

## ABSTRACT

Title of Document: TO TELL OR NOT TO TELL: MARKET VALUE OF  
VOLUNTARY DISCLOSURES OF INFORMATION  
SECURITY ACTIVITIES.

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This study measures the economic consequences of information security activities, in general, and more specifically the market value of disclosures of information security activities. Since information security activities are primarily non-revenue generating, management tends to view them as the cost-of-doing-business, with no impact on firm value. Furthermore, managers are reluctant to share the details, because that they do not want to attract the attention of hackers. However, voluntary disclosures of information security can help reduce information asymmetry, which leads to belief revisions by investors, and hence corrects the misspecifications (if any) of the firm's market value. In other words, voluntary disclosures of security

activities are signaling mechanisms. The objective of this dissertation is to develop a taxonomy of disclosures of information security activities, and empirically test the value relevance of such disclosures. Based on a sample of 1,637 disclosing firms, the empirical results provide support for the argument that voluntary disclosures of information security activities are value-relevant. Industry-wide analyses support the disclosure taxonomy developed, and highlight that firms which are technology and data-dependent, have the most impact from these discretionary disclosures of information security activities. These results are robust to various sensitivity checks, including matched-pair design, returns model, and the model that corrects for self-selection bias.

The main contributions of this research are three-fold: 1) it adds to the discretionary disclosure literature by supporting the signaling hypothesis, 2) it adds to the extant literature on value-relevance vis-à-vis the importance of intangible voluntary disclosures, and 3) it adds to the information security literature concerning the value of information security-related activities to organizations. Future directions highlight the rich stream of potential research, based on the dataset collected as a part of this study.

TO TELL OR NOT TO TELL: MARKET VALUE OF VOLUNTARY  
DISCLOSURES OF INFORMATION SECURITY.

By

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## Dedication

To my late mother, Dr. Fahmida Sohail, and my father, Air Commodore (Ret.) Malik Muhammad Sohail. Your love, inspiration, encouragement, and unwavering support were the prime sources of strength and sanity during my studies. The completion of this program and the dissertation would not have been possible without your commitment and encouragement.

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# Table of Contents

Table of Contents .....	iv
List of Tables .....	vii
List of Figures .....	viii
Chapter 1 Introduction.....	1
Chapter 2 Literature Review.....	10
2.1 Computer Security Literature on Information Security .....	11
2.1.1 Technical and Behavioral Research.....	11
2.1.2 Economics Research – Analytical .....	11
2.1.3 Economics Research – Empirical .....	13
2.2 Accounting Literature on Disclosures .....	16
2.2.1 Analytical Research .....	17
2.2.2 Empirical Research.....	18
Chapter 3 Hypothesis.....	24
3.1 Incentives for Voluntary Disclosure .....	24
3.1.1 Signaling or Screening Incentive .....	24
3.1.2 Capital Market Incentives.....	25
3.2 Value-Based Management.....	26
3.3 Mandatory Disclosure Environment.....	27

Chapter 4	Methodology and Data.....	29
4.1	Methodology.....	29
4.1.1	Valuation-Model Limitations.....	33
4.1.2	Value Relevance Model - Current Status.....	36
4.2	Model.....	41
4.3	Controls.....	45
4.4	Sample.....	46
4.4.1	Security Disclosures.....	47
4.4.2	Security Disclosures Taxonomy.....	49
4.4.3	Overall Sample.....	50
Chapter 5	Results and Discussion.....	56
5.1	Disclosure Characteristics.....	56
5.2	Industry-Wide Disclosure Characteristics.....	57
5.3	Descriptive Statistics.....	58
5.4	Main Results.....	59
5.5	Year-to-Year Results.....	62
5.6	Industry-Wide Results.....	63
5.7	Discussion.....	65
Chapter 6	Robustness Analysis.....	69
6.1	Additional Proxies Check- Size and Abnormal Earnings.....	69
6.2	Returns Model.....	69
6.3	Matched-Pair Analysis.....	73



6.4	Industry-Wide Returns Model .....	75
6.5	Disclosures Endogeneity.....	76
Chapter 7 Conclusions, Limitations and Future Direction .....		82
7.1	Contribution .....	82
7.2	Future (Post-Dissertation) Directions .....	83
7.3	Limitations .....	84
7.4	Conclusion .....	87
Appendix Example of Disclosures of Security Activities .....		90
	Actual Security Breach .....	90
	Proactive Security Measures.....	91
	Potential Vulnerability .....	92
Bibliography .....		123

## List of Tables

Table 1	Listing of Keywords used for Annual Filings .....	93
Table 2	Summary of Sample Selection Process .....	94
Table 3	Fama French Industry Classification for Two Digit SIC Codes.....	95
Table 4	Summary of Disclosures.....	97
Table 5	Summary of Disclosures by Industry.....	98
Table 6	Descriptive Statistics.....	100
Table 7	Correlation Matrix for the Variables .....	102
Table 8	Pooled Cross-sectional Stock Price Regression on Disclosure Proxies .....	104
Table 9	Cross-sectional Stock Price Regression by Years on Disclosures Proxies	105
Table 10	Pooled Stock Price Regression by Industry on Disclosures Proxies .....	107
Table 11	Pooled Cross-sectional Stock Returns Regression on Disclosure Proxies	110
Table 12	Pooled Cross-sectional Matched-Pair Stock Price Regression on Disclosure Proxies .....	111
Table 13	Pooled Cross-sectional Matched-Pair Stock Returns Regression on Disclosure Proxies.....	112
Table 14	Pooled Stock Return Regression by Industry on Disclosures Proxies.....	113
Table 15	Treatment Regression of Stock Price on Disclosure Proxies .....	116

## List of Figures

Figure 1	Number of Disclosures by Years.....	118
Figure 2	Types of Disclosures by Years .....	119
Figure 3	Percentage of Types of Disclosures by Year.....	120
Figure 4	Number of Disclosures by Types of Filers by Year .....	121
Figure 5	Percentage of Disclosures by Types of Filers by Year.....	122

# Chapter 1

## Introduction

Increased interconnectivity among computers enabled by networking technologies, in particular the Internet, has dramatically increased the scale and scope of information technology (IT) related crimes. Specifically, as E-commerce continues to grow, so does cyber-related crime. One of the reasons why cyber-crimes increase, is the fact that companies need to 'open' their IT assets to their supply chain participants, such as vendors and/or customers in order to garner the benefits of enhanced computerization and connectivity. However, by allowing online (real time) access, the organizations are providing potential entry points that can then be used against the firm for malicious activities; in other words, firms are now more vulnerable to information security breaches. Previously, where the only concern was the 'trusted' employee who might cause harm, now firms have to deal with unknown outside threats as well. These reasons are forcing the firm to view information security from an entirely new perspective. Whereas IT security was once considered an overhead, it is now being viewed as an important part of daily business operations (Cagnemi 2001).

In the 'new-economy,' 'information' in various forms like trademarks, proprietary software, patents, trade secrets, customized expert systems, and in-house databases, is considered an asset that provides the firm its competitive advantage. Accordingly, the need to protect information has become all the more critical for a successful firm operation. Consequently, under increased vulnerability with a

potential of substantial economic/reputation loss, the need for development and enforcement of internal controls becomes all the more critical (Gordon and Loeb 2002a). That is, firms are continuously in pursuit of protecting their proprietary information (confidentiality), preserving integrity of their databases (integrity), and ensuring information access to authorized users (access control). Broadly stated, these three activities are defined to construe information security of a firm.

On the other hand, information security product vendors are experiencing a bonanza. By capitalizing on the media frenzy of security breaches, these vendors are continuously trying to sell high-priced products. The firms are in a dilemma. Should they spend more on information security technology (knowing that these investments have unproven return on investment's), or alternatively (without extra investment) what is the best way to secure their information assets? Further compounding the issue is the fact that security-related investments are primarily non-revenue generating. In other words, there is no positive outcome (at least not readily) available for reporting or comparison. More to the point, "the more successful the [security] project, the less likely you are to see breaches [outcomes]" (Gordon and Loeb 2002b, p. 30). Hence, it becomes very difficult, if not impossible, for organizations to quantify benefits. Although not the focus of this dissertation, information security activities could generate revenue by providing a competitive advantage for a firm (see e.g., Gordon and Loeb 2003). Furthermore, a recent survey of the state of information security by Berinato and Ware (2003), shows that companies that had spent more in security were as likely to experience a breach as the

firms that had spent less. Thus, with such conflicting issues, managers are not sure what to do.

The importance of information security is further highlighted by the 2005 survey of the Computer Security Institute (CSI) and Federal Bureau of Investigation (FBI). The CSI/FBI survey reported that 56% of respondents detected an unauthorized use of their computer system within the last year, and the average estimated loss (for organizations that provided estimates) was over US\$ 200,000. However, over the previous year – 2004, the average losses per firm declined substantially by 61% (Gordon et al. 2005). Moreover, for the year 2005, despite the overall decrease in losses for unauthorized access and theft of information categories, the average losses per respondent increased dramatically to US\$ 303,234 and US\$ 355,552, respectively. However, the survey cautions that “the difficulty in interpreting [the] overall downward trend is compounded by the difficulty of accurately measuring the implicit costs of losses associated with certain crimes” (Gordon et al. 2005, p. 15). Interestingly, 95% of the reporting organizations claimed that they have experienced more than 10 website security breach incidents. In a Wall Street Journal Special Report on workplace security, 82% of the firms detected a virus attack where the prime source of these viruses was email attachments (86%) that caused an estimated financial loss of about US\$ 27 million (Wall Street Journal 2003, p. R3).

The CSI/FBI survey (Gordon et al. 2005) also notes that the top two reasons cited by organizations not to disclose security breach are that the negative publicity of the intrusion would hurt the stock price, and that the competitors would use the

breach information to their advantage. The fear of negative stock market reaction was corroborated by a recent study by Campbell et al. (2003), where the authors empirically shows that there is a significant negative market reaction (reduced stock prices) for firms that suffer a security breach (specifically if the breach is of a confidential nature) by as much as 5%. Therefore, it seems that companies that are experiencing security intrusions (even though they have taken effective steps to mitigate the problem) are not comfortable in sharing the details about information security breaches.

Casey (2004) states the interesting point that it seems unfair to punish the organizations that have already experienced a security breach. However, he goes on to point out that it is a credibility issue with the organizations who remain silent after experiencing a security incident, because of significant costs that might accrue to the people whose information is compromised (identify theft). Additionally, customers might indirectly be affected as well, since they would bear the increased cost of doing business with such organizations that would try to recuperate these losses. As such, the general ethical recourse should be to share the security breach information.

As for disclosing an organization's security activities and/or measures, the senior managers face a paradox. If they report that they are concerned about security and disclose flaws that they may have, or if they release that the organization is secure with all the possible safeguards in place, then they are setting themselves up for a security attack in either situation. Gordon et al. (2003) explore the dynamics of security information sharing alliances. Using an analytical economic model, Gordon et al. show that firms would be better off sharing security-related information.

Nevertheless, they caution that for information sharing to happen, economic incentives have to be established, otherwise participants would tend to free-ride as opposed to contribute information. Lack of economic incentives, restrains the firm to be the first mover in the information-sharing alliance. Therefore, the management is living by the old World War II mantra of “Loose lips sink ships” where the general strategy is to be quiet.

Nevertheless, security breaches are on the rise. In the year 2005 alone “Privacy Rights Clearing House,” a privacy rights group, documented that between February 15, 2005 — when the ChoicePoint incident came to attention — to May 22, 2006 over 81 million records have been compromised (*A Chronology of Data Breaches Reported since the Choicepoint Incident 2006*). The list of companies that have experienced a security incident includes firms like Citigroup, Bank of America, Ameritrade, DSW, Lexis Nexus, Polo Ralph Lauren, and even the United States Air Force. The list of firms showed that both personal and financial information of customers have been compromised.

One consequence of increased security breaches is that it has spurred the law makers to introduce a variety legislation similar to the existing California Law SB-1386 (*Security Breach Information Act 2002*) to mandate security breaches reporting. This is in addition to the fact that over half the states have recently been enacting similar laws<sup>1</sup>. Both the House and Senate (U.S. Congress) have introduced various bills that among others includes “Consumer Data Security and Notification Act” (HR. 3140 - Bean), “Information Protection and Security Act” (S. 500 Nelson), “Personal

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<sup>1</sup> For a comprehensive list of state enacted laws see <http://www.privacyrights.org/ar/ChronDataBreaches.htm#CP>



Data Privacy and Security Act” (S 1789 - Specter), “Comprehensive Identity Theft Prevention Act” (S. 768 - Schumer) and “Identity Theft Protection Act” (S 1408 - Smith).

The aforementioned legislation, if approved, would further burden the organizations that are already facing various compliance issues under the Gramm-Leach-Bliley Act (GLB - 1999), Health Insurance Portability and Accountability Act (HIPPA - 1996), and most recently Sarbanes-Oxley Act (SOX - 2002). Most specifically, under SOX section 404, companies need to not only establish, maintain, and report the ‘internal controls,’ but these internal control are to be audited annually, and any material deficiency are to be reported. Even though SOX deals specifically with establishing internal controls only for financial reporting, the majority of organizations rely on computers for their financial reports. Hence, internal controls, if not directly, then for sure indirectly, (see e.g., Nearon et al. 2005), are about implementing information security measures. Gordon et al. (2005) also documents that in about eight out of 14 industry segments, SOX has an impact on security activities.

The discussion above, underscores the following question of interest: *Would voluntary reporting of security disclosures have an economic impact on firms’ market value?* That is, would the market value the discretionary disclosures of information security? Simply stated, the objective of this dissertation is to assess the market value of firms’ voluntary disclosures of information security activities. It is important to note that this research attempts to account for all voluntary disclosures of information security related activities (i.e., proactive security measures, potential vulnerabilities,

and actual security breaches—see section 4.4 for details) as opposed to previous studies, such as Campbell et al. (2003) that focus specifically on the affects of an actual security breach on a firm’s market value.

To investigate the question of market value of voluntary disclosures, I relied on the accounting literature of discretionary disclosures which operates on a maintained assumption that managers possess superior information (Healy and Palepu 2001). If the information is such that it would imply a firm value larger than those assessed by the market, the manager would provide credible disclosures so that the firm market value is revised upwards (Milgrom 1981; Grossman 1981; Lev and Penman 1990). That is, managers ‘signal’ their superior information; and one of the mechanism for conveying information is annual filings (Healy and Palepu 1995). Previous research in accounting has consistently documented the market consequences of voluntary disclosures that include increased stock liquidity, reduced cost of capital, reduced cost of debt, improved intermediations, and increased stock prices through non-financial disclosures (see e.g., Amir and Lev 1996; Botosan 1997; Botosan and Plumlee 2002; Sengupta 1998; Healy et al. 1999; Lang and Lundholm 1996b, 2000). Thus, I hypothesize that discretionary disclosures of security-related activities would be positively related to stock price.

Information security-related data is notoriously hard to obtain, in fact, Kotulic and Clark (2004) documents that information security data is the “most intrusive” type of organizational research, and recommends against using surveys. Thus, one contribution of this research is identifying a public data source of information security activities. Using twenty-four keywords, data was collected for all public filers that

disclosed security activities in their annual filings for the five years between the years 2000-04. To better understand the ‘type’ of information being disclosed, a taxonomy of security disclosures was proposed that categorizes security disclosures as either “proactive security measures,” “potential vulnerability,” or “actual security breach.” The final sample consists of 1,637 firms-years that provided one of these types of security disclosure. One advantage of conducting keyword searches over “all” the annual filers is that the non-disclosing firms can then be used as a potential natural control. Thus, the final sample for analysis was 21,120 (1,637 disclosing and 19,483 non-disclosing) firm-years.

Empirical analysis of value-relevance of voluntary disclosures of information security activities to equity market value was conducted using established accounting methodology of “value-relevance” models<sup>2</sup> (Barth 2000; Barth and Clinch 2005). Using price-levels cross-sectional pooled regressions (Kothari and Zimmerman 1995), the results provided empirical support that security disclosures are significantly and positively related to firm value. These findings were robust to year-to-year and industry-wide analyses. Additionally, industry-wide analyses provided evidence that, in general, the disclosure indicator variable is capturing the effect of security activities and not just “high disclosers,” thereby mitigating proxy (measurement) bias. Additional robustness checks using returns model, matched-pair design, and self-selection control model, supports the main finding of the study.

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<sup>2</sup> Value relevance methodology is an empirical analysis associating a dependent variable (usually stock price) with various explanatory variables. Other methodologies employed include ‘event-studies’ (e.g., Campbell et al. 2003), where the focus is to isolate the affect of an event at a particular time.

The contribution of the research is as follows: it adds to the voluntary disclosures argument by providing support for the signaling argument that manager would disclose information to revise investors' beliefs in a manner consistent with increasing firm value. The study also contributes to the extant literature of value-relevance by providing support for intangible discretionary disclosures. Furthermore, managerial implications of the study are that firms should disclose the firm's current activities in the information security arena, as the market values it.

The remainder of the dissertation is organized as follows: literature review is provided in Chapter 2, while Chapter 3 develops the hypothesis. In Chapter 4, methodology and sample selection is discussed, while Chapter 5 details the results and discussion. Robustness analysis and sensitivity checks are discussed in Chapter 6, and Chapter 7 presents conclusions, limitations, and future directions.

## Chapter 2

### Literature Review

This dissertation proposal draws on two main streams of research: first, the computer science related research addressing information security issues from technical, behavioral, and economics viewpoint; and second, the body of literature in accounting that addresses the issue of disclosures.

Even though information security is a relatively new field, computer science has a mature body of literature on computer security that deals mostly with technical issues. The research on economics of information security, even though growing, is sparse. Researchers are mostly exploring basic questions that pertain to technology i.e., how can the technology (security algorithms efficiency) be improved to increase the security levels, or how can intrusion detection systems be made effective using cost based algorithms (Lee et al. 2002). In addition, another area of interest in the Information Technology (IT) field is exploring the fact that it might just not simply be the technology, but rather the “right” usage of existing resources by people that might be detrimental in protecting information assets. Especially, for IT security, Schultz et al. (2001, p. 621) underscores that “users are ... the weak link in information security” and “many (if not most) security-related controls rely on individuals to implement and deploy”. Nevertheless, there is a shift, where the focus is now towards the “economics of information security”. In other words, the main question of interest is the optimal level of security investment levels, information sharing, and firm costs of security breaches.

Compared to the economics information security research in computer science, accounting has a mature stream of literature for disclosures, especially for voluntary disclosures. The main focal point of disclosures stream is voluntary disclosure of financial information like earnings guidance or management forecasts, and the manager's motivations for such disclosures. This stream of literature contains both analytical models and empirical studies, and is discussed in detail below.

## **2.1 Computer Security Literature on Information Security**

### **2.1.1 Technical and Behavioral Research**

The majority of the research on Information Security (IS) is done to analyze the security issues from a technology perspective, and is carried out by the researchers in computer science and engineering fields. These streams of research focus on the technical design issues (e.g., encryption, public key infrastructure, access controls, and firewalls) with an expectation of reducing the frequency of security breaches (see for e.g., Sandhu et al. 1996; Denning and Branstad 1996; Simmons 1994). In addition, academicians specializing in management issues concentrate on the behavioral aspects of preventing IS breaches (e.g., Straub and Welke 1998; Straub 1990). Especially Straub (1990), using 'general deterrence theory' framework, provides empirical support for the fact the firms that use preventive information security software and institute security polices reduce computer abuse.

### **2.1.2 Economics Research – Analytical**

In contrast, research using economic aspects of information security is rather limited. Anderson (2001) provides an interesting outlook for information security

using economic concepts. The author suggests that barring technology constraints, the “information insecurity is due to perverse economic incentives.” Anderson proposes that the issue should be re-evaluated using economic concepts like information asymmetry, network externalities, and liability dumping. However, the paper is mostly a conceptual discussion without any analytical or empirical results.

One notable exception is the recent paper by Gordon and Loeb (2002a), where the authors propose an economic model to determine the optimal investment in IS. The most interesting finding of the paper is that for a single constant threat, the optimal amount of security investment may or may not be an increasing function of the vulnerability. In fact, for two classes of security breach functions, the optimal amount to spend to information security never exceeds 37% of the expected loss from a breach. However, the paper does not address the varying “expert” levels of the hackers that might incur a loss. It also assumes that the security breach function is known, i.e., the various parameters and their functional forms are known beforehand.

In a game theoretic approach, Schechter and Michael (2003) develop a model where an organization can gauge its attractiveness to thieves and determine the level of security for packaged systems. Under varying conditions of attack, the authors show that the firm would benefit substantially by increasing the probability of detection and/or the probability of repelling (failed) hacker attack, and by increasing the likelihood of (hacker) convictions. However, the study is again based on the assumption that organizations can and/or have developed the estimates for these probabilities, or at the least have their internal cost estimates of these security breaches.

Gordon, Loeb and Lucyshyn (2003) is one of the first papers in the accounting literature that deals with the organization investments in information security in an information sharing environment. Using an analytical model, the authors evaluate the welfare economic implications of sharing information. The model supports the proven economic result that in the absence of information sharing, each firm sets its own information security expenditures at a level where its marginal benefits equal its marginal costs. Gordon et. al. (2003) shows that when information is shared, each firm reduces the amount spent on information security activities, however, the level of information security is increased. That is, the level of information security that would be optimal for a firm in the absence of information sharing, could be attained by the firm at reduced investment when computer security information is shared. Overall, sharing provides benefits to each firm/ and the total welfare also increases. However, the paper goes on to detail that if appropriate incentive mechanisms are absent, then each firm will attempt to free ride on the security investment of other firms resulting in underinvestment of information security. As such the paper suggests that it is imperative to establish appropriate incentive mechanisms to not only increase firm-level profits, but to also enhance the social welfare realized from information sharing arrangements.

