprised by reports about ISBs in cross-listed firms. In contrast, non-cross-listed firms might not be required to release reports about their ISBs routinely, so their investors may tend to be surprised when receiving reports about their ISBs. On the other hand, the routinely released ISB reports may force cross-listed firms to improve their information system management. As a result, cross-listed firms may eventually suffer fewer and fewer ISBs. Among non-cross-listed firms, however, this trend might not exist. Investors tend to be more concerned about the future information security of these firms. This concern is easy to be magnified by release of ISB reports.

According to the efficient market hypothesis, which asserts that financial markets are informationally efficient, that markets recall to all publicly available information, and that stock prices reflect all publicly available information, all of the present and future effects of a publicly reported ISBs are captured in a firm's stock price (Garg, Curtis, & Halper, 2003). In other words, when a report of an ISB is publicly released, it will be immediately absorbed by investors and incorporated into the firm's stock price (Garg, Curtis, & Halper, 2003). This indicates that in an efficient capital market, the true impact of an event will be quickly and completely reflected in the value of the firm. As such, Goel and Shawky (2009) argue that the impact of ISBs can be measured by observing changes in the market values of firms in response to announcements of ISBs. This leads to the hypothesis of this paper:

H1: *The announcement of ISBs causes a smaller drop in the stock prices of cross-listed firms than in those of non-cross-listed firms.*

3. Data and Methodology

Data on ISBs were collected by searching in the LexisNexis database with the term "information security breaches." The search consisted of all public announcements of ISBs between January 1, 2005 and December 31, 2014. The list of firms that suffered ISBs was compared with the records of data breaches provided by Privacy Rights Clearinghouse (<https://www.privacyrights.org>) for triangulation. The initial list included 515 ISB announcements. Some firms were reported by more than one announcement during this time period. For these repeat-reported firms, only the report of the largest total breached customer record was kept. Next, those ISBs in which fewer than 1000 total customer records were breached were eliminated, given the small impact they would generate. Then, the firms that are not publicly traded were eliminated, and 126 firms remained on the list. After checking the listing status of these 126 firms in LexisNexis, the six without any record were removed. The final sample listed 120 firms (25 cross-listing ones and 95 non-cross-listing ones). Each of the 120 firms is publicly traded either on the New York Stock Exchange (NYSE) or on the NASDAQ stock exchange. Twenty-five of them cross-list on other exchanges, such as London Stock Exchange (LSE), the Toronto Stock Exchange (TSE), and the Italian Stock Exchange (ISE).

Each of the 120 firms was considered as one event. The date of the public announcements of the ISB was the event day. Daily firm information data, which includes date, firm name, ticker, and daily last stock price information, was collected from the Bloomberg database. Summary of the firm-level variable statistics, including market capitalization, market-to-book ratio (M/B), return on assets (ROA), price per earning (P/E), and debt to equity ratio (D/E), are listed in table 1. The estimation period started 120 days before the ISB announcement date and ended one day before the

announcement date. The event window started one day before the announcement date and ended five day after the announcement date. Altogether, this study comprises 120 firm-event observations, each of which contains 125 trading days' information.

Table 1. Firm-level variables summary statistics.

Variable	Mean	Std. Dev.	Min	Max
Market Cap (M)	59173.95	87457.24	168.85	647361.02
M/B	6.29	17.16	-13.99	129.35
ROA	6.63	6.34	0.75	28.3
P/E	40.18	112.46	5.54	1014.67
D/E	219.7	1477.26	-357.61	14397.26

An event study was adopted in order to explore the market reaction surrounding the announcements of ISBs. The market model was applied to estimate normal returns. The event date was set as day 0. The parameters for calculating firms' normal returns were calculated based on firm data from day -121 to day -1 (120 non-holiday trading days before the event window). The equation for normal return estimation is:

$$R_{ijt}^* = \alpha_{ij} + \beta_{ij} R_{mjt}^* + \varepsilon_{it} \quad (1)$$

where $E(\varepsilon_{it}) = 0$ and $Var(\varepsilon_{it}) = \sigma_{\varepsilon_{it}}^2$. R_{ijt}^* is the return of stock i in time t listed in market j . R_{mjt}^* is the market j 's return in time t . ε_{it} is the error term. α_{ij} and β_{ij} are parameters to be estimated by ordinary least squares regression.