### **2.1.3 Economics Research – Empirical**

Empirical research for information security currently is very limited mostly because of the fact that it is very hard, if not nearly impossible, to get public data. Mostly the data has to be collected using surveys. However, even then the firms are very reluctant to provide the data. In this vein, Kotulic and Clark (2004) details in



their paper titled “Why There aren’t More Information Security Research Studies” their experience in trying to collect security-related information. The authors propose a conceptual model for testing the overall success of information security risk management program at the firm level. Drawing heavily on previous theoretical background on information systems success factors, the model identifies organizational characteristics, management characteristics, and executive level support as drivers of the overall security risk management program. However, for empirical estimation, the paper relies on surveys. To gather all the requisite information, 1474 packages (each including 4 questionnaires, ( Kotulic and Clark 2004, p. 603)) were sent. However, the response rate was only 1.6% (23 firms) and only 9 firms (0.61% response rate) completed all four of the questionnaires, making it impossible to conduct any parametric or non-parametric tests. In a follow up, the authors determined that one of the top four reasons for a firm’s non-response was due to the “company policy for not disclosing computer security policy with outsiders” (Kotulic and Clark 2004, p. 604). Overall, the paper’s recommendation is that information security research is “one of the most intrusive” type of organizational research.

Campbell, Gordon, Loeb and Zhou (2003) conducted an event study, the first of its kind, to empirically test market reaction to announcements of security breaches. The study used keywords like “information security breach,” “computer system security,” “hacker,” “cyber attack,” and “computer break-in” to search five newspapers (*Wall Street Journal*, *USA Today*, *Washington Post*, *New York Times*, *Financial Times*) for the time period January 1995 to December 2000. The final

sample consisted of 43 events for 38 firms. Using the event study methodology (short window), daily returns over a three-day period are estimated. Overall, the paper does not find any significant market reaction for all the security breaches events. However, when the events are partitioned between two groups of confidentiality and non-confidentiality, the results are statistically significant, with an economic implication of as much as 5 percent reduction in stock price.

One of latest empirical study regarding information security was done using Japanese e-local government data by Tanaka et al. (2005). The authors in this study attempt to provide empirical support for the Gordon and Loeb (2002a) information security investment finding i.e., investment in security is contingent on the vulnerabilities faced by a firm. For a sample of 3,162 local municipalities that included cities, towns and villages involved in e-government initiatives, the authors gathered their information technology expenditures as well as information regarding security policies of the units. One of the unique features of data was the fact that various local governments were in different stages of technology implementation, which allowed the authors to classify the vulnerability of various systems into three groups: high (highly interconnected – inter-governmental network), medium-high (regional network), and low (closed network). The main result of the research provides partial support to the theoretical argument that information security investment is conditional on the vulnerabilities faced by an organization. However, it must be noted that since actual information security expenditure was not available, the authors used the assumption that if a firm has an information security policy, then they must be spending more on information security.

## 2.2 Accounting Literature on Disclosures

Both theoretical and empirical studies on disclosures abound in accounting (see e.g., Healy and Palepu 2001; and Verrecchia 2001, summary papers for a good discussion) where the focus is on the informational role of the disclosures of financial reporting for capital markets. Although the Securities and Exchange Commission (SEC) provides guidelines and legislates the information that a public company must disclose i.e., mandatory reporting, the disclosure literature in accounting relates to discretionary (voluntary) disclosures. For the purpose of this report, voluntary disclosures, discretionary disclosures and disclosures were used interchangeably to mean information that management releases itself.

The underlying assumption in all the voluntary disclosure research is that managers possess superior information to all the outsiders, even if everyone are operating in an efficient market, about the expected future performance. If the auditing and other regulations mandating reporting were perfect, there would not be any need for voluntary disclosures. Thus, managers trade-off between making accounting choices and providing disclosures to “communicate their superior knowledge of a firm’s performance to investors, and to manage reported performance for contracting, political or corporate governance reasons” (Healy and Palepu 2001, p. 420). Under such a scenario, the motives of managers making voluntary disclosures and their credibility are questions of interest. For the former, researchers have put forward six motives: 1) Capital market transaction hypothesis; 2) Corporate control content; 3) Stock compensation; 4) Litigation costs; 5) Management talent signaling; and 6) Proprietary costs.

Under the credibility of voluntary disclosure, much of the empirical evidence focuses on accuracy and stock price effects of management forecasts. Pownall and Waymire (1989) find that market reaction to unexpected management forecasts is similar to unexpected earnings, suggesting that management forecasts have similar credibility as audited financial information. Additionally, other information like market population size and market penetration (of wireless industry) has also been shown to be more significant than financial information (Amir and Lev 1996).

The theoretical papers, under the maintained hypothesis of proprietary cost, are most concerned with what types of disclosures might occur (Healy and Palepu 2001). On the other hand, the empirical studies are more focused on identifying the determinants of increased disclosure (Lang and Lundholm 1993, 1996b); investigating why firms would like to disclose ‘bad news’ (Skinner 1997, 1994); and evaluating the effect of increased disclosures on the cost of capital, both equity and debt (Botosan 1997; Botosan and Plumlee 2002; Sengupta 1998).

### **2.2.1 Analytical Research**

Most of the theoretical studies of voluntary disclosure, assuming credible disclosures and zero disclosure costs, suggest full disclosure of information will occur due to investors’ belief that non-disclosing firms have the worst possible information (Grossman 1981; Milgrom 1981). However, in the presence of fixed positive disclosure costs, only firms whose information implies economic benefits above these costs will disclose (Verrecchia 1983). In addition, a firm’s decision to disclose information to investors is influenced by the fact that such disclosures would also provide information to its competitors i.e., there is a proprietary cost of disclosure as

well (Darrough and Stoughton 1990; Verrecchia 1983; Gigler 1994; Darrough 1993; Wagenhofer 1990). Additionally, another assumption underlying all these studies is that there is no conflict of interest among the managers and shareholders, and that the motivations of disclosing purely arise out of economic forces due to the presence of competitors. These studies show that it is not in the firm's interest to disclose information, or alternatively that the disclosures are constrained. However, Gigler (1994) using "cheap talk" model and Sujis (2005) using the Wagenhofer model (1990), which incorporates three players (firm, competitor and financial markets), demonstrates that under certain conditions, partial equilibrium would exist where it is in the firm's interest to disclose information even if it is not good. That is, the equilibrium choice of not disclosing bad information is contingent on the incentives faced by the firm in terms of competition. Interestingly, in a recent study by Einhorn (2005), the author classifies the voluntary disclosure strategies of a firm in relation to its mandatory disclosure environment. The main finding of the paper is that the probability of voluntary disclosure is independent of the content of their mandatory disclosure, positively related to the scope of disclosing requirements, and negatively related to the level of discretion in mandatory disclosure. Overall, research suggests that in addition to firm-related incentives, the mandatory reporting environment also plays a crucial role in its voluntary disclosures.

### **2.2.2 Empirical Research**

Most of the empirical research in the voluntary disclosure line of literature is focused around either the capital market transaction, or the litigation cost hypothesis. One of the most seminal papers in the empirical line of research for voluntary

disclosures is the Lang and Lundholm paper titled “Cross-Sectional Determinants of Analyst Ratings of Corporate Disclosures” (1993). Lang and Lundholm take the disclosure ratings of the analysts as published in the Reports of the Financial Analyst Federation Corporate Information Committee (FAF Reports). For a sample of 2,272 firms, the authors investigate three measures of disclosures ratings i.e., for annual reports, ‘other publications,’ and investor relations. Using market-adjusted stock returns and its standard deviation; one time period lead-lag of deviation from analyst forecasts; and market value of equity, their study provides evidence that disclosures are increasing in firm size, and in firm performance as measures by earnings and return variables; decreasing in the correlation between earnings and returns and higher for firms issuing securities.

To empirically test the effect of signaling hypothesis, Lev and Penman (1990) use managerial earnings forecast to test if these forecasts help managers to screen themselves out from other firms. The papers test two hypotheses: first, that firms that disclose positive information will have an upward revision in their price, and consequently the second issue of interest is that for the non-disclosing firms, the market should penalize them by revising the stock price downwards. The study used a sample of 3,420 corporate forecasts of annual earnings for 1968-75 by a page-by-page reading of the Wall Street Journal. This sample also included qualitative versus quantitative forecasts. Using a matched-pair firm design, the paper tested the hypotheses for return residuals, and annual cumulative returns across the forecasting and non-forecasting firms. Overall, even though the paper does provide support that firm would use ‘positive’ news to screen themselves out, the conjecture that ‘silent’

firms are punished is not supported. Additionally, the paper does find that on average the firms does good news more often there are many instances of decreased earnings forecasts as well, that do tend to reduce the stock price. However, the surprising finding is that the market does not punish non-disclosing firms, but rather the effect on the non-disclosing firms is generally in the same direction as the disclosing firm.

Skinner (1994) further investigates the reasons of why firms would like to disclose bad news voluntarily, specifically if such a disclosure reduced the firm's value. He observes that even though good news information tends to be more specific, bad news tends to be more qualitative; however, the unconditional stock price reaction to bad news is much larger than the response to good news. The paper uses a ten-year period of 1981-90, and identifies 93 firms on the NASDAQ that provided voluntary disclosures before it is required by law. Since NASDAQ firms during this time-period mainly consisted of smaller and younger firms, the analyst following was relatively less. Also, these firms were likely to experience large shocks of earnings that might lead to securities lawsuits, and last but not least, these voluntary disclosures are valuable means of communication. The overall, finding of the paper is that managers "face an asymmetric loss function...[i.e.,] managers behave as if they bear large costs when investors are surprised by large negative earnings surprises" (Skinner 1994, p. 39). Thus, managers might disclose since they may get sued or because they incur reputational costs.

Botosan (1997) in an another seminal research studied the effect of improved disclosures on the cost of equity capital providing empirical support for the theoretical result of negative associations between disclosure level and cost of equity

capital. Using a sample of 122 manufacturing firms, a disclosures measure was developed based on the amount of voluntary disclosure provided in the 1990 annual reports. The association between level of disclosures and the cost of equity capital was examined by regressing firm-specific estimates of cost of equity capital on the self-constructed measure of disclosure level, while controlling for firm-specific variables like firm beta and size. The main findings of the study was that for firms that have a low analyst following (generally small), greater disclosure was associated with a lower cost of equity capital. However, for firms with a high analyst following, there was no evidence of an association between level of disclosure and cost of equity capital. Botosan concluded that the lack of evidence in the high analyst following firms could be attributed to the fact that the self-created disclosure measure was limited to the annual report, and might not be a powerful proxy for overall disclosure level, especially where analysts have a significant role in disseminating information.

Further expanding the literature on voluntary disclosures, Healy et al. (1999) investigates the effects on expanded disclosures on changes in capital market factors associated with increases in analyst disclosure. By using a “time-series approach,” the paper provides support that firms with ‘sustained improvements’ in disclosures, experience an improved stock performance and capital market intermediation i.e., increased institutional interest. They use a sample of firms that made sustained and materially significant improvements in their disclosures over the 1978-91 timeframe. Using the same database as Lang and Lundholm (1993) , which covered about 1,044 firms in 38 industries, the authors identified 97 firms for the years 1978-91 that met with their sample criteria. The main findings of the paper provided support that firms



with increased disclosures are accompanied with firms' stock returns, institutional ownership, analyst following and stock liquidity.

Sengupta (1998) extends the voluntary disclosure literature by investigating the relationship of disclosures and firms cost of debt. His model uses disclosure as an explanatory variable along with control variables to examine the association. The sample size of the study is around 100 individual firms over the 1987-91 timeframe. The small sample size is due to the fact that the main research questions was to explain the cross-sectional variation in the cost of debt, and using firm-year (i.e., following multiple firms across years) observations might bias the t-values due to autocorrelation. Using two proxies for cost of debt, yield to maturity and effective interest cost to the issuer, Sengupta documents a significant negative relationship between extended disclosures and cost of debt after controlling debt, and firm characteristics. These findings provide support for the argument that lenders and underwriters account for a firm's disclosure quality in the risk estimates. Additionally, the paper also documents that there is a greater reliance on disclosures when the uncertainty (stock volatility) surrounding a firm is higher. Overall, the increased disclosures not only affect the cost of equity capital but debt as well.

Finally, Bhojraj et al. (2004) in a recent paper, attempts to empirically test the theoretical argument that firms, for strategic reason (product market), might choose not to disclose information. The paper identified 81 electric utilities that were going through deregulation during 1996-97 and were facing conflicting demands for their disclosures requirements since they had to cater to at least three diverse audiences: the regulators, capital market participants, and product market competitors. The

authors constructed an overall disclosure measure on two broad issues: plans to deal with new risks (keep the current customer base intact); and plans to exploit new emerging opportunities in the industry (increase competition). They used annual reports and 10-K filings<sup>3</sup> to identify “qualitative” disclosures that were accordingly dummy coded as 1 if the disclosure was firm-specific regarding strategy to expand or steps to preserve the existing customer base, and 0 otherwise. A “total disclosure” measure was constructed across the two years 1996-97, which was also disaggregated into two sub-categories. The first sub-group specifically dealt with disclosures of plans to protect revenues while the second related to steps for exploiting new opportunities. In the research design, appropriate controls were added to account for real economic difference among the firms as well, and firm-specific variables that might influence the disclosing choices of the firms. Overall, the paper provides evidence that types of voluntary disclosures are conditional on the target audience i.e., according to the firm’s incentives. Firms that were waiting for regulators to establish cost-recovery methods were inclined to provide less disclosure, consistent with the incentive to appear vulnerable. On the other hand, voluntary disclosures of strategic nature that exploited the new available opportunities to the firms were sharply increased after the regulatory concern abated. However, these disclosures were “dampened” when there was competition, therefore providing support for the theoretical notion to ‘hold information’ in product market competition. Finally, disclosures regarding plans to protect revenue base are motivated for reducing uncertainty about survival under deregulation, consistent with capital-market reasons.

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<sup>3</sup> 10-K is the official filing that a firm has to provide to Securities and Exchange Commission as opposed to the annual report, which primarily is for investors.

## **Chapter 3**

### **Hypothesis**

#### **3.1 Incentives for Voluntary Disclosure**

Accounting literature has been interested in voluntary disclosures of information from managers, and considerable work has been done in identifying various conditions under which manager might or might not be willing to disclose (see Verrecchia 2001; Healy and Palepu 2001; Dye 2001 for summaries of empirical and theoretical literature on corporate voluntary disclosures). Accordingly, my analysis is based on the theoretical and empirical analyses of corporate disclosures that assume management can have value-relevant private information about a firm's prospect. This information is not available to market participants (i.e., the information is private), thus the information is not reflected in the firm's stock prices. Therefore, this private information provides an opportunity for management to voluntarily disclose information to reduce information asymmetry between the investors and management, thus potentially influencing the stock price.

##### **3.1.1 Signaling or Screening Incentive**

Building on the Akerlof (1970) 'market for lemons model,' "signaling" or "screening" rationales are proposed as strong motivation for disclosures (Milgrom 1981; Grossman 1981; Verrecchia 1983). Under such a scenario, managers with private information that implies larger firm values than what is assessed by the market, will credibly disclose that information such that the prices are revised upwards. Accordingly, managers that have information that implies firm values

below market estimates, will withhold that information. However, the “silent” firms are identified by investors as having less than average values, and will further revise the stock prices downwards i.e., no news is bad news. This downward revision of the non-disclosing firms will in turn compel the firms within the group with good news to disclose (relative to the recently decreased valuations) in order to ‘screen’ themselves out of the group (of the non-disclosing firms). Thus, one way to look at voluntary disclosure is that firms can use it as a signaling or screening device to distance itself from other companies.

### **3.1.2 Capital Market Incentives**

Beyond the signaling advantage, the accounting literature also underscores capital-market benefits as one of the reasons for firms to expand disclosures. Verrecchia (1983; 1990) shows that even when the disclosure is costly – under product market consequences – managers may still choose to enhance their reporting to correct undervaluation. However, it is instructive to note that in these studies there is no agency conflict assumption i.e., the interest of the managers and investors are aligned. Consequently, investors can be confident that any voluntary disclosures are ‘truthful,’ and therefore credible signals. The negative relation between the cost of capital and disclosure (Botosan 1997), and debt and expanded disclosures (Sengupta 1998) are clear indications of managers committing to a policy of prompt disclosure of news. Furthermore, expanded disclosures can also “improve intermediation for a firm’s stock” (Healy et al. 1999, p. 497) by reducing information asymmetries between the outsider and manager, which in turn help improve the liquidity in a

firm's stock prices, and makes it more attractive, at least for the institutional investors.

### **3.2 Value-Based Management**

According to Ittner and Larcker (2001), accounting practices and research is at the stage where controls and procedures are being designed and implemented to move management's focus away from a strict concentration on planning and control. Currently, the emphasis is towards: waste-reduction; increased oversight to encompass a more strategic emphasis on the creation of firm-value through identification, measurement, and management of the drivers of customer value; and organization innovation that ultimately increase the shareholder return. As Ittner and Larcker points out, the hallmark of this era is the introduction of a diverse set of 'new' managerial accounting techniques that are concentrating on value creation. This comprehensive set of measures is what is termed as a value-based management framework or procedures that ensure management is operating in a manner to maximize stakeholder value. Thus, proper utilization and protection of the organization's assets will not only assist the firm attain its strategic goal "differentiator" or "cost leader," but will also generate value for its stakeholders.

Under the value creation paradigm (Ittner and Larcker 2001), firms are interested in operational and strategic expenditures that in one way or another create 'firm value.' Therefore, the main issue of interest is to investigate the market impacts of information security activities on a firm. Assuming that the market value maximization hypothesis holds, and that managers will invest only in those forms of information security activities that accrue positive benefits to the firm, it is reasonable

to expect that Information Technology security expenditures will positively impact the market value of a firm. However, as discussed previously, information security does not contribute directly to the top line growth. On the contrary, information security-implementing departments are primarily cost-centers. Nevertheless, if a firm is allocating its resources efficiently, it will benefit due to secondary effects of these investments. For example, the benefits of these expenditures would be saving direct losses (labor and resources cost of recreating the information asset breached), and indirect losses like reputation (increased customer confidence would result in repeat purchase), as well as litigation (compliance). Campbell et. al. (2003) already provides evidence that there is a substantial negative impact of security breaches, therefore, firms that are actively engaged in information security activities should have a positive market value. Nevertheless, none of the firms are reporting the actual expenditures in their information security activities. Hence, the only way to communicate is to disclose the information security activities or steps, if not the actual investment amounts, to revise the stock prices.

### **3.3 Mandatory Disclosure Environment**

Finally, to better understand the value of the voluntary disclosure and its effect on the stock price, I need to account for its interaction with the mandatory disclosure environment of the firm as well (Einhorn 2005). Specifically, if the correlation between the mandatory and the voluntary disclosure is negative, the direct and indirect effect of voluntary disclosure will be such that the coefficient on the voluntary disclosure signal will be positive. For example, if expenditures on information security reduce the current earnings, then any signal (voluntary

disclosure of security activities) that is negatively related to earnings (mandatory disclosure), should result in an upward revision of the priors about earnings. Such an upward revision of priors will cause the firm's price to be adjusted upward as well.

Subsequently, under the maintained assumption, firms will engage in activities that tend to maximize their values (i.e., managers will only accept projects – even information security related – that have a positive net present value). Therefore, managers who possess private information (information security activities and investments are unobservable), which can result in correcting the otherwise undervalued stock, will disclose that information, if not for capital-market reason, then at least to ‘signal’ that their firms’ are different from the rest. More specifically, if the voluntary disclosure is negatively correlated with the mandatory disclosures, it will cause the company’s stock price to increase, and will have a positive coefficient (Einhorn 2005). Hence, my general hypothesis, stated in null form is:

*H<sub>0</sub>: Disclosures of information security activities are negatively associated with stock prices.*

## Chapter 4

### Methodology and Data

#### 4.1 Methodology

For this research, I draw on the value-relevance methodology which is a well established technique in accounting. Value-relevance methodology has been used for not only valuing fair-value accounting for financial, intangible and intangible assets, but also for the studies that evaluate the effects of recognition<sup>4</sup> versus disclosures of various types of information and firm value (Barth 2000; Aboody et al. 2002; Aboody and Lev 1998; Adams and Hossain 1998; Amir 1996; Amir and Lev 1996; Barth 1994; Barth et al. 1992; Barth et al. 1998). Other financial and non-financial information that have been found to be value-relevant by prior research include non-financial information in the wireless communications industry (Amir and Lev 1996), value of customer satisfaction for firm value (Ittner and Larcker 1998), the disclosure of net periodic pension cost components as under SFAS 87 (Barth et al. 1992), the capitalization of Research and Development (R&D) expenditures (Lev and Sougiannis 1996), the capitalization of software development costs as under SFAS 86 (Aboody and Lev 1998), and fair value disclosures (Barth 1994; Barth and Clinch 1996).

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<sup>4</sup> Recognition relates to accounting information that is formally a part of financial reports i.e., appear in a balance sheet, income or cash flow statement, while disclosure refers to information that is usually presented, but not accounted for e.g., under SFAS No. 123 expense guideline stock-based employee compensation is expensed but not 'recognized' in the income statement (Aboody et al. 2004b).



Barth (2000) provides an excellent summary of the value-relevance literature in her paper titled “Valuation-based Accounting Research: Implications for Financial Reporting and opportunities for future research” in which she identifies three main models that have been used extensively in the value-relevance research as earnings (dividend) model, balance sheet model, and firm value model. Each of the three models is discussed in detail below.

Price dividend (earnings) model is based on the relationship that current value  $P_t$  (price at time  $t$ ) of the firm is expected value of the future value of the dividends,  $D_{t+\tau}$  (dividends at time  $t + \tau$ <sup>5</sup>):

$$P_t = \frac{\sum_{\tau=1}^{\infty} E_t[D_{t+\tau}]}{(1+r)^\tau} \quad (1)$$

Where  $E$  is the expectation operator and ‘ $r$ ’ is the discount rate for the appropriate time-period ‘ $t$ ’. For empirical studies, a link is posited between the accounting numbers and expected future dividends, which usually is in the form of some components of net income that are considered to be permanent rather than earnings that are persistent (Barth 2000). The balance sheet model expresses market value of equity (MVE) as a function of the market values of the firm’s assets (MVA) and market value of its liabilities (MVL) (Barth 1991). These values are considered to be the present value future expected dividends associated with the firm’s obligations. Hence, the model to be estimated becomes:

$$MVE_t = MVA_t + MVL_t \quad (2)$$

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<sup>5</sup>  $\tau$  is the summation operator i.e., for future time period 1 to  $\infty$ .

For evaluation purposes, the reported accounting assets and liabilities numbers are posit to be the proxy for all of the firm's assets and liabilities. However, it should be noted that accounting numbers do not reflect the values of intangibles like R&D, goodwill or other non-financial measures that might affect the firm's market value (Barth and Landsman 1995). Hence, a careful consideration of the research issue and the variables is required, since the inferences from the model might be confounded due to missing variables.

Recently, the focus in the value-relevance research has slowly shifted to using an empirical specification that has come to be known as Ohlson's model. Even though most of the credit for the model development is attributed to Ohlson (1995), references to theoretical arguments for using accounting numbers (book value of equity – BVE and net income – NI) dates back to Edwards and Bell (1961), and Peasnell (1982), who mathematically shows the formal link between using the current BV and NI to estimate firm value. Nevertheless, it was the Ohlson (1995) paper that revived the interest in firm value and accounting numbers, thus, for the purpose of this paper, the valuation specification will henceforth be referred to as Ohlson's model.

The most important feature of the model that has made it so popular, is the fact that it provides a direct link between accounting amounts and the firm value, and thus, has become the most pervasive valuation model in accounting research. The main underlying assumption for the model is the clean surplus accounting i.e., change in book value of equity = earnings less dividend plus or minus capital transactions (Holthausen and Watts 2001), which yields the following equation:

$$V_t = BVE_t + \frac{\sum_{\tau=1}^{\infty} E_t[x_{t+\tau}^a]}{(1+r)^\tau} \quad (3)$$

Where  $V_t$  is the resulting firm value which should equal stock price  $P_t$ , and  $x^a$  is abnormal earnings or net income in excess of the discount rate time beginning of period book value of equity given by  $N_{it} - r*BVE_{t-1}$  (Barth 2000). Ohlson (1995), provides more structure to the model (by adding information dynamics assumptions), and thus provides an empirically testable valuation function as:

$$V_t = (1+k)BVE_t + k(\varphi NI_t - d_t) + \alpha_2 v_t \quad (4)$$

In the above equation, “ $v$ ” is other information and “ $\varphi$ ” is a function of the discount rate while “ $k$ ” becomes a function of the discount rate and persistence of abnormal earnings. Specifically, the inclusion of “ $k$ ” in the above model assists in thinking about the relative importance of BVE or NI in valuation. As Barth (2000) notes, since these functions can not only vary temporally but also for each firm, one can use the model to evaluate the relative importance of either BVE or NI for relative valuation implications. For example, “ $k$ ” can depend on the measurement attributes of BVE and NI i.e., if all assets (intangible as well as tangible) were recognized at fair value, NI is simply measured as gains and losses, and  $v = 0$ , then  $k = 0$  because the persistence of abnormal earnings equals zero. On the contrary, if BVE is measured at historical cost and NI captures the excess of value-in-use over the start values for a firm’s asset, then  $k$  can reasonably be expected to equal 1 (Barth 2000).

### 4.1.1 Valuation-Model Limitations

As with all functional forms, the Ohlson valuation model has its limitation. In a comprehensive review of the accounting value-relevance literature, Holthausen and Watts (2001) concludes that in general most, of the models and more specifically at least the earnings and balance sheet models are flawed. The major concern put forth by them is that since the prime objective of the value-relevance studies is to provide guidance for accounting standard setting, the contribution of value-relevance research is 'modest' since "literature does not seek to develop a descriptive theory of accounting and standard settings (Holthausen and Watts 2001, p. 63). Furthermore, for all valuation models the underlying assumptions are seldom true i.e., the maintained assumption of perfect and complete markets for balance sheet models, competitive capital-markets conjecture for earnings specifications and costless information for Ohlson's models, are seldom if at all correct. Hence, the models do not provide any "accounting theory."

For the price dividend (earnings) model, where earnings or its components are regressed against stock prices, Holthausen and Watts points out that earnings are not 'cash flows,' and do not represent cash flows in the period in which they occur. Accordingly, the discount rate being estimated is not the firm's 'true' cost of equity (see equation 1), and hence cannot make capitalized earnings equal to the market value of firms (since the discount rate is not identified). Accordingly, the coefficient of earnings in the earnings models cannot be predicted (2001, p. 57). Notwithstanding, the conservatism (in accounting), the model specification requires use of net earnings or its components that are persistent in nature. Hence, it is not

clear how a generalization can be made across all firms where extreme earnings (especially negative values) are not only transient, perhaps due to abandonment option (Hayn 1995), but also exhibit non-linear trend (Freeman and Tse 1992). Specifically, in the earnings model, these non-linear trends are not reflected. Additionally, there might be correlated omitted variables of the earnings components like depreciation which could be positively correlated cross-sectionally with net assets, and as such might proxy for omitted abandonment and/or growth options.

For the balance sheet model, Holthausen and Watts points out that the functional form (see equation 2) holds only if all the relevant markets exist i.e., there is a market for a company's assets, liabilities, and for its stock (2001, p. 53). Also, all the markets are competitive so that there are no abnormal returns (rents) to the firm. However, if the firm has some competitive advantage, then the company can earn 'excess' returns, provided that the technology can be sold separately. Nevertheless, if the technology is not separable e.g., process advantage in manufacturing, and not saleable, then the value of the net asset is not associated with the value of the firm, except to the extent the technology affects future operating cash-flow. Also in this case, the equity value is an increasing convex function of the net assets (Wysocki 1998). Hence, the linear specification in equation 2 is not correct. Moreover, in most of the studies, not all the assets or liabilities are included, which creates a correlated omitted variable bias resulting in inconsistent coefficient estimates. This situation is further exacerbated when 'notional' proxies are included in the valuation for items that are not recognized as part of the balance sheet, since it is not clear if these 'off-

balance sheet' items are off value, or if it is because of the expected rents that might accrue (Holthausen and Watts 2001, p. 56).

The Ohlson's (1995) model, although by far the better of the other two, has its own limitations. Under residual income valuation mode and a clean surplus assumption, primarily the most significant issue with the model is that the results from the analysis have no empirical implications for the choice of different accounting procedures. Also, any test of the Ohlson model is a joint test of the residual income valuation model and the assumed information dynamics, which might differ significantly especially in a case of cross-country analysis. Last but not least, even though the model accounts for book value, it does not take into consideration options, which might conflict with the linearity assumption of the model (Holthausen and Watts 2001, p. 60).

Additionally, two other concerns that should be addressed in valuation research have to deal with using a levels versus returns specification (Barth 2000), and firm and industry level effects especially in a cross-sectional pooled design (Holthausen and Watts 2001; Barth et al. 2001; Barth and Kallapur 1996; Wild 1992). Easton (1999) documents that results from levels valuation models could be misleading since the statistical association between price and explanatory variables maybe nothing more than spurious 'scale' effects. This result occurs because, in general, large firms will have a large total market value, large book value and accordingly large net income. Furthermore, since other attributes of interest of the large firms might also be large, the price levels regressions will be capturing nothing more than a scale. One possible remedy is to deflate the firm's variable by total

outstanding shares; however, this might not correct the scale effect, because management has discretion over the number of shares outstanding. Thus, the management may choose to split the stock, effectively changing the per-share-price, “*without effectively changing the economic characteristics of the firm*” (Easton 1999, p. 404). Thus, regression results might be capturing the scale effect of a firm for its attributes, while scale might differ across firms. Returns regression i.e., change in prices with associated change in explanatory variables is an effective remedy since ceteris paribus, return is price difference for each individual firm, and is not affected by managers’ choices of number of shares outstanding. Furthermore, time-differencing a price model would account for any misspecification (e.g., intertemporal constant correlated omitted variable – industry or firm specific effect), if present, and will result in a well-specified model.

#### **4.1.2 Value Relevance Model - Current Status**

In a response to Holthausen and Watts (2001) critique, Barth et al. (2001) provides a comprehensive reply which concludes that even though the empirical specifications might not be optimal, the valuation models with all their limitation still persist. First and foremost, addressing the issue that current value-relevance research is not providing guidance for accounting standard setters, Barth et al. (2001) argues that value-relevance research helps investors (who are the primary users of accounting information) in better estimating the value of the firm. Also, the main focus of the research is to provide evidence for standard setters to assist in their deliberations rather than prescribe or direct actions. Also, a key element that needs to be underscored here is that valuation studies do not attempt to “estimate” a firm’s

value, but rather to learn about the “valuation characteristics of a particular accounting amounts” (Barth et al. 2001, p. 90).

Currently, among all of the three valuation specifications, Ohlson’s (1995) model and its subsequent refinements is the most commonly used model. This model is based on the simplifying assumptions and represents a parsimonious view of the complex world. Even though the model assumes perfect capital markets, it allows for imperfect product markets for at least a finite number of periods. With additional assumptions of information dynamics the model allows the firm value to be expressed as linear function of equity book value, net income and other information (Barth et al. 2001, p. 91). Also, since there is no well-specified model of equity valuation under imperfect and incomplete capital market, the best that value relevance studies can do is to use something like Ohlson’s model, but make suitable modifications to the estimating equation to represent the particular setting being studied.

Two main concerns raised by Holthausen and Watts (2001) relate to omitted economic rents and accounting for non-linearities between the specification. Barth et al. suggest that even though economic rents can be viewed in the Ohlson’s framework as being reflected in the persistence of abnormal earnings, these rents can also be modeled specifically i.e., including proxies that value present value of future cash-flows attributable to such recognized assets, which might even include intangible like customer lists, brand names, and research and development. As for non-linearity, even though the model is a linear function of equity book value and abnormal earnings, the persistence of these abnormal earnings is accounted in the model nonlinearly i.e., for given BVE and NI, “the marginal differences in persistence are



not associated with constant marginal differences in equity value” (Barth et al. 2001, p. 92). Simply stated, the model explicitly allows the valuation coefficients to vary not only cross-sectionally but also across components of BVE and NI, and thus provides a means for effectively controlling nonlinearities (see e.g. Barth et al. 1992; Barth et al. 1998; Aboody et al. 2004b).

As for the concern regarding which type of analysis is to be conducted i.e., levels versus returns, the final selection depends jointly on the hypothesis of interest and on econometric concerns (Landsman and Magliolo 1988). The main difference between the two types of analysis is that in former, the interest is in determining what is reflected in the firm value, while in the latter specification, concern is in addressing the question, “what is reflected in *changes in value* over a specific period of time” (Barth et al. 2001, p. 95 emphasis added). Thus, it is imperative that an appropriate specification is selected based on the question under consideration. That is, the choice of model is contingent upon the fact that it is a question of timeliness or of the association of value- relevance of accounting information.

Econometric concerns in price level consist of coefficient bias induced by correlated omitted variables, measurement error, cross-sectional difference in valuation parameters, and possibly incorrectly calculated standard errors of coefficients due to heteroscedasticity (inefficiency). Nevertheless, these issues have been discussed in great detail in literature which provides remedies to correct for these misspecifications (see e.g. Bernard 1987; Christie 1987; Kothari and Zimmerman 1995; Barth and Kallapur 1996; Barth and Clinch 2005; Landsman and Magliolo 1988).

Barth and Kallapur (1996), and Barth and Clinch (2005) ran simulation studies to empirically test the effects of scale and heteroscedasticity concerns and to see which deflator (if used at all) would provide the most consistent and unbiased estimates. Both scale and heteroscedasticity form a main contention in the debate of price-levels versus returns models selection (e.g. see Easton 1999).

Barth and Kallapur (1996) assumed that scale is an omitted regression variable. Deflation or including scale as an independent regression variable, are two possible remedies to compensate for scaling. It is also interesting to note, that in value relevance literature, a number of potential accounting measures have been suggested that might proxy for scale and among other includes total assets, sales, number of shares outstanding. Their finding suggests that including the scale-related variable in the model is more helpful in mitigating coefficient bias than deflating (for any of the possible scale factors). This recommendation holds even when the proxy scale variable is 95 percent correlated with the true scale factor. Thus, the study concludes that using an independent scale variable as an independent variable is superior to deflating. However, it is worthwhile to note here that the main model of concern in this study was the balance sheet valuation model whose limitations have been discussed before.

Barth and Clinch (2005) in a recent study again revisit the scale effects implications in the value relevance research. However, this time the focused model is the Ohlson's valuation specification. The authors note that their reason for selecting Ohlson's model is not because it represents a complete description of the firm value, but rather that it presents a parsimonious representation of equity market values and

accounting amounts. Distinct from the previous studies, the paper starts out by formally characterizing as to what is a scale effect, since scale is not a well-defined concept in accounting and often the recommendations provided to mitigate it is conflicting (e.g. see Bernard 1987; Christie 1987; Landsman and Magliolo 1988; Easton 1998). Thus, one contribution of the study is that it provides a clear distinction between the type of scale effects and their related affects on the model. The four varying scale effects are classified as: additive and multiplicative correlated omitted variable, scale varying valuation parameters, and scale-related heteroscedasticity. Using simulated data to reflect the four effects (based on actual accounting numbers), the study attempts to empirically validate the inferences on the coefficient using an un-deflated specification, deflation using shares outstanding or book value of equity and a returns model. Barth and Clinch concludes that share-deflated specifications, overall, performs the best for data that might have scale effects, regardless of the 'type' of scale issue. They also point out that "in principle the number of shares outstanding is arbitrary, so these finding might be surprising. However, market forces motivate firms to issue and repurchase shares to maintain their share prices within an acceptable trading range. Our findings suggest that this activity results in number of shares outstanding being an effective general proxy for scale" (Barth and Clinch 2005, p. 26). Notwithstanding, it is also worth nothing that the remedies suggested are specific to the model under investigation (Barth and Clinch 2005, see footnote 2).

Furthermore, per the theoretical discussion of the Ohlson's model, it might be the case that current earning is noisy, and hence not capturing the future earnings

potential. In a similar vein, Aboody et al. (2004b, p. 255) suggests using an additional variable in the model that proxies for future earning potential, and recommends using mean year-end analyst's earning's growth forecast. Their intuition behind using a future growth proxy is that the variable will capture or provide information regarding the future abnormal returns. Accordingly, I used a measure Q (= Market Value/Book Value). Technically, the measure Q is a representation of a firm's monopoly power. However, in the accounting literature, Q is also used to reflect the future growth potential. The rationale for this application is that if price is a reflection of future earnings, that its ratio with the existing book value of the firm is a ratio of future earning potential for the organization. Thus, Q is a proxy for the future abnormal earnings potential of a firm.

## 4.2 Model

Based on the discussion in the methodology section, I used Ohlson's valuation model. Specifically, the main question of interest is the value relevance of voluntary disclosures of security, and not the timeliness of the disclosure. Therefore, I used price-level model in a cross-sectional pooled regression design. Additionally, because price leads accounting recognition in incorporating new information, price levels design provides more economically sensible results (Kothari and Zimmerman 1995). Accordingly, I estimated the following equation:

$$P_{it} = \beta_0 + \beta_1 \times EPS_{it} + \beta_2 \times BVPS_{it} + \beta_3 \times Dis_{it} + \beta_4 \times Q_{it} + \sum_{k=1}^4 \beta_k \times Year + \sum_{j=1}^N \beta_j \times Ind + \varepsilon_{it} \quad (5)$$

Where:

$P_{it}$  = Stock price of firm 'i' for year 't', 90 days after fiscal year close

$EPS_{it}$  = Earnings per share (basic excluding special items) for firm 'i' for year 't', year-end

$BVPS_{it}$  = Book value of equity divided by No. of shares outstanding for firm 'i' for year 't', year-end

$Q_{it}$  = MV divided by BV of firm 'i' for year 't'

Dis = Proxy variable for "types" of disclosure being analyzed. I use three regression specifications as follows:

1) Base model without any disclosure variables,

2) Generic security disclosure, where Dis = 1 if proactive security measure or potential security vulnerability or actual security breaches =1, 0 otherwise,

3) For the second regression, I add the following six dummy variables in place of Dis to proxy for the following groups:

- i. Proactive security disclosures, where P = 1 if proactive security measure =1, 0 otherwise,
- ii. Potential security vulnerabilities (V), where V= 1 if potential security vulnerability =1, 0 otherwise,
- iii. Actual security breaches disclosures, where A = 1 if actual security breaches =1, 0 otherwise, and

- iv. Joint disclosures of proactive security measures and potential vulnerabilities, where  $PV = 1$  if there is a joint disclosure, 0 otherwise,
- v. Joint disclosures of potential vulnerabilities and actual security breach, where  $VA = 1$  if there is a joint disclosure, 0 otherwise,
- vi. Joint disclosures of proactive security measures and actual breaches, where  $PA = 1$  if there is a joint disclosure, 0 otherwise,
- vii. Joint disclosure of proactive security measures, potential vulnerabilities and actual security breaches, where  $PVA = 1$  if joint disclosure, 0 otherwise

Year = 1 if current year, 0 otherwise

Industry = 1 if current industry, 0 otherwise

Price, earnings and book value of equity are calculated for each firm 'i' for each time period 't.' All the financial data is gathered from the CRSP/COMPUSTAT merged annual database of 2004, and are fiscal year-end values with the exception of stock price. Book value of the firm is the stockholder's equity (Compustat # 216), while earnings are basic earning per shares excluding extra items (Compustat # 58) and shares outstanding are proxied by common shares outstanding (Compustat # 25). Q is estimated as the ratio of market value [(Price per share \* shares outstanding) / (book value of the firm)]. Since companies have up to 90 days to 'officially' file the

annual filings with the SEC, I use the three-month lead price. This is important in my specification, since the variable of interest, voluntary disclosures of information security, are provided in the annual filings; and for its value to be reflected in market value of equity, I need to select a time by which the information is available to the market i.e., annual filing is publicly available to the investors. Therefore,  $P_{it}$  is the price-per-share of the firm three months after the fiscal year-end. Since my data includes the year 2004, I use COMPUSTAT industrial quarterly database (Q1) 2005 to get  $P_{t+Q1}$  prices for all firms<sup>6</sup>. Furthermore, to ensure tractability, only the firms with fiscal year-end of December are included. This helps in generating a natural control sample of the firms that did not disclose. By restricting my sample to December fiscal-year end, I easily match the observations over all the firms in the COMPUSTAT/CRSP database.

This model is a variant of the Ohlson's valuation specification where price, earnings and book value of equity are scaled by shares outstanding at time 't'. As discussed before, I use the outstanding shares to minimize the scale affect since this specification performs the best, regardless of the type of scale effects (Barth and Clinch 2005). However, it is noteworthy that my variables of interests are neither the BVPS, EPS nor Q, so in my case they act more as "controls" or known explanatory variables for the stock prices i.e., I am interested incremental association of information security disclosures above and beyond what is provided by book value, earnings or future earnings potential.

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<sup>6</sup> CSRP/COMPUSTAT merged industrial annual database is only updated on an annual basis.

### 4.3 Controls

One of the main objections for the levels-based research in general, and more specifically for the cross-sectional pooled research design, is the underlying assumption that the estimated coefficients are constant across time, as well as for all the firms (Lang and Lundholm 1996a). Furthermore, previous research has documented that firms' stock prices are also a function of many other factors, including time series parameters of their earnings process, their own systematic risk, and their information environment (see e.g. Kormendi and Lipe 1987; Collins and Kothari 1989; Easton and Zmijewski 1989). Therefore, careful consideration of "correlated omitted variables" is required to ensure that coefficients are not biased. Consequently, I used the following additional controls, in addition to the ones mentioned above.

First, any economy-wide changes might have an impact on all of the firm's earnings i.e., exogenous growth in the economy as a whole. To control for these effects, and to reduce cross-correlation, indicator (dummy) variables for each year should be employed (Barth et al. 1999; Kerstein and Kim 1995; Collins and Kothari 1989). Therefore, I use dummy variables for each year with the assumption that coefficients for all the firms are same and any temporal change is reflected through intercept (e.g., Collins and Kothari 1989; Kerstein and Kim 1995). Furthermore, it could be the case that pooling is inappropriate if there are shifts in the cross-sectional parameters over time (e.g., technology changes, competition laws and regulations) or if the error terms are correlated. To account for these misspecifications, I also estimate separate annual regressions (Kerstein and Kim 1995).



Second, previous research also documents that there might be industry-specific effects, and imposing a strict constant coefficient restriction might unduly affect the coefficient's estimates (Wild 1992). Therefore it is important to control for omitted variables related to industry membership (Aboody et al. 2004a). To account for the industry-wide affects, two approaches have been used in the literature to deal with this issue: 1) use an industry indicator variable (Barth et al. 1992; Aboody et al. 2004b) at least in the cross-sectional pooled regression and, 2) conduct separate industry-wide regression (Lang and Lundholm 1996a; Wild 1992). Therefore, I use industry dummies in the main regression model.

Furthermore, for my specific research question, where I am looking partially at a type of disclosure (information security related activities), it could be the case that the firms that I have identified as providing disclosures is a biased sample. Simply stated, it could be the case that the firms providing security-related disclosure, in general, provide more disclosures (i.e., it is a high disclosure firm). If that were indeed the case, then *ceteris paribus*, the disclosure dummies would be significant across all the industry groups (since these firms are high-disclosing firms and generally, market values firm that disclose more information). Thus, I re-estimate the following equation for each industry group:

$$P_{it} = \beta_0 + \beta_1 \times Earn_{it} + \beta_2 \times BVPS_{it} + \beta_3 \times Dis_{it} + \beta_4 \times Q_{it} + \sum_{k=1}^4 \beta_k \times Year + \varepsilon_{it} \quad (6)$$

#### 4.4 Sample

Based on the findings of Kotulic and Clark (2004), I decided against using surveys to collect my data. However, since a key requirement for information

security research was the availability of public information, considerable time, and effort was spent towards identifying a public source, and developing techniques and methods to collect it (discussed in detail in the next section). Thus, one of the hallmarks of this research is that the entire sample for security reporting was gathered from public sources. Additionally, as the main objective of the research is to find the effect of security-related disclosure to the firm value, appropriate financial data as discussed above was gathered as well, and matched.