An abnormal return was calculated as the difference between the real return of each stock and the expected return of this stock on the same day, based on the parameters gotten from the estimation period, $\hat{\alpha}_{ij}$ and $\hat{\beta}_{ij}$. The abnormal returns for the event window were calculated with:

$$AR_{ijt} = R_{ijt} - \hat{\alpha}_{ij} - \hat{\beta}_{ij} R_{mt} \quad (2)$$

where AR_{ijt} denotes the abnormal return of stock i listed in market j on time t . R_{ijt} and R_{mt} are real returns of stock and market on time t . The cumulative abnormal returns (CARs) were calculated with:

$$CAR_{ij} = \sum_{T_1}^{T_2} AR_{ijt} \quad (3)$$

where T_1 to T_2 is the event window.

Table 2. Cumulative abnormal return (CAR) of cross-listing firms and non-cross-listing firms.

Days	Mean CAR (%)	t	Positive/Negative
<i>Cross-Listing Firms</i>			
(-1,-1)	0.0024	0.256	15/10
(0,0)	-0.0044	-0.3146	12/13
(1,5)	0.0029	0.0369	12/13
(-1,5)	0.0009	0.0091	12/13
<i>Non-Cross-Listing Firms</i>			
(-1,-1)	-0.0008	-0.0986	35/42
(0,0)	-0.0019	-0.1718	31/46
(1,5)	-0.0091	-0.0169	36/41
(-1,5)	-0.0118	-0.0174	33/44

<i>All Firms</i>			
(-1,-1)	-2.90E-05	-0.0117	50/52
(0,0)	-0.0025	-0.2068	43/59
(1,5)	-0.0062	-0.0116	48/54
<u>(-1,5)</u>	<u>-0.0087</u>	<u>-0.1967</u>	<u>45/57</u>

Abnormal returns were computed by using an event study approach. Not all of the 120 selected firms completed data for running event study. Table 2 presents the CAR analysis around the ISB announce date for 25 cross-listing firms and 77 non-cross-listing firms. Results are presented for the windows (-1, -1), (0, 0), (+1, +5) and (-1, +5), where day 0 represents ISB announcement day. The third column is the results of t tests on the cumulative mean abnormal return. The positive/negative column lists the number of firms having positive CARs versus the number of firms having negative CARs in the event window.

The mean of a CAR did not change much throughout the event window across the two groups of firms. In addition, all of the t values were not significant. For cross-listing firms, the number having positive CARs was larger than that of those having negative CARs before the ISB announcement date. However, the ratio reversed on the announce date and continued unchanged for the duration of the event window. In contrast, for non-cross-listing firms, the ratio between firms having positive CARs and those having negative CARs remained the same throughout the event window. And the latter was always bigger than the former.

4. Discussion and conclusion

The small changes of the mean of CAR throughout the event window and a cross the two groups of firms indicate that the announcement of ISB impacted the market value of firms in the same way. Although the means of CAR for cross-listing firms dropped on the ISB announcement day and rose after that day, and the means of CAR for non-cross-listing firms continued to drop throughout the event window; all of the t values are not significant. There is no difference in the impact that the announcement of ISBs had on cross-listing firms and non-cross-listing firms. Therefore, H1 is rejected. Cross-listing does not mitigate the impact of ISBs announcement on firm market value.

However, even though all of the t values were not significant, the numbers of firms having positive CARs was larger than or close to those having negative CARs for cross-listing firms throughout the event window. In contrast, for non-cross-listing firms, the number of firms having negative CARs was always larger than those having positive CARs. What does this difference mean? The answer(s) are not provided in this study. Future research is need to explore the question.

In addition, the ratio between firms having positive CARs and those having negative CARs for cross-listing firms on the day before the ISB announcement day (15/16) was found to be quite different from those of the other days in the event window (12/13). As previous study (e.g. Goel & Shawky, 2009) pointed out, this difference might be caused by insiders leaking information. This introduces a new question: does cross-listing cause more insider leaking information?

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