#### **4.4.1 Security Disclosures**

The focus of the paper is towards the firm-level effects, or more specifically, the market valuation of firms' voluntarily disclosure of their information security security-related activities. Therefore, the appropriate level of disclosure data is firm-level disclosure. Healy and Palepu (2001) details that managers possessing superior information could use various mechanism accessible to them to disseminate the information. These mechanisms include annual general meeting, analyst phone conversation, management forecast, earning forecasts, press releases and news coverage. Among these many venues, annual filings is also one such mechanism. Although annual reports are required by law (SEC mandates certain financial disclosures for all publicly-traded firms), these reports also provides a means for management to voluntarily disclose information above and beyond what is required, and at their own discretion. For example, management discussion and analysis is one section that provides strategic insights by the managers for the future direction of the organization, and is highly regarded by analysts in their evaluation of managements disclosure practices (Lang and Lundholm 1993, 1996b). Furthermore, previous

studies have also used annual reports to developed either their own disclosure index (Botosan 1997), or to study the effect of disclosure for multi-audience environment (Bhojraj et al. 2004), or to measure the effect of non-financial information on the security prices of the organization (Amir and Lev 1996). There are three main advantages of concentrating on annual filings. First, by default, the sample is focused on those firms that are publicly-traded. Second, under the SEC legislation, the information about these firms is available to all the prospective parties. Third, such a sample would have the related financial information in public domain that would facilitate evaluating the effect of disclosure on the firm market value. Thus, I decided to focus on the annual filings to identify the security disclosures.

One possible method to identify the firms that made security disclosure was to gather the annual reports of representative samples of firms from the pool of all publicly-traded organization, and then manually go through all of them. However, this procedure would be too time consuming, and might include a selection bias based on the firms that got selected in the first place. Notwithstanding the fact that it might also be the case that sample firms selected for evaluation might not have any information security-related disclosure in the first place. Therefore, the consensus was to focus on two years of annual filings, to see if voluntary information security disclosures are available. The annual filings for all the public filers were searched using keywords. The keyword list included the words that have already been used (see e.g., Campbell et al. 2003), and were supplemented with additions by browsing popular security literature. For the initial analysis, a list of 20 keywords, such as ‘computer breach,’ ‘security breach(es),’ ‘network security,’ and ‘computer virus(es)’

were compiled through discussions with my co-chairs. These keywords were then used on Lexis-Nexus, FreeEdgar and 10Kwizard databases. Each of the annual reports that had a keyword hit was read to see what, if any, types of security-related disclosures were being provided by the firms.

#### **4.4.2 Security Disclosures Taxonomy**

The sample of reports that included computer security-related disclosures were independently read by three reviewers to see if a possible taxonomy for these disclosures could be developed. The plan for having a taxonomy was two-fold: i.e., not only to identify the ‘type’ of disclosure that will capture the essence of information content of the disclosure (i.e., to be able to generalize to all the industries); but also to narrow it down enough to facilitate cross-sectional comparison. The latter is important since there is no standard format for security-related reporting, and each firm uses its own reporting styles. Based on the available sample of two years, a consensus was achieved to classify the disclosures as either “proactive security measures,” or “potential security vulnerability,” or an “actual security breach” category.

The first category encompasses the firms that report current activities, and the steps that they are taking to improve the security of their systems. This category is titled “proactive security measures,” and includes examples of firms that disclose either using specific technology, such as encryption, secure socket layers data transmission, implementation of network security measures, or disclose a computer security policy. The second category comprises “potential security vulnerability,” which includes the class of firms that discusses vulnerability in their infrastructure

(i.e., they acknowledge a susceptibility for their computer systems, or admit that their infrastructure is at risk of being disrupted by computer viruses or hacking). The third category titled “actual security breaches,” captures the fact that the firm revealed an actual breach had occurred (i.e., these disclosures explicitly consist of reports that details ‘denial-of-service’ attacks, or hackers penetrating the information system infrastructure). In addition, if the company’s report itemizes an actual security breach, along with proactive security measures and vulnerabilities, then that single firm would get classified in each of the three categories independently.

For each type of disclosure, the firm was coded as 1 if the disclosure was present, and 0 otherwise. As mentioned before, a firm issuing multiple types of disclosures would be categorized for each type of disclosure. Additionally, an overall generic disclosure index was also developed where the firm was coded as having a disclosure if it provided disclosure in any category i.e., generic disclosure was coded as 1 if either the proactive security, or potential vulnerability, or actual security breach type disclosure was available, and 0 otherwise. See the appendix for samples of disclosures that were coded as 1 for each type of security disclosure.

#### **4.4.3 Overall Sample**

Pre-test sample results showed that about 30% of the firms that were identified by keywords actually had an information security-related disclosure. Thus, it was decided to expand the sample to include all the industries from years 2000 to 2004. The lower cut-off of 2000 was selected for two main reasons: 1) security breaches were not a main concern for managers until 2000-2001, (i.e., in early 2001 media frenzy brought the issue of information security to limelight as an unintended

consequence of doing real-time operations), and 2) keep the data collection manageable<sup>7</sup>. The upper cut-off of 2004 is restricted due to the fact that 2004 is the latest year for which majority of the annual filings reports and financial data was available.

To collect the sample, 24 keywords (see Table 1) were used in a meta-search engine. All the annual filings<sup>8</sup> (specifically 10-K, 10KSB and 20-F) that were filed with the SEC during 2000-2004 were searched. 10-K is the official annual financial document that companies file with the SEC, and it contains detailed financial statements and financial footnotes. 10KSB is a modified 10-K annual report, and is filed by companies whose revenues are less than US\$ 25 Million, is a U.S. or Canadian issuer, is not an investment firm, and if a majority owned subsidiary, then the parent is also a small business (SEC-2345). Finally, 20-F is the annual form that is required to be submitted by foreign private holder issuing equity in U.S. pursuant to Section 13 or 15(d) of the Securities Exchange Act 1934 (*Securities Exchange Act of 1934*). Table 1 shows that the ‘security measure(es)’ keyword has the highest number of hits – 2,211– followed by ‘authentication’ which has 1,823 instances. As expected ‘encryption,’ ‘computer virus(es),’ ‘security breach(es)’ follows with 1,411, 1,277, and 1,209 occurrences respectively. However, the most surprising of all the keywords is ‘disaster recovery,’ which had a hit rate of approximately 1,200. It seems that firms, besides worrying about computer viruses and implementing computer security technology, are also concerned with disaster recovery plans. It is

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<sup>7</sup> Furthermore, the lower bound of 2000 is selected because the Y2K effect might confound the effect of information security related activities with other Information Technology expenditures.

<sup>8</sup> Besides 10-K reports, companies also issue Annual Reports to stockholders. A quick search of the keywords on the annual reports did not get many hits. As such, these filings were not included.

however in-line with the recommendations of trade publications, security magazines, and news reports that have continuously touted establishing disaster recovery plans as important part of an organizations repertoire of measures against potential security threats. Furthermore, it is also instructive to note that there are not many occurrences of ‘security expenditures’ (7 instances) and unlisted results of (keyword) ‘security investments’ returned high false positives, and as such was not used <sup>9</sup>.

An annual filing was included in the sample if it included an occurrence of one or more of these keywords. The firms were then collated in a database such that multiple instances of keywords for a single firm were associated with the particular firm in the year in which the security disclosure occurred. To get a better feel of the ‘type’ of disclosure, 200 words around the keyword were recorded and downloaded in a database. The text around the keyword is required to ensure that the reporting was classified appropriately in one of the three categories identified above. Maintaining all the information in a database allows a permanent record that can be revisited later for further analysis and/or accountability. Additionally, a hyperlink (static Uniform Resource Locator – URL) to each keyword occurrence was also recorded to allow direct access to annual reports<sup>10</sup> filed with the SEC, in the event that 200 words text was ambiguous. The total sample was 11,160 firms-years, which was reduced to 6,485 firms-years when the firms with missing ticker symbol, and

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<sup>9</sup> Stock investments are also referred to as security investments; due to high number of false hits (i.e., text containing mentions of company stock as opposed to information security investment, the keyword was dropped.

<sup>10</sup> Annual reports and annual filings are used interchangeably throughout. However, they refer to the legal filings (i.e. form 10-K, 10-KSB or 20-F) and not Annual Report that is issued for stockholders.

those whose fiscal year other than December were discarded<sup>11</sup>. The 6,485 firm-year sample was then manually read to identify and categorize the information security disclosure (if reported). Concurrently, the firm's Permanent identification number (PERMNO) was also identified based on the Chicago Research Security Prices (CRSP) 2004 annual securities identification file<sup>12</sup>.

Table 2 summarizes the selection process of the disclosing versus non-disclosing firms-years. As can be seen from the table, that total number of firms providing any security-related disclosure was 2,479. To be included in the final sample, the firms should not have missing identifiers (PERMNO that cannot be matched) or missing financial information. Furthermore, the firms (both disclosing and non-disclosing firms) must have a positive book value which is consistent with previous accounting research, especially for the price levels regression (Hayn 1995; Collins et al. 1997), and also should not be in the top or bottom 1 percentile range (influential observations) for financial variables. The latter step is to mitigate the extreme effects of influential observations due to their transitory nature (e.g., see Kothari and Shanken 2003, p. 76; Collins et al. 1997). Therefore, a firm is included in my sample if the following criteria are met: no missing financial information; positive book value; not missing industry classification; and is not considered an influential observation. Thus, the final sample consists of 21,120 firm-year observations of which 1,637 observations are for the disclosing sample, and 19,483 observations are for the control group. Table 3 (Panel A) shows the industry

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<sup>11</sup> The reason for discarding firms with fiscal year not ending in December is discussed in more detail in the financial sample section.

<sup>12</sup> CRSP database classifies each firm using a permanent identifier (PERMNO) which is required for matching the firm with its financial data. The file used was 2004 daily stocks "chead.txt."



membership mapping which is based on the two digit Standard Industrial Classification (SIC) code for Fama and French (1997) industry classification as provided by Bhojraj et al. (2003), while Panel B lists the 35 unique industry groups that are represented in my sample.

Breakdown of the security-related disclosures and their distribution according to the type of disclosures (i.e., security vulnerability, proactive security measure or actual security breach) is listed in Table 4. It is important to note that the disclosure (dummy) variable takes on a value one if a firm reports any of the three types of information security activities related disclosures (i.e., it is a joint representation of any one or combination of different types of disclosures by a firm). For example, there are 757 instances (panel A column 2 Table 4) of firms disclosing only proactive security measures, but nothing about their systems vulnerability or actual security breaches. Additionally, there are 1,258 instances (panel A group 6 Table 4) where firms not only disclosed system vulnerabilities, but also provided disclosures related to proactive security measures. However, since the latter are joint occurrences of proactive measures and potential system vulnerabilities, the overall disclosure index is 1,258 (column 5 Table 4), reflecting the fact that an information security-related disclosures was provided.

For the original sample of 2,479 disclosing firms, it is interesting to note that among the three categories of the disclosures, most of the disclosures relate to proactive security measures (2,090) being implemented by firms. Of the total potential systems vulnerability disclosures (1,716), 1,258 disclosures relate to potential vulnerability, as well as some mention of the firm's proactive security

measure, while only 374 instances strictly relate to the vulnerabilities. For the bulk of reports involving actual security breaches (73 instances), the firms provided information about their security measures, while at the same time maintained that the systems are still susceptible to further security intrusions. Table 4 Panel B shows that there are 5,815 unique firms in the sample, of which 86.13% do not disclose. The total sample consists of 807 (5,818-5,011) disclosing firms, of which 49.32% (398/807) firms have disclosed only once, while over 50% of the disclosing firms have provided more than one disclosure of information security activities.

# Chapter 5

## Results and Discussion

### 5.1 Disclosure Characteristics

Overall, the number of disclosures has been increasing steadily, and has almost doubled from just 331 in year 2000 to over 700 by year 2004 (Figure 1). A similar pattern can be seen in types of security disclosures in Figure 2, where reports regarding proactive security measure and potential security vulnerabilities have increased with an annual cumulative growth rate of approximately 25% and 24%, respectively over the sample period (i.e., 2000-04). However, the number of actual security breach disclosures increased from 5 in 2000 to 24 by 2003, and then decreased to 10 for year 2004. It is also interesting to note that even though the numbers of disclosures are on an increase (Figure 3), the percentage distribution among the three categories of disclosures is quite stable across all the five years i.e., about 53% of disclosures relate to proactive security measures, while about 43% relate to system vulnerabilities.

Figure 4 shows the types of companies disclosing, based on filing status of 10-K, 10-KSB or 20-F, wherein the bulk of disclosures are provided by 10-K filers i.e., US-based large firms. For example, for year 2000, 377 disclosures were by the 10-K filers, while 10-KSB and 20-F companies supplied only 8 and 11 disclosures respectively. For 2004, both 10-K and 10-KSB disclosures more than doubled, however, the 20-F disclosures tripled. On a percentage composition basis (Figure 5), 10-KSB filer accounted for around 4% of the disclosures, while the percentage of 10-

K filers decreased from 90% to about 5% for 2000-4. It seems that on a company-wide basis, the foreign company disclosures are on the rise.

## **5.2 Industry-Wide Disclosure Characteristics**

Summary disclosures by industry are presented in Table 5 (sorted in descending order by column 6). Banks and business services comprise two of the largest industry segments having approximately 3,000 observations each. Drugs, Financial Services, Chips, and the Lab Equipment industries follow with a cumulative number of observations of 5,460 firm-years. These six segments represent about 54.53% of the total sample.

Table 5 (column 6) shows that for disclosing firms, approximately 42.21% of disclosures are being provided by the Business Services group alone. The next biggest sector is Banks, which contributes about 13.68% of the total 1,637 disclosures in my sample. Overall, 89.07% (column 9 of Table 5) of security-related disclosures are offered by less than one-third of the industry groups i.e., 10 industry segments. The next 5 industries account for an additional 6% of total disclosures, making a total of 95.85% reported by 15 industries. In terms of sample size, the 15 industries comprise about 80% of the total sample.

Among all the industries, the Business Services sector leads the others where 23.44% (column 7 of Table 5) of all the firms provide security disclosures. The Business Services sector is followed by Retail, wherein approximately 15% of the firms disclose. About 11% of firms in each of the Insurance and Telecommunication industries disclosed, while for Banks and Financial Services segments only 7% of

firms in each group disclosed, which is lower than the Books, Personal Services and Wholesales industry segments. Overall, it appears that security disclosures are fairly evenly distributed, with the majority of the disclosures being concentrated within the services industry segments, and firms that are customer-facing.

### **5.3 Descriptive Statistics**

Summary statistics for the full sample, disclosing firms and non-disclosing firms, are shown in Table 6 panels A, B and C respectively, while their correlation matrix is presented in Table 7. Panel A of Table 6 shows that the mean equity market value of the sample is about US\$ 3 Billion, with a range of US \$ 12,000 to over US\$ 400 billion. Mean (median) net earnings of all the firms are 48 (44) cents per share, while the mean (median) stock price is US\$ 17.40 (13.13) per share. Even though the mean book value of equity is about US\$ 1.23 billion, the median is only US\$ 131.42 million, indicating that the sample includes firms with a large book value.

For disclosing firms (Table 6 panel B), average stock price for the five year period is about US\$ 16.30 per share, which is about US\$ 1.19 less than the non-disclosing firms' (Table 6 panel C) stock price of US\$ 17.49 per share. The mean earnings for disclosing firms is 14 cents per share, compared to 51 cents per share for non-disclosing firms, yet, the minimum and maximum are relatively the same. Nevertheless, the mean values of equity market price, book value, and number of

shares outstanding are all greater for the disclosing firms as compared to the non-disclosing firms<sup>13</sup>.

In the correlation matrix, (Table 7), I find the usual positive and significant correlations between price, market values, earnings and book values. However, for disclosures proxies, the case is quite interesting. First, proactive security measures are positively correlated to market value, book value, and number of shares outstanding and are statistically significant at  $p < 0.001$ . Potential vulnerability disclosure is only positively correlated with number of shares outstanding, while actual security breach is not statistically significant with market value, book value, or stock price. Both proactive security measures, and potential vulnerability disclosures have a negative and statistically significant relation to stock price with a p-value  $< 0.10$ , and p-value  $< 0.000$  respectively. Finally, for proactive security measure and potential vulnerability the relationship is negative and significant at  $p < 0.001$ . While for actual security breach disclosures, the correlation is also negative and significant, but at  $p < 0.05$ . Thus, it appears that larger firms with lower than average earnings are the ones that are providing security-related disclosures. While actual security measures are not correlated with stock price, proactive security measures and potential vulnerabilities would tend to decrease the price.

## 5.4 Main Results

The main results of the cross-sectional pooled regression are presented in Table 8. In all of the regressions, the dependent variable is the firm's stock price three month after fiscal year close. In total, there are five different regressions. The

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<sup>13</sup> Untabulated multivariate and univariate tests show that the two samples are statistically different.

first model is the base case without a disclosure dummy proxy. Two different models are used to investigate the effect of a generic information security disclosure, as well as using proxies for various types of disclosures. Finally, models using disclosure proxies are estimated on a reduced sample, which excludes firms from Banks and Financial Industries as these segments are subject to unique governmental regulations including Gramm-Leach-Bliley Act.

For information security disclosures, I first use a generic “disclosure” measure (Model 2) i.e., a dummy variable equal to 1, if a firm had any ‘type’ of disclosure, and estimate Model 2 and 4 respectively. To get a better understanding of the relationship of each type of information security related disclosure, I use dummy variables representing the seven groups (as detailed in Table 4 panel A) related to proactive security disclosures, potential vulnerabilities disclosures, actual security breaches, and their combination in Models 3 and 5. Model 3 is estimated using the full sample of 21,120 observations, while Model 5 is the reduced version (i.e., excluding Finance and Banking firms), and is estimated using 16,607 observations. In the reduced sample, the firms from Finance and Banking industries are eliminated, since these are regulated industries, and might have unique coefficients of their own. In the base case (Model 1), I use book value per share (BVPS), earnings per share (EPS), growth measure ( $Q = MV/BV$ ), year and industry dummies as explanatory variables. I checked for heteroscedasticity using White’s test, and fail to accept the null that error terms are homoskedastic (White 1980). Therefore, all reported t-statistics are based on asymptotically consistent robust covariance matrix.

As expected, the coefficient on BVPS, EPS and Q are positive and significant in the base case with an  $R^2$  of 0.58. The magnitude of the coefficient, and the model fit is similar to the findings of the previous accounting studies using price–levels models (see e.g. Aboody et al. 2004b). As discussed above, Model 2 shows the result of regressing the generic disclosure measure along with base model variables. The coefficient on the disclosure dummy has a magnitude of 2.394, is positive and statistically significant at  $p < .001$ . In Model 4, the coefficient on the disclosure variable is again positive and statistically significant ( $p < .001$ ). However, the magnitude on the disclosure variable in Model 4 is 2.484, which is slightly higher than the estimated coefficient in Model 2. Model 3 (Model 5) supports the results that disclosures of proactive security measures (P) and potential vulnerability (V) are positive and statistically significant ( $p < .001$ ) with coefficients magnitudes of 3.054 (3.157) and 1.491 (1.636) respectively. The estimated coefficient on actual security breaches is not statistically significant, but has a negative coefficient in Models 3 and 5. Joint disclosures of PV (i.e., proactive security measures and potential vulnerabilities), and PVA are significant at  $p < 0.001$ , and positively related to stock price. In addition, joint disclosures of PA, even though positive, is only marginally significant ( $p < 0.1$ ) in Model 3, but is more significant ( $p < 0.05$ ) in Model 5. Interestingly, joint disclosures of VA (i.e., potential vulnerability and actual security breach) is not significant at any reasonable significance level, but has a positive coefficient of 0.527 and 0.758 in Models 3 and 5, respectively. It is also noteworthy that the estimated coefficient on VA is smaller than other information security related disclosures in both models. Overall, it seems that disclosures of information security-



related activities have a positive affect on a firm's stock price. On further inspection, it seems that disclosures of proactive security measures have the most value-relevance to a firm's stock price. Thus, I can reject the null hypothesis that security disclosures do not affect market price.

## 5.5 Year-to-Year Results

As I am using a cross-sectional pooled analysis and controlling for the year effect, it could be that the results are inconsistent if there are shifts in cross-sectional parameters over time (e.g., new technology), or if the errors are autocorrelated. Furthermore, market sentiment for disclosures of information security related-activities might change over time. Therefore, I re-ran the model for each year for each of the disclosures types (generic and the seven groups). For these regressions, the same base model is used (Model 1 Table 8) with the only exception that the year dummies are not included. The results of these regressions are presented in Table 9. Panel A shows the progression of generic disclosure over years 2000-04. The coefficient on the variable is positive and significant ( $p < 0.001$ ) in all the five years. The model fit  $R^2$  varies between 0.558 and 0.639. BVPS, EPS and Q are relatively the same across all five years. Interestingly, the magnitude on the coefficient is largest in year 2001 (3.032), while it is smallest (2.003) for year 2003.

Results of the types of disclosures of information security activities (seven groups as discussed before) are detailed in Panel B (Table 9). Coefficient on the proactive security measure (P) disclosure is significant ( $p < 0.001$ ) in four of the five years (i.e., in year 2002 it is not significant). Potential vulnerability (V) disclosure is marginally significant at  $p < 0.1$  only in year 2004, while actual security breach (A)

estimated coefficient is negative, but not statistically significant. However, the most interesting trends are found in the joint disclosures. The estimated coefficient on PV is positive and statistically significant in all five years. PA-related disclosures are positive and significant in year 2003 ( $p < 0.001$ ) only, while PVA disclosures are positive for the five years, but statistically significant only in years 2001-03. For the VA disclosures, it seems that in the earlier years, 2000-01, market seems to value the joint disclosures positively. However by the year 2004, joint disclosures of VA have a negative and significant effect at  $p < 0.05$ . As listed in panel A, the  $R^2$  of the model has a range of 0.558-0.638.

## 5.6 Industry-Wide Results

As discussed in the hypothesis section, industry memberships also have consequences on the estimated coefficient; therefore I conduct industry-wide analysis. Additionally, if the information security disclosure proxy variable is picking up the effect of other 'omitted-variables' (i.e., the firms being high disclosers), then its coefficient in all the industry analysis would be significant. Industry-wide results are tabulated in Table 10, whereas before, the generic security disclosure, and regression on various types of disclosures are listed in panel A and panel B of Table 10 respectively. Since these regressions are for firms in an industry group over time-period 2000-2004, I include year dummy variables to control for year-effects.

For generic disclosure (Panel A), fourteen industry segments have either a significant or a marginally significant coefficient. Most notably Business Services, Paper, Retail, and Transportation industry segments are significant at  $p < 0.001$ . For these segments, the magnitude of the coefficient varies between 2.006 for Business

Services to 32.389 for Paper. The Clothes, Healthcare, Insurance, Food and Toys industry groups have a significance of  $p < 0.05$ , while Chips and Lab Equipment segments have a statistical significance of  $p < 0.10$  with a positive coefficient. However, for the Households and Steel industries, the disclosure coefficient is significant at  $p < 0.05$  and negative. The  $R^2$  for all the regressions varies between 0.418-0.865. The most interesting point to note in the panel A is that for both the Finance and Banking industries, the coefficient on information security disclosure activities dummy is positive, but not significant. This finding confirms my previous expectations, since both these industries are heavily regulated under GLB, which requires firms in these industries to actively enforce and maintain information security procedures. Accordingly, as these organizations are already regulated, then any voluntary disclosure of information security activity should not have any effect on the firm's price, since that is what the market expects anyway.

Panel B (Table 10) details the regression analysis on the various types of information security disclosures for the 35 industry segments. Proactive security disclosures (P) is positive and statistically significant at  $p < 0.001$  in the Business Services and Transportation industries, while for Banks it is significant at  $p < 0.05$  and positive. The potential vulnerability (V) is positive and significant at  $p < 0.001$  in Clothes, Healthcare, and Paper segments. However, for the Books and Wholesale sectors, the coefficient is significant at  $p < 0.001$  and negative. Actual security breach (A) has a mixed sign across industries, but is not significant at any statistical level ( $p < 0.10$ ). Across industries, PV is positive and statistically significant ( $p < 0.05$ ) for the Business Services, Healthcare, Insurance, Retail and Toys

industries. PA is either not significant, or if statistically significant ( $p < 0.001$ ), then only for the Business Services sector. VA has a mixed sign across industries where it is positive and significant ( $p < 0.001$ ) for Wholesale industry, but negative and significant at  $p < 0.05$  for Personal Services sectors. Finally, PVA is also positive and significant ( $P < 0.001$ ) for the Business Services, Transportation and Wholesale industries.

Overall, consistent with the main results (cross-sectional pooled design, Table 8), the proactive security measure disclosure has the most effect on price. Additionally, industries like Business Services, Clothes, Retail, Insurance, and Transportation are the ones where the information security related disclosures have most significance. All these industries rely heavily on online e-commerce, and interact with sensitive customer data. However, for Banks and Financial industries, the market does not seem to be reacting to any disclosures of information security related activities. Thus, the industry analysis seems to corroborate the cross-sectional pooled analysis, and provides support that my proxy for information security disclosure has merit.

## **5.7 Discussion**

Overall, it seems that larger firms tend to disclose security-related activities more often than the smaller firms. Even though the mean stock price and the standard deviation of the price are not that different between the two groups, the average earnings for the reporting firms is 37 cents (per share) lower than the non-disclosing firms. Furthermore, it is also instructive to note that the correlation between earnings

and various categories of disclosures are generally negative and statistically significant.

The main empirical findings of the research are shown in Table 8, which is a cross-sectional pooled regression. It appears that disclosure, in general, is positively and significantly related to stock prices. Even though the model fit is not that different from the base case i.e., the additional variable does not improve the model fit, it still helps explain 59% of the variation. However, the main interesting finding is that the coefficient on disclosures of information security activities is positive and significant. For individual categories of disclosure, it appears that the proactive security measures dominate other types of disclosures (i.e., the price is positively and significantly related to disclosures of proactive security measures).

For year-to-year regression, the results are somewhat interesting. First, generic security reporting regression shows that disclosures are significant for each year. The magnitude of coefficient on year 2001 is the highest (3.032) while for year 2002 it is the lowest (2.003). The model fit parameter changes slightly from 0.558 in year 2000 to 0.639 for year 2004 indicating that with time, investors are getting more knowledgeable about this intangible disclosure. For individual types of disclosures, proactive security activities' (P) reporting is positive and significant across the study time-period. However, disclosures of potential vulnerability (V) seem to have an effect (positive and significant) in year 2004 alone, while actual security breaches (A) disclosure occur only in year 2003, but has a negative coefficient that is statistically insignificant. Furthermore, for the joint disclosures (PV, PA, VA, PVA), it appears that wherever there is a mention of proactive security steps, the disclosures are

positive and statistically significant. Interestingly, joint disclosures of VA are positive in the early years (2001-02), but for year 2004, VA disclosures have a negative ( $p < 0.05$ ) effect on the price. Thus, the empirical evidence supports that the proactive security measures are consistently economically significant.

Overall, I find empirical support that the market values discretionary disclosure of security. Additionally, the results also empirically corroborate Einhorn's (2005) theoretical price model, which shows that the coefficient on voluntary disclosure will be positive, if the correlation between the mandatory and voluntary disclosures is negative. However, these results do not rule out the alternative hypothesis that since these firms have lower earnings and a somewhat depressed stock price, they are "high" disclosers, and the indicator variable is detecting the effect of high numbers of disclosures as opposed to information security-related information.

If that is the case, then a priori, I would assume that I would find significance on this indicator variable across all industry groups as well. However, for the industry-wide analysis (Table 10), it seems that not all industry groups have significance. In general, my analysis reveals that fourteen industries have statistically significant disclosure coefficients, and all of them except two, have positive magnitudes. The firms in these industries (Business Services, Clothes, Retail, Insurance Healthcare, and Transportation<sup>14</sup>) are not only technologically advanced, but are also data dependent. Furthermore, these firms rely heavily on online initiatives, which increase their vulnerability, and consequently make them cognizant

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<sup>14</sup> Firms in the transportation industry include airlines that are relying on an online sales model.

of information security concerns. It should also be noted that information security investments could have the potential to generate revenue for a firm (i.e., competitive advantage). Consumers would have a higher trust with firms that are actively engaged in protecting the information, and thus, would increase the cash flow for the firm. On the other hand, security disclosures by firms in other industry sectors, such as Automobiles and Books (Printing and Publishing) that do not have a consumer focus, seem to be insignificant. Finally, since government has already mandated organizations in Banking and Financial industries to implement information security procedures (Gramm-Leach-Bliley Act 1999), it is not surprising that the information security disclosures in these industries are insignificant. In fact, the non-significant results provide further support for the information security activities disclosure proxy, in that the proxy variable represents the affect of voluntary disclosures of information security-related activities, and not just increased disclosures.

## Chapter 6

### Robustness Analysis

These results are based on the most parsimonious of models to explore the effects of voluntary disclosures. To further check the consistency of results, the following robustness checks are conducted.

#### 6.1 Additional Proxies Check- Size and Abnormal Earnings

Aboudy et al. (2004b, p. 255) suggests using an additional variable in the model that proxy for future earning potential, and recommends using mean year-end analyst's earnings growth forecast. As discussed in the methodology section, I proxy for the future earning potential by using the ratio of market-value to book-value (Q). However, to be consistent with the prior literature, I re-estimate the model using mean year-end analysts' earnings growth forecast. Untabulated results showed that there is no material difference in my main findings. Additionally, one of the main concerns for the price-levels model is the biasing of the estimated coefficients due to scale effects. Therefore, I use the log of assets (lnassets) as a proxy for firm size in addition to scaling by the number of shares outstanding. Results of the expanded model (untabulated) adding the lnassets variable do not alter the results in any significant manner.

#### 6.2 Returns Model

Based on the prior discussion on methodology, the question of which model to use i.e., price-levels versus returns model, depends jointly on the hypothesis of



interest, and on econometric concerns (Landsman and Magliolo 1988). The main difference between the two types of analysis is that the former is interested in determining what is reflected in the firm value, and the latter is interested in addressing the question, “What is reflected in *changes in value* over a specific period of time?” (Barth et al. 2001, p. 95 emphasis added). Thus, it is imperative that appropriate specification is selected based on the question under consideration. That is, if the concern is more of timeliness rather than association of value relevance of accounting information, then returns model is the appropriate specification. Although not necessarily required, but as Kothari and Zimmerman (1995, p. 34) notes, the use of both price and return model specifications has the potential to further corroborate the results. Following this suggestion, Amir and Lev (1996) and Aboody et al. (2004b, p. 255) also use a combined methodology in their studies. However Aboody and Lev (1998 , p. 170) cautions that “an association between unexpected [items] and the contemporaneous annual stock returns indicates the extent to which the information contained in [items] is consistent with that used by investors (such and association test cannot, of course, indicate whether investors actually used [items] data in assessing security values).” Thus, I estimate the following return model<sup>15</sup>:

$$\text{Annret}_{it} = \alpha_0 + \alpha_1 * \text{Dis}_{it} + \alpha_2 * \text{EPSS}_{it} + \alpha_3 * \Delta \text{EPS}_{it} + \alpha_4 * \Delta \text{Q}_{it} + \sum \alpha_j * \text{Indus}_{it} + \varepsilon_{it} \quad (7)$$

Where:

$\text{Annret}_{it}$  = Annual return of firm ‘i’ for year ‘t’, cumulated 9 months before ‘t’ to 3 months after ‘t’

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<sup>15</sup> It should be noted that econometrically, the returns model is actually a first-difference price model scaled by the prior-period price. The intuition behind using the return model is that first differencing will take account of, at least, the fixed correlated omitted variables.

$EPSS_{it}$  = Earnings per share for firm 'i' for year 't', scaled by previous year-end EPS

$\Delta EPSS_{it}$  = Change in  $EPS_t - EPS_{t-1}$  scaled by previous year beginning EPS for firm 'i' for year 't'

$\Delta Q$  = Changes in Q ( $MV_t/BV_t$ ) i.e.,  $Q_t - Q_{t-1}$  for each firm 'i' for year 't',

Dis = Proxy variable for "types" of disclosure being analyzed. I use three regression specifications as follows:

- 1) Base model without any disclosure variables,
- 2) Generic security disclosure, where Dis = 1 if proactive security measure or potential security vulnerability or actual security breaches =1, 0 otherwise,
- 3) For the second regression, I add the following six dummy variables in place of Dis to proxy for the following groups:
  - i. proactive security disclosures, where P = 1 if proactive security measure =1, 0 otherwise,
  - ii. Potential security vulnerabilities (V), where V= 1 if potential security vulnerability =1, 0 otherwise,
  - iii. Actual security breaches disclosures, where A = 1 if actual security breaches =1, 0 otherwise, and

- iv. Joint disclosures of proactive security measures and potential vulnerabilities, where  $PV = 1$  if there is a joint disclosure, 0 otherwise,
- v. Joint disclosures of potential vulnerabilities and actual security breach, where  $VA = 1$  if there is a joint disclosure, 0 otherwise,
- vi. Joint disclosures of proactive security measures and actual breaches, where  $PA = 1$  if there is a joint disclosure, 0 otherwise,
- vii. Joint disclosure of proactive security measures, potential vulnerabilities and actual security breaches, where  $PVA = 1$  if joint disclosure, 0 otherwise

Industry =1 if current industry, 0 otherwise

The results of pooled cross-sectional analysis of returns model is presented in Table 11. Similar to Table 8, I estimate five models, where three models (1,2,3) are analyzed using full sample of 21,120 observations, while Models 4, and 5 are estimated using sample excluding firms from Banking and Financial industries. Consistent to levels analysis, I find that the generic information security disclosure (Model 2 and 4) is positive and significant ( $p < 0.001$ ). Further analysis of types of information security disclosure provides some interesting findings. Model 3 shows that proactive security measure (P) is not significant, while potential vulnerability (V) is positive and significant. Compared to price models, PV and PVA are again both

positive and significant ( $p < 0.05$ ). Coefficients on PA and VA are not significant and negative, as compared to positive in levels models. However, a couple of interesting points from the returns models are that P becomes positive and significant ( $p < 0.05$ ) when the sample exclude Banking and Financial firms (Model 5), and coefficient on actual security breaches (A) is positive and significant (Models 3, and 5). Overall, it appears that disclosures of proactive security measure have a positive and statistically significant effect (i.e., the market values them). The positive coefficient on the actual security breaches might be due to the fact that the market had reacted quite negatively on the original breach news, but over a long window<sup>16</sup>, the market compensates these firms.

### **6.3 Matched-Pair Analysis**

To further check the consistency of the results, and to investigate if significance in the model is due to the sample size, I re-ran the price (levels) models using a matched-pair design. For this analysis, each disclosing firm is matched with a non-disclosing firm with the closet market value (equity) for a given year and industry. The intuition behind matched-pair design is that by matching firms from same time-periods, industries, and size (market value), the ‘correlated omitted variables’ (including size, and risk characteristics) is mitigated. Another advantage of matched-pair design is that if the results hold in a ‘smaller’ sample, then the findings are more robust. However, one consequence of reducing the sample size is that the estimated coefficient might not have statistical significance.

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<sup>16</sup> Long window has a horizon of one-year i.e., annual returns are cumulated over 12 months as opposed to short window analysis, wherein duration of 3 to 7 days is used for cumulating stock returns.

The results of the price regression for the matched-pair sample are presented in Table 12. The explanatory variables are similar to the ones included in the main results (i.e., year and industry dummies are also included). For the matched-pair sample, I estimate four separate regressions. Model 1 and 3 use the all the matched-pairs, while in Models 2 and 4 (as before), Banks and Financial firms are excluded. The coefficient on generic disclosure is positive and still statistically significant ( $p < 0.001$ ). The proactive security measure (Models 2 and 4) is also positive and statistically significant at  $p < 0.05$ . Compared to the main results (Table 8) joint disclosures of PV, PA and PVA are again positive and significant ( $p < 0.05$ ). The coefficient on VA is also positive (similar to main results) and insignificant. However, potential vulnerability (V) is now insignificant on any statistical level while still being positive.

Additionally, I estimate the returns equation for the matched-pair sample as well (Table 14). Identical to the price levels, I estimate four separate regressions. However, in this analysis, I do not find any significance, except for the actual security breach (A) coefficient, which is significant and positive. One possible explanation for this set of the results (as compared to the all firms sample – Table 11) is that the power of the test is weak. Another possible explanation could be that previous literature has documented that disclosures of voluntary nature are endogenous, and not controlling for this endogeneity might be the cause for a lack of statistical insignificance.

## 6.4 Industry-Wide Returns Model

In a similar vein, the results of returns regression on industry sectors are presented in Table 14. Panel A shows the return regressions on the generic disclosure dummy variable, while panel B lists the results by various types of disclosures. Generic information security disclosures (panel A Table 14) is positive and statistically significant only in three industries (Business Services, Household, and Smoke [tobacco products]) at  $p < 0.001$ , while for Telecommunications, the coefficient is positive and statistically significant only at  $p < 0.05$  and Meals (restaurants, hotels and motels) have a marginal significance. For the Steel industry, the disclosure coefficient is negative and significant ( $p < 0.001$ ). An examination of the individual types of disclosures on annual returns shows some interesting results as well (panel B Table 14). The Business Services, Households, Machinery, Meals, and Smoke sectors all have positive proactive security measures (P) coefficient ( $p < 0.05$ ). However, for the Banking and Finance sector, the coefficient is marginally significant ( $p < 0.10$ ) and negative. On the other hand, the potential vulnerability coefficient is always positive when it is statistically significant (Business Services, Paper, and Not-classified industries). Actual security breaches (A) is also positive and statistically significant for the Business Services sector. Joint disclosures VA and PA are not significant in any industries, while PVA is positive and significant for the Business Services and Machinery sectors. Joint disclosures of PV are negative for the Books and Miscellaneous industries, while for the Banks, Business Services, and Telecommunications industries the coefficient is positive and statistically significant.

Overall, there is no clear support from the returns model for the earlier (tabulated) price-levels results with the exception for the Business Services industry.

## 6.5 Disclosures Endogeneity

In almost all of the disclosures-related studies, disclosure is usually the dependent variable, and the idea is to find the determinants of the disclosures. However, in this research, the disclosure is used as an explanatory variable along with other independent variables. Voluntary disclosures, in of themselves, are an ex ante commitment or policy to provide information, and is endogenously determined by the firm. Specifically,

*“When a manager receives information at a point in time, the manager may ex-post choose to withhold or provide this information in order to correct mis-valuation. If the manager chooses to disclose this information, this disclosure will change the stock price. However, firms with high disclosure quality will withhold less information. Therefore, there are two effects: 1) disclosure quality [precision], which is the firms’ ongoing ex ante commitment to provide disclosure; and 2) “discretionary” disclosure, which is an ex post realization of this ex ante commitment” (Core 2001, p. 448).*

Therefore, any study that does not take into account the endogenous factors might run into the problem of spurious inferences. Hence, one possible refinement to the model is to try to account for this endogenous effect. Leuz and Verrecchia (2000) address the issue of voluntary disclosure in their study as well. Specifically, they refer to the voluntary disclosure as a “self-selection” (Leuz and Verrecchia 2000, p. 99) issue. The intuition behind the self-selection bias is that the firms choose to disclose information based on their own cost benefits analysis (i.e., the firms self select themselves to either provide a disclosure or not). Thus, a simple OLS (Ordinary least square) analysis using a dummy variable for disclosures suffers from

self-selection bias (Heckman 1978). However, econometric methods are available that correct for the selection bias, while including the main effect of the variable on which the selection occurs. These models are referred to as “treatment effects” (e.g., Wooldridge 2002). In its most simplistic form, a treatment model is characterized as follows:

$$y_i = x_i + \delta z_i + \varepsilon_i \quad (8)$$

Where  $z_i$  is an endogenous dummy variable on which selection occurs (i.e., the decision to obtain ‘treatment’ is modeled as an outcome of the unobserved latent variable,  $z_i^*$ , which is a linear function of covariates  $w_i$ :

$$z_i^* = w_i \gamma_i + u_i \quad (9)$$

Where the observed decision is:

$$z_j = \begin{cases} 1, & \text{if } z_j^* > 0 \\ 0, & \text{otherwise} \end{cases}$$

Simply, the disclosure variable is an endogenous binary variable. Ideally, endogenous variables can be consistently estimated using Instrument Variables (2 Stage Least Squares – 2SLS) models. However, there are two issues that need to be addressed in self-selection models. First, if I use the 2SLS method, the first stage equation would become a linear probability model since the dependent variable is binary, which has its own limitations. Additionally, I am interested in the estimating the probability that a firm is either a discloser or not. Therefore, a better model to use for estimation is a first stage Probit model. Second, in the main equation of interest, I would like to control for the potential probability of being a discloser (i.e., the interest



is in controlling for the omitted variables that might bias the coefficient based on the unobserved variables). Heckman (1978) and Maddala (1983) both show that such a model can be consistently estimated by using a two equation system (as shown above), and employing an inverse mills ratio (hazard of disclosing) as a proxy variable in the main equation of interest. It is instructive to note that since the two equations are correlated, both of the equations need to be estimated simultaneously to ensure that the estimated variances are consistent. Thus, the two equations model for my study becomes:

$$D_i^* = \gamma' z_i + \varepsilon_i \quad (\text{Disclosure Model}) \quad (10)$$

$$P_i = \delta D_i + \beta' x_i + u_i \quad (\text{Value-relevance model}) \quad (11)$$

Where:

$x_i$  = includes all the variables defined for the main model (Eq. 5), the inverse mills ratio (i.e., probability [hazard] of issuing an information security-related disclosure) and the intercept term

$D_i$  = 1 is the firm reporting choice (i.e., either proactive security disclosure or potential vulnerability or actual security breach = 1), 0 otherwise

$D_i^*$  =: unobserved choice variable of the firm, such that  $d_i = 1$  if  $d_i^* > 0$ , and  $d_i = 0$  otherwise

$z_i$  = is a vector of variables that determine the firm's disclosures strategies

The main question thus, in estimating the treatment model is to identify the variables that effect firms' disclosure choices. In this regard, the extant literature is replete with studies of cross-sectional determinants of corporate disclosures. Specifically, I rely on Luez and Verrecchia (2000) and Field et al (2005) studies, since both the studies provide a comprehensive list of variables that affect a firms' disclosures. Based on the review of the two papers, following variables are identified:

1. Firm performance - Return on assets (operating income before extraordinary items/assets)
2. Capital requirement (long term assets/assets – financing needs),
3. Firm size (log of assets)
4. Industry dummy variables (membership of industries affect disclosure)
5. Liquidity – stock turnover ( $[1 - \Pi_t (1 - \text{volume traded}_t / \text{total shares}_t)]$ )
6. Information asymmetry - Volatility (standard deviation of stock returns)
7. Analyst following (total number of analysts following a firm)
8. Institutional holding (percentage of shares held by institutions/total shares outstanding).

The additional financial variables for the firms are collected from the Annual Combined CRSP/COMPUSTAT database. Stock turnover and volatility is estimated using monthly CRSP file for volume of shares traded and returns. Analyst following is computed from the I/B/E/S detail file that provides information on the number of

analysts issuing forecasts for a firm; and institutional holding is obtained from Thomson 13f database that provides information of number of shares held by institutions.

The results of selection-controlled regression are presented in Table 15. Panel A (Table 15) details the first stage Probit regression results that is used to estimate the inverse mills ratio. The coefficient on the generic disclosure variable is positive and significant at 0.001 level, after controlling for the selection-bias (price model panel A Table 15). The coefficient on EPS, BVPS, and Q exhibit the usual signs and significance. The estimation on individual types of disclosure is presented in panel B (Table 15). For these results, I estimate each type of disclosure independently (i.e., each selection model is run separately for the seven groups of information security disclosures). As compared to the main results (Table 8), I find that the proactive security measures (P), and potential vulnerabilities (V) coefficients to be positive and significant at 0.001 levels. Actual security breach (A), shows its consistent negative sign, but is not significant. Joint disclosures of PA, and PVA are positive and significant at 0.001 levels, while VA is significant at 0.10 level. Possibly the most interesting of all the finding is that of the joint disclosures of VA. Compared to the main results (Table 8 where VA is not significant), the coefficient is negative and statistically significant at  $p < 0.001$ . Additionally, the  $R^2$  for all the models are consistently above 0.57, indicating that the model does provide a reasonable fit.

Overall, the previous conclusion that disclosures' containing any mention of proactive security measures has a positive impact on the stock price, holds. Furthermore, I also found empirical support that firms that have had actual security

breaches and still disclose that their systems are vulnerable, have a negative price association. Intuitively, these finds make sense, as markets should reward firms that are undertaking steps to protect their information assets, and should penalize firms that still disclose vulnerabilities, even after they have suffered a security breach.

## Chapter 7

### Conclusions, Limitations and Future Direction

#### 7.1 Contribution

The main contributions of the study are: 1) an attempt to further our understanding regarding voluntary disclosures, specifically vis-à-vis qualitative managerial disclosures<sup>17</sup>; 2) an endeavor to contribute to the extant literature value relevance of non-financial information; 3) an addition to the information security literature concerning the value of information security-related activities to firms; and 4) identifying a public source of information security data. In addition, the study is an attempt to highlight an important area of research for accounting, particularly as we are now in an information-economy. Under the new economy paradigm, information is the strategic tool that helps to gain a competitive advantage. Thus, this asset needs to be protected and/or valued.

Besides providing empirical support, this study also has practical managerial implications. Perhaps one of the most important findings of the study is that information security disclosures matter. Overall, market response for security disclosures is positive. In other words, voluntary disclosures of information security related disclosures help in increasing the firm value i.e., managers should report their security-related activities. Consequently, the research also (indirectly) underscores the importance of information security investments. Surveys by leading industry

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<sup>17</sup> This research also attempts to adds to the current debate of recognitions versus disclosures in accounting.

practitioners (e.g., Berinato and Ware 2003) show that firms investing more in security are as susceptible to breaches as the ones that invest less<sup>18</sup>, which results in providing confounding signals to firms regarding the value of information security investments. In contrast to these surveys, the results of this study underscore the importance of market value of the expenditures on information security – at least the proactive security measures investments. Thus, management that thinks of security investments as nothing but “the cost of doing business,” should note that these investments, even though non-revenue generating, do provide value. Accordingly, investment in information security might help firms to differentiate themselves, and provide a strategic competitive advantage. Finally, if the market does not want to have more regulations imposed on them, then a policy of voluntary disclosure would be beneficial, for at least the short run, it would provide value to the firms.

## **7.2 Future (Post-Dissertation) Directions**

This dataset provides unique opportunities to develop a stream of research. One such possibility is to use the same methodology in an international setting. For example, an interesting extension would be to use European firms’ data, which face stringent European Union Privacy and more information protection regulations than US firms. Another possible extension to the study is to attempt to match the voluntary disclosures in the annual filings to previously reported security breaches for the firms in the popular press (Campbell et al. 2003), and see if the market re-

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<sup>18</sup> Berinato and Ware (2003) is a CIO magazine and PricewaterHouseCoopers sponsored survey. The finding of no differences in likelihood of security breach between high vs. low security investments could be the result of the companies sampled i.e., sample bias. Furthermore, as opposed to investigating the probability of a security breach, this study is focused on the market-value of voluntary disclosures of information security related activities, including disclosures of proactive security measures, potential vulnerabilities, and actual security breaches.

evaluates these firms differently. Furthermore, as discussed previously, most of the voluntary disclosures studies are usually focused on identifying the determinants of the disclosures. Therefore, another possibility that can be pursued is to study the determinants of voluntary disclosures of information security-related activities. Even though I identify and use some explanatory variables (instruments) to correct for the self-selection of firms to voluntary disclose information security activities, the overall  $R^2$  (0.1495 – for the selection model Table 15 Panel A) is relatively small. Thus, empirically testing determinants of voluntary disclosures of information security-related activities will help us better understand the factors that effect the organizations in the information economy. Last but not the least, another interesting question that can be explored is to analyze the managerial compensation schemes (structures) for the firms providing voluntary disclosure. Broadly, such an analysis could also explore the various corporate governance structures at the organization level to get a better understanding of firm characteristics. Such an analysis can provide further insights as to the motivation of why firms provide disclosures of information security related activities.

### **7.3 Limitations**

As with all research, my research has its limitations as well. First, as discussed throughout this document, the value-relevance model is a parsimonious description of an otherwise complex firm valuation. Specifically, the model assumes a linear relationship between the firm value and explanatory variables. It could be that this relationship is either non-linear, or suffers from correlated omitted variables

issue. Every precaution is taken to mitigate these effects where robustness checks are conducted specifically to mitigate potential biases.

Second, the disclosure variable might be noisy. This noise could happen since I not only use textual information, but I am also focusing on a single source of information i.e., annual filings of firms with the SEC. It could be that other firms might have disclosed in another medium or perhaps in some table format that was not identified. For textual coding, the taxonomy was kept as simple as possible (0 or 1) to ensure consistency. Also, for the pre-test sample, the disclosures were rated by three people to check the classification, and if there were any difference, they were reconciled. Furthermore, one of contribution of the study is to identify a public source of data so that these results can easily be replicated. I also checked press releases and firms' annual reports (for the investors) to see the number of disclosures: consistent with the idea of security through obscurity, there were not many reports.

Third, the implicit underlying assumption in all disclosures studies is that all voluntary disclosures are truthful. Nevertheless, there are competitor deterrence models that might view disclosures as "cheap-talk" (Gigler 1994). However, I anticipate that both reputational consideration and litigation costs will preclude firms from disclosing untruthful information.

Fourth, the information security activities are time sensitive i.e., right now there is enormous attention for privacy and data protection issues. Therefore, it could be the case that the results are due to the time-frame that was selected for analysis. I specifically extended the time period to five years, especially to tweak out the affect of the 'recent' years, as opposed to the time when security was not such a hot topic.



My results consistently provide empirical support that information activities are value relevant. Additionally, the annual returns analysis for the matched-pair design and industry analysis requires further evaluation. One possible explanation for the return analysis in matched-pair design as compared to the all firms sample (Table 11) is that the power of the test could be weak. Another possible explanation could be that disclosures of a voluntary nature are endogenous (Core 2001), and not controlling for this endogeneity might be the cause for lack of statistical insignificance. For the industry analysis, the results (besides the above-mentioned reasons) could be due to the industry classification used in this research. Currently the industry classification being used separates the full sample into 35 different segments (see Bhojraj et al. 2003, Table 2 p. 757-759). For example, previous research that has conducted industry membership analysis had used various industry memberships, ranging from nine groups (Wild 1992), to fifteen (Barth et al. 1998, p. 25 Table 5), to forty- seven industry classification (Lang and Lundholm 1996a). Furthermore, Kenneth French of “Fama and French industry classification schema” (Fama and French 1997), lists industry portfolios that range anywhere from 49 to 17 classification schemes<sup>19</sup>. However, as noted in previous research, a finer partition of industry segments might make the sample size too small for individual group analyses. Furthermore, since ordinary least square regression is particularly sensitive to extreme (influential) observations, it could be that significance or negative coefficients could be due to the granular partition. For example, in the Automobile industry there are only three firms that disclosed (Table 5). Also, the fact that the Household industry has a strong

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<sup>19</sup> Further details on the industry portfolio see [http://mba.tuck.dartmouth.edu/pages/faculty/ken.french/Data\\_Library/changes\\_ind.html](http://mba.tuck.dartmouth.edu/pages/faculty/ken.french/Data_Library/changes_ind.html)

negative and significant coefficient for vulnerability disclosures (Table 10) is based on three security disclosures that were made for the whole industry in the study period. The above notwithstanding, it could be the case that for firms in certain industries, like Construction, the market looks at security investments as unnecessary, and are hence penalizing these firms.

Last but not least, it could be that the assumptions on error terms for my analysis are being violated. That is, since I am running pooled cross-sectional regression, it could be that error terms for firms are auto-correlated, besides being heteroscedastic. If that is the case, then the standard error might be biased. Thus, a feasible GLS model, or a random-effect model might be employed to further corroborate the robustness of my current findings.

## **7.4 Conclusion**

Technology and telecommunications innovations have fundamentally changed the way businesses operate, and we are now in what is termed as an ‘information-economy’ that is characterized by ‘information’ as one of the firm’s critical assets. One of the unintended consequences of interconnectivity is that the organization’s network has become that much more vulnerable. Although, organizations are actively involved in securing their digital assets, they face serious costs in disclosing such activities. Compounding the issue, is the fact that recent security breaches are spurring more legislations that would further burden the firms who are already under a lot of pressure to comply with the existing laws. Since information security investments are primarily non-revenue generating activities, firms are not sure if there

is any economic benefit from such endeavors, or if it is just the “cost-of-doing-business” in the new economy.

This research is the first attempt to provide empirical support that security-related disclosures, and indirectly information security activities, have economic consequences for firms. Drawing on accounting literature of disclosures and using a sample of 1,637 disclosing and 19,843 non-disclosing firms-years in a cross-sectional pooled model, my main results provide support that security disclosures, in general, are significantly and positively related to stock price. The result is robust to year-to-year analysis with an interesting finding that magnitude of disclosures is highest in the first year of the sample. For industry analysis, the effect is more pronounced in firms that are not only technology and data dependent, but have customer-facing operations. The industry-wide analysis provides partial support to the disclosure proxy. That is, if the proxy variable is a representation of firms that, in general, disclose more information (high-disclosers), then the dummy variable should be significant across all the industries. Specifically, for the regulated industries (Banks and Finance), lack of significance for generic information security disclosures provides further support that my proxy is indeed reflecting the affect of information security activities disclosures. Furthermore, the results are robust to various proxies for size and abnormal earnings, matched-pair design, and self-selection models.

The research has both theoretical and managerial implications. First, it adds to the debate on discretionary disclosure as a ‘signaling’ mechanism. Whereas Lev and Penman (1990) concludes that there is no signaling effect, my sample shows a positive effect of discretionary disclosure. Second, the paper makes an attempt to add

to the extant literature of value-relevance and voluntary disclosures of intangible assets. The study provides empirical support that the market does recognize these voluntary disclosures, in general, and specifically the disclosures of proactive security measures are valued highly. Finally, managerial implications are: 1) security reporting is better for firm value; and 2) indirectly, the results show that security activities have economic value for the firm. However, as with all research, there are limitations. Nevertheless, the dataset has rich information that will allow further refinements to the analysis, as well as address other interesting questions that could provide a fruitful stream of research for the future.

## Appendix

### Example of Disclosures of Security Activities

#### Actual Security Breach

*For example, approximately four percent of our customers experienced a brief delay in delivery of services on June 15, 2004 as a result of a denial of service resulting from an attack by hackers on our network. We believe this attack targeted several well-known websites that are customers of Akamai. Although we have taken steps to enhance our ability to prevent the recurrence of such an incident, there can be no assurance that similar attacks will not be attempted in the future, that our enhanced >>security measures>> will be effective or that a successful attack would not be more damaging. Any widespread loss or interruption of our network or services would reduce our revenues and could harm our business, financial results and reputation. >>>>PAGE: 10>>>*

*Filer: AKAMAI TECHNOLOGIES INC*

*Report: 10-K*

*Date Filed: 3/16/2005*

*Period: 12/31/2004*

*...have a material adverse effect on our business, results of operations and financial condition. We have security risks On occasion, some experienced programmers (hackers") have attempted to penetrate our network security. We expect that these attempts, some of which have succeeded, will continue to occur from time to time. Because a hacker who penetrates our network security could misappropriate proprietary information or cause interruptions in our services, we might be required to expend significant capital and resources to protect against, or to alleviate, problems caused by hackers. Additionally, we may not have a timely remedy against a hacker who is able to penetrate our network security. In addition to purposeful security breaches, the inadvertent transmission of >>computer viruses>> could expose us to litigation or to a material risk of loss. Such security breaches and inadvertent transmissions could have a material adverse effect on our business, results of operations and financial condition. In offering certain online payment services, we may increasingly rely on technology licensed from third parties to provide the security and authentication >>>>PAGE: 24>>>*

*Filer: AUTOWEB COM INC*

*Report: 10-K*

*Date Filed: 4/2/2001*

*Period: 12/31/2000*

## Proactive Security Measures

(j) Notifying D&B's risk management group of any security violation or unauthorized attempt to access or alter D&B data and escalating the issue in accordance with applicable D&B security policy guidelines and procedures. (k) Conducting periodic reviews, as appropriate, to validate that individual employee access to programs, databases, and libraries is appropriate. (l) Capturing data regarding routine access and exceptions for audit trail purposes, and making such data available to D&B upon request. (m) Performing periodic security reviews, providing incident investigation support, providing copies of the report to D&B, and initiating corrective actions to minimize and prevent >>security breaches>>. (n) Providing monthly reports on violation and access attempts, and retaining documentation of the investigation for a period of one (1) year. (o) Providing security access control tools for data, software, and networks in compliance with D&B security policies, standards and procedures and maintaining such security and access control devices in proper working order. (p) Establishing and administering p>>>>EX-10.43>>>>PAGE: 178>>>>

Filer: DUN & BRADSTREET CORP/NW  
Report: 10-K  
Date Filed: 3/14/2005  
Period: 12/31/2004

> disclose nonpublic personal information to nonaffiliated third parties and affiliates; annual notices of their privacy policies to current customers; and a reasonable method for customers to opt out" of disclosures to nonaffiliated third parties. Compliance with these rules was mandatory after July 1, 2001. San Rafael Bancorp and Tamalpais Bank were in full compliance with the rules as of or prior to their respective effective dates. SAFEGUARDING CONFIDENTIAL CUSTOMER INFORMATION. Under Title V, federal banking regulators are required to adopt rules requiring financial institutions to implement a program to protect confidential customer information. In January 2000, the federal banking agencies adopted guidelines requiring financial institutions to establish an >>information security>> program. Tamalpais Bank implemented a security program appropriate to its size and complexity and the nature and scope of its operations prior to the July 1, 2001 effective date of the regulatory guidelines, and since initial implementation has, as necessary, updated and improved that program. COMMUNITY REINVESTMENT ACT SUNSHINE REQUIREMENTS.>>>>>Body of Filing>>>PAGE: 27>>>>

Filer: EPIC BANCORP  
Report: 10-KSB  
Date Filed: 3/30/2004  
Period: 12/31/2003

## Potential Vulnerability

*Many of our competitors have substantially greater resources to invest in technological improvements. We cannot assure you that we will be able to effectively implement new technology-driven products and services, which could reduce our ability to effectively compete. Our hardware and software systems are vulnerable to damage that could harm our business. We rely upon our existing information systems for operating and monitoring all major aspects of our business, including deposit and loan information, as well as various internal management functions. These systems and our operations are vulnerable to damage or interruption from natural disasters, power loss, network failure, improper operation by our employees, >>security breaches>>, computer viruses or intentional attacks by third parties. Any disruption in the operation of our information systems could adversely impact our operations, which may affect our results of operations and financial condition.*

*Filer: YARDVILLE NATIONAL BANCORP*

*Report: 10-K*

*Date Filed: 3/31/2003*

*Period: 12/31/2001*

*If hackers gain unauthorized access to our systems, we could suffer disruptions in our business and long-term damage to our reputation. As an anti-virus company that delivers virus protection products over the internet, we may be more susceptible to problems caused by hackers than other software companies. For example, if hackers were able to cause us to transmit computer viruses or interrupt the delivery of our anti-virus software monitoring and security services over the internet, we could suffer substantial disruptions in our business and material damage to our reputation. This could result in a significant loss of our customers and other important business relationships. We could also incur costs for public relations efforts following attacks by hackers. >>Hacker>> activities could also force us to incur substantial costs to fix technical problems or result in hackers gaining access to our proprietary information.*

*10 >>>>Body of Filing>>>>PAGE: 10>>>>*

*Filer: TREND MICRO INC*

*Report: 20-F*

*Date Filed: 6/29/2001*

*Period: 12/31/2000*

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**Table 1**

**Listing of Keywords used for Annual Filings**

Keyword	No of Instances
Security Measure* <sup>a</sup>	2,211
Authentication	1,823
Encryption	1,411
Computer Virus*	1,277
Security Breach*	1,209
Disaster Recovery	1,182
Information Security	937
(Network Or Computer) Join(1) Security	906
Access Control	595
Intrusion	573
Business Continuity	406
Security Management	224
Hacker	204
Security Monitoring	188
Denial Of Service	158
Cyber Security	26
Cyber Attack*	19
Security Incident	16
Infosec	7
Security Expenditure*	7
Computer System Security	3
Cybersecurity	3
Computer Breach*	2
Computer Intrusion*	1

<sup>a</sup> \* = wild-card searches e.g. for Computer Breach\* both 'computer breach' and 'computer breaches' are searched



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**Table 2****Summary of Sample Selection Process**

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	Number of Disclosing firms-years	Percent	Number of Non-Disclosing firm-years	Percent
Total firm-years	2,479	129.38%	25,088	100.00%
Missing Permno	<u>(563)</u>	<u>(29.38%)</u>		<u>0.00%</u>
Firms identified	1,916	100.00%	25,088	100.00%
Missing financial + outliers	(274)	(14.30%)	(5,340)	(21.29%)
Missing industry classification	<u>(5)</u>	<u>(0.26%)</u>	<u>(265)</u>	<u>(1.06%)</u>
Total Firm-Year sample	1,637	85.44%	19,483	77.66%
Total sample size: Firm-years (Disclosing + Non-disclosing firms)		7.75%	21,120	92.25%

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**Table 3****Fama French Industry Classification for Two Digit SIC Codes***Panel A: Two digit SIC code mapping to Fama French industry portfolios*

Two-digit SIC Group	Fama French Industry Classification Primary Equivalent	Two-digit SIC Group	Fama French Industry Classification Primary Equivalent
01	Agric	45	Trans
10	Gold	47	Trans
12	Coal	48	Telcm
13	Enrgy	49	Util
14	Mines	50	Whlsl
15	Cnstr	51	Whlsl
16	Cnstr	52	Rtail
17	Cnstr	53	Rtail
20	Food	54	Rtail
21	Smoke	55	Rtail
22	Txtls	56	Rtail
23	Clths	57	Rtail
24	BldMt	58	Meals
25	Hshld	59	Rtail
26	Paper	60	Banks
27	Books	61	Banks
28	Drugs	62	Fin
29	Enrgy	63	Insur
30	Not Classified	64	Insur
31	Clths	67	Fin
32	BldMt	70	Meals
33	Steel	72	PerSrv
34	BldMt	73	BusSv
35	Mach	75	BusSv
36	Chips	78	Fun
37	Autos	79	Fun
38	LabEq	80	Hlth
39	Toys	82	PerSrv
40	Trans	87	BusSv
42	Trans	99	Misc
44	Trans		

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Two digit SIC code mapping from Table 2 of Bhojraj et al (2003)

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**Table 3 (Cont'd)****Panel B: Fama French industry description**

	Fama French Industry Classification Primary Equivalent	Description
1	Agric	Agriculture
2	Gold	Precious Metals
3	Coal	Coal
4	Enrgy	Petroleum and Natural Gas
5	Mines	Nonmetallic Mining
6	Cnstr	Construction
7	Food	Food Products
8	Smoke	Tobacco Products
9	Txtls	Textiles
10	Clths	Apparel
11	BldMt	Construction Materials
12	Hshld	Consumer Goods
13	Paper	Business Supplies
14	Books	Printing and Publishing
15	Drugs	Pharmaceutical Products
16	Not Classified	
17	Steel	Steel Works Etc.
18	Mach	Machinery
19	Chips	Electronic Equipment
20	Autos	Automobiles and Trucks
21	LabEq	Measuring and Control Equipment
22	Toys	Recreational Products
23	Trans	Transportation
24	Telem	Telecommunications
25	Util	Utilities
26	Whsl	Wholesales
27	Rtail	Retail
28	Meals	Restaurants, Hotel, Motels
29	Banks	Banking
30	Fin	Trading
31	Insur	Insurance
32	PerSrv	Personal Services
33	BusSv	Business Services
34	Fun	Entertainment
35	Hlth	Healthcare
36	Misc	Miscellaneous

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Description from Appendix A of Fama and French (1997)

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**Table 4****Summary of Disclosures***Panel A: Number of security disclosures by type*

Group	Proactive Security	Potential Security Vulnerability	Actual Breaches	Disclosures
1	0	0	4	4
2	757	0	0	757
3	2	0	2	2
4	0	374	0	374
5	0	11	11	11
6	1,258	1,258	0	1,258
7	<u>73</u>	<u>73</u>	<u>73</u>	<u>73</u>
<b><u>Total (1) – (7)</u></b>	<b><u>2,090</u></b>	<b><u>1,716</u></b>	<b><u>90</u></b>	<b><u>2,479</u></b>

*Panel B : Number of unique firms providing security disclosures*

No. of Disclosures	Unique Firms	Percent of total	Cumulative frequency
0	5,011	86.13	86.13 %
1	398	6.84	92.76 %
2	155	2.66	95.55 %
3	139	2.39	97.90 %
4	63	1.08	99.19 %
5	52	0.89	100.00 %
Total unique firms	5,818	100	

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**Table 5****Summary of Disclosures by Industry**

No.	Industry	Non-Disclosers		Disclosers			Totals		
		No. of firms-years	% of col.	No. of firms-years	% of col.	% of row	No. of firms	Cumulative freq of disclosers	Cumulative freq of firms-years
1	BusSv	2,257	11.58%	691	42.21%	23.44%	2,948	42.21%	13.96%
2	Banks	2,884	14.80%	224	13.68%	7.21%	3,108	55.89%	28.67%
3	Fin	1,305	6.70%	100	6.11%	7.12%	1,405	62.00%	35.33%
4	Insur	744	3.82%	98	5.99%	11.64%	842	67.99%	39.31%
5	Telcm	805	4.13%	91	5.56%	10.16%	896	73.55%	43.56%
6	Rtail	370	1.90%	67	4.09%	15.33%	437	77.64%	45.63%
7	Chips	1,192	6.12%	54	3.30%	4.33%	1,246	80.94%	51.52%
8	Drugs	1,689	8.67%	53	3.24%	3.04%	1,742	84.18%	59.77%
9	Whlsl	475	2.44%	41	2.50%	7.95%	516	86.68%	62.22%
10	Trans	457	2.35%	39	2.38%	7.86%	496	89.07%	64.56%
11	Mach	898	4.61%	34	2.08%	3.65%	932	91.14%	68.98%
12	LabEq	1,042	5.35%	25	1.53%	2.34%	1,067	92.67%	74.03%
13	Hlth	298	1.53%	22	1.34%	6.88%	320	94.01%	75.54%
14	Books	158	0.81%	16	0.98%	9.20%	174	94.99%	76.37%
15	Util	702	3.60%	14	0.86%	1.96%	716	95.85%	79.76%
16	Fun	234	1.20%	10	0.61%	4.10%	244	96.46%	80.91%
17	PerSrv	75	0.38%	9	0.55%	10.71%	84	97.01%	81.31%
18	Clths	143	0.73%	8	0.49%	5.30%	151	97.50%	82.03%
19	Meals	330	1.69%	6	0.37%	1.79%	336	97.86%	83.62%
20	BldMt	403	2.07%	5	0.31%	1.23%	408	98.17%	85.55%
21	Food	305	1.57%	4	0.24%	1.29%	309	98.41%	87.01%

**Table 5 (Cont'd)**

	Non-Disclosers		Disclosers			Totals		
	No. of firms-years	% of col.	No. of firms-years	% of col.	% of row	No. of firms	Cumulative freq of disclosers	Cumulative freq of firms-years
22 Misc	86	0.44%	4	0.24%	4.44%	90	98.66%	87.44%
23 Toys	152	0.78%	4	0.24%	2.56%	156	98.90%	88.18%
24 Autos	318	1.63%	3	0.18%	0.93%	321	99.08%	89.70%
25 Enrgy	836	4.29%	3	0.18%	0.36%	839	99.27%	93.67%
26 Hshld	61	0.31%	3	0.18%	4.69%	64	99.45%	93.97%
27 Cnstr	198	1.02%	2	0.12%	1.00%	200	99.57%	94.92%
28 NotClassified	173	0.89%	2	0.12%	1.14%	175	99.69%	95.75%
29 Steel	257	1.32%	2	0.12%	0.77%	259	99.82%	96.97%
30 Coal	31	0.16%	1	0.06%	3.13%	32	99.88%	97.13%
31 Paper	202	1.04%	1	0.06%	0.49%	203	99.94%	98.09%
32 Smoke	23	0.12%	1	0.06%	4.17%	24	100.00%	98.20%
33 Gold	279	1.43%	0	0.00%	0.00%	279	100.00%	99.52%
34 Mines	43	0.22%	0	0.00%	0.00%	43	100.00%	99.73%
35 Txtls	58	0.30%	0	0.00%	0.00%	58	100.00%	100.00%
<b>Total</b>	<b>19,483</b>	<b>100%</b>	<b>1,637</b>	<b>100%</b>		<b>21,120</b>		

Industry classification is based on two-digit SIC code as detailed in Table 4

**Table 6****Descriptive Statistics****Panel A: Full sample of firms**

Variable	Mean	Min	Max	Percentile			SD	N
				25 <sup>th</sup>	50 <sup>th</sup>	75 <sup>th</sup>		
Price -3 Mnth	17.40	0.09	100.95	4.31	13.13	25.70	16.27	21,120
Earn per share	0.48	-10.87	9.31	-0.33	0.44	1.45	1.84	21,120
Mkt Val	3,184.08	0.12	476,115.50	56.30	253.52	1,177.76	14,766.06	21,120
Bok Val	1,229.41	0.07	152,027.00	36.04	131.42	556.06	4,989.33	21,120
Asset	7,549.51	0.08	1,520,140.00	84.95	395.45	1,852.47	53,057.99	21,120
Sharesout	112.97	0.34	10,586.36	9.81	25.22	61.88	413.37	21,120
Q	3.09	0.01	827.94	1.10	1.79	3.04	9.06	21,120
Ann Ret	0.14	-0.96	4.88	-0.28	0.07	0.40	0.71	20,518
Turnover	0.59	0.02	1.07	0.34	0.61	0.87	0.30	21,120
Volat	0.15	0.00	1.72	0.07	0.12	0.20	0.12	20,485
Analys	5.75	0.00	62.00	0.00	2.00	8.00	8.18	21,120
Inst Hold	0.36	0.00	2.52	0.09	0.30	0.59	0.29	19,093

**Panel B: Disclosing firms**

Variable	Mean	Min	Max	Percentile			SD	N
				25 <sup>th</sup>	50 <sup>th</sup>	75 <sup>th</sup>		
Price -3 Mnth	16.30	0.09	96.74	4.00	11.03	23.51	16.31	1,637
Earn per share	0.14	-10.33	9.03	-0.55	0.16	1.11	1.89	1,637
Mkt Val	4,608.28	1.54	250,277.90	99.28	371.42	1,634.09	17,477.24	1,637
Bok Val	1,728.81	0.21	109,291.00	44.36	150.11	599.50	7,218.67	1,637
Asset	17,067.36	1.94	1,484,101.00	82.59	336.25	1,775.06	103,733.90	1,637
Sharesout	173.86	1.12	6,253.00	19.33	37.79	84.51	527.52	1,637
Q	3.65	0.07	75.51	1.41	2.36	4.07	4.87	1,637
Ann Ret	0.16	-0.96	4.88	-0.38	0.03	0.43	0.84	1,611
Turnover	0.70	0.02	1.07	0.49	0.75	0.95	0.28	1,637
Volat	0.18	0.01	1.64	0.09	0.15	0.24	0.14	1,609
Analys	7.31	0.00	57.00	1.00	4.00	10.00	9.00	1,637
Inst Hold	0.38	0.00	1.00	0.12	0.33	0.62	0.29	1,496

**Table 6 (Cont'd)**

**Panel C: Non-disclosing firm**

Variable	Mean	Min	Max	Percentile			SD	N
				25 <sup>th</sup>	50 <sup>th</sup>	75 <sup>th</sup>		
Price -3 Mnth	17.49	0.09	100.95	4.36	13.31	25.87	16.26	19,483
Earn per share	0.51	-10.87	9.31	-0.31	0.48	1.47	1.84	19,483
Mkt Val	3,064.42	0.12	476,115.50	53.71	243.64	1,134.14	14,509.37	19,483
Bok Val	1,187.45	0.07	152,027.00	35.61	129.26	552.55	4,752.53	19,483
Asset	6,749.80	0.08	1,520,140.00	85.28	402.09	1,860.14	46,258.14	19,483
Sharesout	107.85	0.34	10,586.36	9.37	24.21	60.03	401.90	19,483
Q	3.05	0.01	827.94	1.08	1.75	2.95	9.33	19,483
Ann Ret	0.14	-0.96	4.86	-0.27	0.07	0.40	0.70	18,907
Turnover	0.59	0.02	1.07	0.32	0.60	0.86	0.30	19,483
Volat	0.15	0.00	1.72	0.07	0.12	0.19	0.12	18,876
Analys	5.62	0.00	62.00	0.00	2.00	8.00	8.10	19,483
Inst Hold	0.35	0.00	1.00	0.09	0.30	0.59	0.29	17,597

Price – 3 Month = Stock price of firm 'i' for year 't', 90 days after fiscal year close - \$/share  
 EPS = Earnings per share (basic excluding special items ) for firm 'i' for year 't', at year-end - \$/share  
 Mkt Val = Equity market value of firm 'i' for year 't', at year-end – Price fiscal year end \* No. of shares outstanding  
 Bok Val = Book value of equity for firm 'i' for year 't', at year-end - '000,000  
 Sharesout = No. of shares outstanding for firm 'i' for year 't', at year-end - '000,000  
 Asset = Total assets of the firm 'i' for year 't' at year end - '000,000  
 Q = Ratio of Mkt Val / Bok Val for firm 'i' for year 't'  
 Annret = Annual return of firm 'i' for year 't', cumulated 9 mnths before 't' to 3 mnths after 't'  
 Turnover = Shares turnover computed as  $[1 - \Pi_t(1 - \text{volume traded}_t / \text{total shares}_t)]$  9 mnths before 't' to 3 mnths after 't'  
 Volat = Standard deviation of monthly returns, 9 mnths before 't' to 3 mnths after 't'  
 Analys = Number of analyst following for firm 'i' for year 't' from I/B/E/S detail file  
 Inst Hold = Percentage of shares held by institutions for firm 'i' for year 't' over total shares outstanding



**Table 7**

**Correlation Matrix for the Variables**

	PRC-3M	EPS	BV	Shares	MV	Assets	Q	Annret	Turnover	Volat	Analys	Hold	Dis	Pro	Vul
EPS	0.60 (0.00)***	1.00													
BV	0.28 (0.00)***	0.17 (0.00)***	1.00												
Shares	0.17 (0.00)***	0.08 (0.00)***	0.77 (0.00)***	1.00											
MV	0.30 (0.00)***	0.16 (0.00)***	0.83 (0.00)***	0.86 (0.00)***	1.00										
Assets	0.18 (0.00)***	0.13 (0.00)***	0.69 (0.00)***	0.50 (0.00)***	0.54 (0.00)***	1.00									
Q	0.06 (0.00)***	-0.00 (0.85)	-0.01 (0.05)**	0.04 (0.00)***	0.04 (0.00)***	-0.01 (0.16)	1.00								
Annret	0.23 (0.00)***	0.21 (0.00)***	-0.01 (0.07)*	-0.03 (0.00)***	-0.01 (0.23)	-0.00 (0.61)	0.04 (0.00)***	1.00							
Turnover	0.13 (0.00)***	-0.06 (0.00)***	0.06 (0.00)***	0.09 (0.00)***	0.05 (0.00)***	0.03 (0.00)***	0.08 (0.00)***	0.04 (0.00)***	1.00						
Volat	-0.43 (0.00)***	-0.44 (0.00)***	-0.13 (0.00)***	-0.09 (0.00)***	-0.12 (0.00)***	-0.08 (0.00)***	0.02 (0.02)**	-0.11 (0.00)***	0.24 (0.00)***	1.00					
Analys	0.45 (0.00)***	0.21 (0.00)***	0.35 (0.00)***	0.36 (0.00)***	0.38 (0.00)***	0.17 (0.00)***	0.04 (0.00)***	-0.01 (0.10)*	0.34 (0.00)***	-0.14 (0.00)***	1.00				
Hold	0.43 (0.00)***	0.18 (0.00)***	0.06 (0.00)***	0.03 (0.00)***	0.06 (0.00)***	0.01 (0.06)*	0.04 (0.00)***	0.04 (0.00)***	0.45 (0.00)***	-0.18 (0.00)***	0.51 (0.00)***	1.00			

**Table 7 (Cont'd)**

	PRC-3M	EPS	BV	Shares	MV	Assets	Q	Annret	Turnover	Volat	Analys	Hold	Dis	Pro	Vul
Dis	-0.02 (0.00)***	-0.05 (0.00)***	0.03 (0.00)***	0.03 (0.00)***	0.03 (0.00)***	0.05 (0.00)***	0.02 (0.01)***	0.01 (0.35)	0.10 (0.00)***	0.07 (0.00)***	0.06 (0.00)***	0.03 (0.00)***	1.00		
Pro	-0.01 (0.06)*	-0.05 (0.00)***	0.03 (0.00)***	0.02 (0.02)**	0.02 (0.00)***	0.05 (0.00)***	0.02 (0.02)**	0.00 (0.60)	0.10 (0.00)***	0.06 (0.00)***	0.05 (0.00)***	0.03 (0.00)***	0.92 (0.00)***	1.00	
Vul	-0.05 (0.00)***	-0.08 (0.00)***	0.00 (0.95)	0.02 (0.01)***	0.01 (0.30)	0.00 (0.81)	0.02 (0.02)**	0.00 (0.93)	0.10 (0.00)***	0.09 (0.00)***	0.04 (0.00)***	0.01 (0.16)	0.82 (0.00)***	0.70 (0.00)***	1.00
Act	0.00 (0.89)	-0.01 (0.04)**	-0.00 (0.66)	0.00 (0.67)	0.01 (0.15)	-0.01 (0.38)	0.02 (0.02)**	0.03 (0.00)***	0.04 (0.00)***	0.02 (0.01)***	0.03 (0.00)***	0.01 (0.38)	0.19 (0.00)***	0.17 (0.00)***	0.21 (0.00)***

\*\*\* Significant at 1%; \*\* significant at 5%. \* significant at 10%, N = 21,120.

Price – 3 Month = Stock price of firm 'i' for year 't', 90 days after fiscal year close - \$/share  
 EPS = Earnings per share (basic excluding special items ) for firm 'i' for year 't', at year-end - \$/share  
 Mkt Val = Equity market value of firm 'i' for year 't', at year-end – Price fiscal year end \* No. of shares outstanding  
 Bok Val = Book value of equity for firm 'i' for year 't', at year-end - '000,000  
 Shares = No. of shares outstanding for firm 'i' for year 't', at year-end - '000,000  
 Asset = Total assets of the firm 'i' for year 't' at year end - '000,000  
 Q = Ratio of Mkt Val / Bok Val for firm 'i' for year 't'  
 Annret = Annual return of firm 'i' for year 't', cumulated 9 mnths before 't' to 3 mnths after 't'  
 Turnover = Shares turnover computed as  $[1 - \Pi_t(1 - \text{volume traded}/\text{total shares})]$  9 mnths before 't' to 3 mnths after 't'  
 Volat = Standard deviation of monthly returns, 9 mnths before 't' to 3 mnths after 't'  
 Analys = Number of analyst following for firm 'i' for year 't' from I/B/E/S detail file  
 Inst Hold = Percentage of shares held by institutions for firm 'i' for year 't' over total shares outstanding  
 Dis = 1 if either Potential Vulnerability, or Proactive Measures or Actual Breach equals 1, 0 otherwise.  
 Pro = 1 for a disclosure of proactive security activities, 0 otherwise.  
 Vul = 1 for a disclosure of vulnerability, 0 otherwise.  
 Act = 1 if there is a report of actual security incident, 0 otherwise

**Table 8**

**Pooled Cross-sectional Stock Price Regression on Disclosure Proxies**

$$P_{it} = \alpha_0 + \alpha_1 * Dis_{it} + \alpha_2 * BVPS_{it} + \alpha_3 * EPS_{it} + \alpha_4 * Q_{it} + \sum \alpha_k * Year_{it} + \sum \alpha_j * Indus_{it} + \epsilon_{it}$$

- $PRC - 3M_{it}$  = Stock price of firm 'i' for year 't', 90 days after fiscal year close  
 $EPS_{it}$  = Earnings per share (basic excluding special items ) for firm 'i' for year 't', year-end  
 $BVPS_{it}$  = Book value of equity divided by No. of shares outstanding for firm 'i' for year 't', year-end  
 $Q_{it}$  = MV divided by BV of firm 'i' for year 't'  
 $Dis_{it}$  = 1 if either potential vulnerability, or proactive measures or actual breach equals 1, 0 otherwise.  
 $Pro Msre (P)$  = 1 for a disclosure of proactive security activities only, 0 otherwise.  
 $Ptn Vul (V)$  = 1 for a disclosure of vulnerability only, 0 otherwise.  
 $Actl Brch (A)$  = 1 if there is a report of actual security incident only, 0 otherwise  
 $PV$  = 1 for joint disclosure of proactive security and potential vulnerability, 0 otherwise  
 $VA$  = 1 for joint disclosure of potential vulnerability and actual security breach, 0 otherwise  
 $PA$  = 1 for joint disclosure of proactive security and actual security breach, 0 otherwise  
 $PVA$  = 1 for joint disclosures of proactive security measures, potential vulnerability and actual security breach, 0 otherwise  
 $Year_{it}$  = 1 if current year, 0 otherwise  
 $Industry_{it}$  = 1 if current industry, 0 otherwise  
 Coefficient for year and industry variables are suppressed  
 p-values in parentheses are heteroscedastic corrected values  
 \* significant at 10%; \*\* significant at 5%; \*\*\* significant at 1%

	(1) Base Case	(2) Generic Dis	(3) Types	(4) Sample w/o Banks/Fin	(5) Types w/o/ Banks/Fin
Dis		2.394 (0.000)***		2.484 (0.000)***	
Pro Msre (P)			3.054 (0.000)***		3.157 (0.000)***
Ptn Vul (V)			1.491 (0.026)**		1.636 (0.019)**
Actl Brch (A)			-1.237 (0.796)		-0.678 (0.888)
PV			1.954 (0.000)***		2.066 (0.000)***
VA			0.527 (0.805)		0.758 (0.725)
PA			1.639 (0.097)*		2.261 (0.030)**
PVA			7.959 (0.000)***		8.385 (0.000)***
BVPS	1.034 (0.000)***	1.038 (0.000)***	1.038 (0.000)***	1.076 (0.000)***	1.077 (0.000)***
EPS	2.958 (0.000)***	2.961 (0.000)***	2.958 (0.000)***	2.719 (0.000)***	2.716 (0.000)***
Q	0.221 (0.004)***	0.221 (0.004)***	0.220 (0.004)***	0.230 (0.014)**	0.230 (0.014)**
Intercept	4.116 (0.000)***	3.984 (0.000)***	3.989 (0.000)***	4.300 (0.000)***	4.305 (0.000)***
Obs	21,120	21,120	21,120	16,607	16,607
Adjstd R <sup>2</sup>	0.584	0.585	0.586	0.574	0.574

**Table 9**

**Cross-sectional Stock Price Regression by Years on Disclosures Proxies**

$$P_{it} = \alpha_0 + \alpha_1 * Dis_{it} + \alpha_2 * BVPS_{it} + \alpha_3 * EPS_{it} + \alpha_4 * Q_{it} + \sum \alpha_j * Indus_{it} + \epsilon_{it}$$

- PRC -3M<sub>it</sub> = Stock price of firm 'i' for year 't', 90 days after fiscal year close  
 EPS<sub>it</sub> = Earnings per share (basic excluding special items ) for firm 'i' for year 't', year-end  
 BVPS<sub>it</sub> = Book value of equity divided by No. of shares outstanding for firm 'i' for year 't', year-end  
 Q<sub>it</sub> = Ratio of Mkt Val / Bok Val for firm 'i' for year 't'  
 Dis<sub>it</sub> = 1 if either potential vulnerability, or proactive measures or actual breach equals 1, 0 otherwise.  
 Pro Msre (P) = 1 for a disclosure of proactive security activities only, 0 otherwise.  
 Ptn Vul (V) = 1 for a disclosure of vulnerability only, 0 otherwise.  
 Actl Brch (A) = 1 if there is a report of actual security incident only, 0 otherwise  
 PV = 1 for joint disclosure of proactive security and potential vulnerability, 0 otherwise  
 VA = 1 for joint disclosure of potential vulnerability and actual security breach, 0 otherwise  
 PA = 1 for joint disclosure of proactive security and actual security breach, 0 otherwise  
 PVA = 1 for joint disclosures of proactive security measures, potential vulnerability and actual security breach, 0 otherwise  
 Industry<sub>it</sub> =1 if current industry, 0 otherwise  
 Coefficient for industry variables are suppressed  
 p-values in parentheses are heteroscedastic corrected values  
 \* significant at 10%; \*\* significant at 5%; \*\*\* significant at 1%

**Panel A: Year-to-year regression on generic disclosures**

	2000	2001	2002	2003	2004
Dis	2.701 (0.001)***	3.032 (0.000)***	2.003 (0.000)***	2.733 (0.000)***	2.343 (0.000)***
BVPS	0.945 (0.000)***	1.134 (0.000)***	0.911 (0.000)***	1.105 (0.000)***	1.092 (0.000)***
EPS	2.637 (0.000)***	2.608 (0.000)***	2.556 (0.000)***	3.682 (0.000)***	3.974 (0.000)***
Q	0.778 (0.000)***	0.352 (0.013)**	0.316 (0.000)***	0.334 (0.000)***	0.098 (0.009)***
Intercept	3.292 (0.000)***	5.099 (0.000)***	3.811 (0.000)***	6.092 (0.000)***	6.452 (0.000)***
Observations	4738	4376	4169	3983	3854
Adjstd R <sup>2</sup>	0.558	0.542	0.598	0.637	0.639

**Table 9 (Cont'd)***Panel B: Year-to-year regression on various types of disclosures*

	2000	2001	2002	2003	2004
Pro Msre (P)	4.045 (0.037)**	5.159 (0.004)***	1.027 -0.258	3.141 (0.000)***	3.136 (0.001)***
Ptn Vul (V)	2.197 -0.394	1.21 -0.538	0.711 -0.562	1.631 -0.172	2.261 (0.092)*
Actl Brch (A)	0 (.)	0 (.)	0 (.)	-0.161 -0.966	0 (.)
PV	2.17 (0.007)***	1.751 (0.064)*	2.555 (0.000)***	2.389 (0.003)***	1.866 (0.014)**
VA	4.392 (0.000)***	2.706 (0.003)***	3.622 -0.349	-0.197 -0.814	-4.011 (0.012)**
PA	0 (.)	0 (.)	-0.978 -0.208	3.067 (0.000)***	0 (.)
PVA	0.756 -0.524	12.456 (0.020)**	7.824 (0.084)*	8.329 (0.028)**	5.762 -0.139
BVPS	0.945 (0.000)***	1.133 (0.000)***	0.912 (0.000)***	1.105 (0.000)***	1.092 (0.000)***
EPS	2.632 (0.000)***	2.6 (0.000)***	2.559 (0.000)***	3.681 (0.000)***	3.967 (0.000)***
Q	0.777 (0.000)***	0.35 (0.013)**	0.317 (0.000)***	0.33 (0.000)***	0.098 (0.009)***
Intercept	3.296 (0.000)***	5.11 (0.000)***	3.798 (0.000)***	6.106 (0.000)***	6.461 (0.000)***
Observations	4,738	4,376	4,169	3,983	3,854
Adjstd R <sup>2</sup>	0.558	0.543	0.599	0.637	0.638

**Table 10**

**Pooled Stock Price Regression by Industry on Disclosures Proxies**

$$P_{it} = \alpha_0 + \alpha_1 * Dis_{it} + \alpha_2 * BVPS_{it} + \alpha_3 * EPS_{it} + \alpha_4 * Q_{it} + \sum \alpha_k * Year_{it} + \epsilon_{it}$$

- PRC – 3M<sub>it</sub> = Stock price of firm ‘i’ for year ‘t’, 90 days after fiscal year close
- EPS<sub>it</sub> = Earnings per share (basic excluding special items ) for firm ‘i’ for year ‘t’, year-end
- BVPS<sub>it</sub> = Book value of equity divided by No. of shares outstanding for firm ‘i’ for year ‘t’, year-end
- Q<sub>it</sub> = Ratio of Mkt Val / Bok Val for firm ‘i’ for year ‘t’
- Dis<sub>it</sub> = 1 if either potential vulnerability, or proactive measures or actual breach equals 1, 0 otherwise.
- Pro Msre (P) = 1 for a disclosure of proactive security activities only, 0 otherwise.
- Ptn Vul (V) = 1 for a disclosure of vulnerability only, 0 otherwise.
- Actl Brch (A) = 1 if there is a report of actual security incident only, 0 otherwise
- PV = 1 for joint disclosure of proactive security and potential vulnerability, 0 otherwise
- VA = 1 for joint disclosure of potential vulnerability and actual security breach, 0 otherwise
- PA = 1 for joint disclosure of proactive security and actual security breach, 0 otherwise
- PVA = 1 for joint disclosures of proactive security measures, potential vulnerability and actual security breach, 0 otherwise
- Year<sub>it</sub> = 1 if current year, 0 otherwise

Coefficient for year variable is suppressed for readability.

p-values for BVPS, EPS and Intercept are suppressed and only significance values are shown

p-values in parentheses are heteroscedastic corrected values

\* significant at 10%; \*\* significant at 5%; \*\*\* significant at 1%; NS not significant

**Panel A: Stock price regression by industry on generic security disclosure**

	Disclosure		BVPS		EPS		Intercept		Q		N	Adj R <sup>2</sup>
Autos	-0.786	-0.954	0.719 ***		4.418 ***		0.275		7.662 ***		321	0.603
Banks	0.215	-0.688	1.098 ***		3.554 ***		4.314 ***		-4.482 **		3108	0.762
BldMt	-3.598	-0.55	1.093 ***		2.27 ***		1.266 ***		1.722 ***		408	0.614
Books	0.483	-0.874	1.038 ***		5.569 ***		0.359 ***		7.992 ***		174	0.717
BusSv	2.006	(0.000)***	1.408 ***		1.949 ***		0.612 ***		1.876 ***		2948	0.487
Chips	1.588	(0.071)*	1.518 ***		1.42 ***		0.442 ***		1.602 **		1246	0.637
Clths	6.434	(0.012)**	1.275 ***		3.97 ***		2.361 *		-2.515		151	0.728
Cnstr	-0.421	-0.761	0.795 ***		3.418 ***		2.117 **		0.71		200	0.777
Coal	-0.215	-0.963	0.225		4.489 ***		0.227		23.264 ***		32	0.559
Drugs	0.471	-0.767	1.317 ***		2.673 ***		0.227 **		7.922 ***		1742	0.444
Engry	2.724	-0.487	1.511 ***		1.828 ***		0.827 ***		2.237 **		839	0.737
Fin	1.02	-0.418	0.802 ***		4.228 ***		0.095 *		6.677 ***		1405	0.556
Food	13.281	(0.013)**	0.777 ***		6.451 ***		0.578		6.862 ***		309	0.467
Fun	0.352	-0.898	1.17 ***		2.701 ***		1.01 **		3.907 **		244	0.532
Gold	0	(.)	1.564 ***		1.992 **		2.406 ***		-3.683 ***		279	0.709
Hlth	5.768	(0.039)**	1.487 ***		4.165 ***		1.393 ***		-0.309		320	0.663
Hshld	-14.459	(0.030)**	1.14 ***		1.914		2.738 ***		-0.783		64	0.691
Insur	5.049	(0.014)**	1.001 ***		2.268 ***		3.235 ***		-1.409		842	0.665
LabEq	2.246	(0.085)*	1.769 ***		2.907 ***		0.737 ***		2	**	1067	0.598
Mach	0.944	-0.482	1.127 ***		3.625 ***		0.672 ***		4.259 ***		932	0.63
Meals	3.478	-0.308	1.002 ***		3.419 ***		1.163 **		3.574 **		336	0.541
Mines	0	(.)	1.051 ***		3.798 ***		7.007 ***		-6.732 **		43	0.778
Misc	-8.347	(0.038)**	1.244 ***		1.17 ***		0.477		2.22		90	0.789
Not												
Classified	0.929	-0.908	0.812 ***		3.905 ***		0.402 *		3.084 ***		175	0.674
Paper	32.389	(0.000)***	0.724 ***		3.445 ***		0.185		8.043 ***		203	0.418
PerSrv	5.003	-0.372	0.544 ***		5.515 ***		0.438 ***		9.3 ***		84	0.435
Rtail	4.502	(0.002)***	0.718 ***		4.663 ***		0.393 ***		5.252 ***		437	0.568
Smoke	-8.994	-0.106	1.489 **		4.892 *		0.036 **		9.195 **		24	0.662
Steel	-6.903	(0.033)**	1.28 ***		1.296 ***		3.398 ***		-4.211 **		259	0.67
Telcm	-0.443	-0.662	1.049 ***		1.755 ***		0.168 **		6.246 ***		896	0.506
Toys	3.065	(0.014)**	0.712 ***		4.407 ***		1.339 ***		1.336		156	0.676
Trans	5.626	(0.002)***	0.829 ***		2.2 ***		0.872 *		5.827 ***		496	0.477
Txtls	0	(.)	1.118 ***		2.107 ***		9.224 ***		-9.395 ***		58	0.865
Util	0.128	-0.934	1.105 ***		2.316 ***		2.207 **		1.38		716	0.671
Whsl	0.809	-0.346	0.891 ***		3.471 ***		0.303 ***		3.766 ***		516	0.587

**Table 10 (Cont'd)**

**Panel B: Stock price regression by industry on various types of security activities related disclosures**

Coefficients for BVPS, EPS, Q, Year and Intercept are suppressed for readability

	P		V		A		PV		VA		PA		PVA		Obs	Adj R <sup>2</sup>
Autos	11.067	-0.494	0	(.)	0	(.)	-23.602	(0.000)***	0	(.)	0	(.)	0	(.)	321	0.608
Banks	1.264	(0.049)**	-0.652	-0.655	0	(.)	-2.124	-0.155	0	(.)	0	(.)	0	(.)	3108	0.763
BldMt	-3.029	-0.687	-5.826	(0.000)***	0	(.)	0	(.)	0	(.)	0	(.)	0	(.)	408	0.613
Books	0.739	-0.89	-5.061	(0.016)**	0	(.)	1.741	-0.65	0	(.)	0	(.)	0	(.)	174	0.714
BusSv	3.333	(0.008)***	0.873	-0.238	-5.632	0.356	1.479	(0.001)***	3.929	0.649	4.217	(0.000)***	7.403	(0.004)***	2948	0.49
Chips	0.8	-0.591	2.384	-0.119	0	(.)	1.371	-0.311	0	(.)	0	(.)	10.784	(0.000)***	1246	0.636
Clths	0	(.)	6.434	(0.012)**	0	(.)	0	(.)	0	(.)	0	(.)	0	(.)	151	0.728
Cnstr	-1.797	-0.121	0	(.)	0	(.)	0.98	-0.602	0	(.)	0	(.)	0	(.)	200	0.776
Coal	-0.215	-0.963	0	(.)	0	(.)	0	(.)	0	(.)	0	(.)	0	(.)	32	0.559
Drugs	0.243	-0.905	6.466	-0.105	0	(.)	-2.893	-0.236	0	(.)	0	(.)	0	(.)	1742	0.445
Engry	2.724	-0.487	0	(.)	0	(.)	0	(.)	0	(.)	0	(.)	0	(.)	839	0.737
Fin	0.594	-0.719	7.185	-0.231	0	(.)	0.492	-0.776	0	(.)	0	(.)	3.516	0.731	1405	0.556
Food	15.227	-0.12	11.358	(0.026)**	0	(.)	0	(.)	0	(.)	0	(.)	0	(.)	309	0.465
Fun	0.706	-0.781	-6.767	(0.047)**	0	(.)	-4.046	(0.077)*	0	(.)	0	(.)	6.162	-0.335	244	0.529
Gold	0	(.)	0	(.)	0	(.)	0	(.)	0	(.)	0	(.)	0	(.)	279	0.709
Hlth	0.041	-0.99	37.947	(0.000)***	0	(.)	6.788	(0.037)**	0	(.)	0	(.)	0	(.)	320	0.674
Hshld	-14.459	(0.030)**	0	(.)	0	(.)	0	(.)	0	(.)	0	(.)	0	(.)	64	0.691
Insur	5.238	(0.060)*	-2.03	-0.139	0	(.)	7.907	(0.007)***	-1.499	-0.191	0	(.)	0	(.)	842	0.667
LabEq	-0.31	-0.906	6.424	(0.011)**	0	(.)	2.552	(0.068)*	0	(.)	0	(.)	0	(.)	1067	0.598
Mach	1.456	-0.711	0.894	-0.778	12.731	(0.198)	0.461	-0.757	0	(.)	0	(.)	-1.758	-0.542	932	0.629
Meals	7.269	-0.173	-4.71	(0.000)***	0	(.)	3.754	-0.415	0	(.)	0	(.)	0	(.)	336	0.539
Mines	0	(.)	0	(.)	0	(.)	0	(.)	0	(.)	0	(.)	0	(.)	43	0.778
Misc	0	(.)	0	(.)	0	(.)	-8.347	(0.038)**	0	(.)	0	(.)	0	(.)	90	0.789
Not Classified	-18.595	(0.057)*	10.367	(0.000)***	0	(.)	0	(.)	0	(.)	0	(.)	0	(.)	175	0.681
Paper	0	(.)	32.389	(0.000)***	0	(.)	0	(.)	0	(.)	0	(.)	0	(.)	203	0.418

**Table 10 (Cont'd)**

*Panel B: Stock price regression by industry on various types of security activities related disclosures*

	P		V		A		PV		VA		PA		PVA		Obs	Adj R <sup>2</sup>
PerSrv	0	(.)	0	(.)	0	(.)	6.307	-0.292	-6.569	(0.031)**	0	(.)	0	(.)	84	0.435
Rtail	1.226	-0.465	-7.388	-0.297	0	(.)	6.216	(0.001)***	0	(.)	0	(.)	0	(.)	437	0.573
Smoke	-8.994	-0.106	0	(.)	0	(.)	0	(.)	0	(.)	0	(.)	0	(.)	24	0.662
Steel	-3.661	-0.234	0	(.)	0	(.)	-10.104	(0.000)***	0	(.)	0	(.)	0	(.)	259	0.669
Telcm	-5.458	0.106	-0.673	0.756	-6.354	0.549	0.666	0.675	0.961	0.840	0.198	0.985	0	(.)	896	0.505
Toys	0	(.)	0	(.)	0	(.)	3.065	(0.014)**	0	(.)	0	(.)	0	(.)	156	0.676
Trans	5.855	(0.000)***	2.77	-0.418	0	(.)	6.811	-0.154	0	(.)	0	(.)	14.582	(0.000)***	496	0.476
Txtls	0	(.)	0	(.)	0	(.)	0	(.)	0	(.)	0	(.)	0	(.)	58	0.865
Util	0.128	-0.934	0	(.)	0	(.)	0	(.)	0	(.)	0	(.)	0	(.)	716	0.671
Whlsl	-0.296	-0.776	-2.475	(0.000)***	0	(.)	1.057	-0.358	5.222	(0.000)***	0	(.)	9.604	(0.000)***	516	0.587



**Table 11**

**Pooled Cross-sectional Stock Returns Regression on Disclosure Proxies**

$$\text{Annret}_{it} = \alpha_0 + \alpha_1 * \text{Dis}_{it} + \alpha_2 * \text{EPSS}_{it} + \alpha_3 * \Delta \text{EPS}_{it} + \alpha_4 * \Delta \text{Q}_{it} + \sum \alpha_j * \text{Indus}_{it} + \varepsilon_{it}$$

- Annret<sub>it</sub> = Annual return of firm 'i' for year 't', cumulated 9 mnths before 't' to 3 mnths after 't'  
 EPSS<sub>it</sub> = Earnings per share for firm 'i' for year 't', scaled by previous year-end EPS  
 ΔEPSS<sub>it</sub> = Change in EPS<sub>t</sub>-EPS<sub>t-1</sub> scaled by previous year beginning EPS for firm 'i' for year 't'  
 ΔQ<sub>it</sub> = Changes in Q (MV<sub>t</sub>/BV<sub>t</sub>) for each firm 'i' for year 't',  
 Dis<sub>it</sub> = 1 if either potential vulnerability, or proactive measures or actual breach equals 1, 0 otherwise.  
 Pro Msre (P) = 1 for a disclosure of proactive security activities only, 0 otherwise.  
 Ptn Vul (V) = 1 for a disclosure of vulnerability only, 0 otherwise.  
 Actl Brch (A) = 1 if there is a report of actual security incident only, 0 otherwise  
 PV = 1 for joint disclosure of proactive security and potential vulnerability, 0 otherwise  
 VA = 1 for joint disclosure of potential vulnerability and actual security breach, 0 otherwise  
 PA = 1 for joint disclosure of proactive security and actual security breach, 0 otherwise  
 PVA = 1 for joint disclosures of proactive security measures, potential vulnerability and actual security breach, 0 otherwise  
 Industry<sub>it</sub> = 1 if current industry, 0 otherwise  
 Coefficient for industry variables are suppressed  
 p-values in parentheses are heteroscedastic corrected values  
 \* significant at 10%; \*\* significant at 5%; \*\*\* significant at 1%

	(1) Base Case	(2) Generic Dis	(3) Types	(4) Sample w/o Banks/Fin	(5) Types w/o/ Banks/Fin
Dis		0.079 (0.001)***		0.117 (0.000)***	
Pro Msre (P)			0.026 (0.466)		0.107 (0.044)**
Ptn Vul (V)			0.133 (0.031)**		0.156 (0.020)**
Actl Brch (A)			0.895 (0.001)***		0.899 (0.001)***
PV			0.075 (0.026)**		0.085 (0.024)**
VA			-0.012 (0.947)		-0.009 (0.958)
PA			-0.138 (0.722)		-0.133 (0.731)
PVA			0.431 (0.018)**		0.438 (0.016)**
EPSS	-0.007 (0.661)	-0.007 (0.688)	-0.006 (0.697)	-0.009 (0.560)	-0.009 (0.557)
ΔEPSS	0.066 (0.002)***	0.066 (0.002)***	0.066 (0.002)***	0.062 (0.003)***	0.062 (0.003)***
ΔQ	0.000 (0.626)	0.000 (0.626)	0.000 (0.626)	0.000 (0.655)	0.000 (0.656)
Intercept	0.160 (0.000)***	0.154 (0.000)***	0.154 (0.000)***	0.126 (0.000)***	0.126 (0.000)***
Obs	18,838	18,838	18,838	14,715	14,715
Adjstd R <sup>2</sup>	0.025	0.026	0.027	0.023	0.023

**Table 12**

**Pooled Cross-sectional Matched-Pair Stock Price Regression on Disclosure Proxies**

$$P_{it} = \alpha_0 + \alpha_1 * Dis_{it} + \alpha_2 * BVPS_{it} + \alpha_3 * EPS_{it} + \alpha_4 * Q_{it} + \sum \alpha_k * Year_{it} + \sum \alpha_j * Indus_{it} + \varepsilon_{it}$$

- PRC-3M<sub>it</sub> = Stock price of firm 'i' for year 't', 90 days after fiscal year close  
 EPS<sub>it</sub> = Earnings per share (basic excluding special items ) for firm 'i' for year 't', year-end  
 BVPS<sub>it</sub> = Book value of equity divided by No. of shares outstanding for firm 'i' for year 't', year-end  
 Q<sub>it</sub> = Ratio of Mkt Val / Bok Val for firm 'i' for year 't'  
 Dis<sub>it</sub> = 1 if either potential vulnerability, or proactive measures or actual breach equals 1, 0 otherwise.  
 Pro Msre (P) = 1 for a disclosure of proactive security activities only, 0 otherwise.  
 Ptn Vul (V) = 1 for a disclosure of vulnerability only, 0 otherwise.  
 Actl Brch (A) = 1 if there is a report of actual security incident only, 0 otherwise  
 PV = 1 for joint disclosure of proactive security and potential vulnerability, 0 otherwise  
 VA = 1 for joint disclosure of potential vulnerability and actual security breach, 0 otherwise  
 PA = 1 for joint disclosure of proactive security and actual security breach, 0 otherwise  
 PVA = 1 for joint disclosures of proactive security measures, potential vulnerability and actual security breach, 0 otherwise  
 Year<sub>it</sub> = 1 if current year, 0 otherwise  
 Indus<sub>it</sub> = 1 if current industry, 0 otherwise  
 Coefficient for year and industry variables are suppressed  
 p-values in parentheses are heteroscedastic corrected values  
 \* significant at 10%; \*\* significant at 5%; \*\*\* significant at 1%

	(1) Generic Dis	(2) Types	(3) Sample w/o Banks/Fin	(4) Types w/o/ Banks/Fin
Dis	1.176 (0.001)***		1.443 (0.001)***	
Pro Msre (P)		1.338 (0.021)**		1.659 (0.030)**
Ptn Vul (V)		0.335 (0.626)		0.551 (0.443)
Actl Brch (A)		-1.090 (0.806)		-0.613 (0.893)
PV		1.015 (0.018)**		1.248 (0.007)***
VA		0.922 (0.648)		0.954 (0.647)
PA		2.102 (0.000)***		2.488 (0.000)***
PVA		6.085 (0.005)***		6.549 (0.003)***
BVPS	1.247 (0.000)***	1.246 (0.000)***	1.254 (0.000)***	1.253 (0.000)***
EPS	2.750 (0.000)***	2.743 (0.000)***	2.553 (0.000)***	2.545 (0.000)***
Q	0.578 (0.000)***	0.571 (0.000)***	0.544 (0.000)***	0.536 (0.000)***
Intercept	3.540 (0.000)***	3.606 (0.000)***	3.358 (0.000)***	3.432 (0.000)***
Obs	3,274	3,274	2,626	2,626
Adjstd R <sup>2</sup>	0.624	0.625	0.583	0.584

**Table 13**

**Pooled Cross-sectional Matched-Pair Stock Returns Regression on Disclosure Proxies**

$$\text{Annret}_{it} = \alpha_0 + \alpha_1 * \text{Dis}_{it} + \alpha_2 * \text{EPSS}_{it} + \alpha_3 * \Delta \text{EPS}_{it} + \alpha_4 * \Delta Q_{it} + \sum \alpha_j * \text{Indus}_{it} + \varepsilon_{it}$$

- Annret<sub>it</sub> = Annual return of firm 'i' for year 't', cumulated 9 mnths before 't' to 3 mnths after
  - EPSS<sub>it</sub> = Earnings per share for firm 'i' for year 't', scaled by previous year-end EPS
  - ΔEPSS<sub>it</sub> = Change in EPS<sub>t</sub>-EPS<sub>t-1</sub> scaled by previous year beginning EPS for firm 'i' for year 't'
  - ΔQ<sub>it</sub> = Changes in Q (MV<sub>t</sub>/BV<sub>t</sub>) for each firm 'i' for year 't',
  - Dis<sub>it</sub> = 1 if either potential vulnerability, or proactive measures or actual breach equals 1, 0 otherwise.
  - Pro Msre (P) = 1 for a disclosure of proactive security activities only, 0 otherwise.
  - Ptn Vul (V) = 1 for a disclosure of vulnerability only, 0 otherwise.
  - Actl Brch (A) = 1 if there is a report of actual security incident only, 0 otherwise
  - PV = 1 for joint disclosure of proactive security and potential vulnerability, 0 otherwise
  - VA = 1 for joint disclosure of potential vulnerability and actual security breach, 0 otherwise
  - PA = 1 for joint disclosure of proactive security and actual security breach, 0 otherwise
  - PVA = 1 for joint disclosures of proactive security measures, potential vulnerability and actual security breach, 0 otherwise
  - Indus<sub>it</sub> = 1 if current industry, 0 otherwise
- Coefficient for industry variables are suppressed  
p-values in parentheses are heteroscedastic corrected values  
\* significant at 10%; \*\* significant at 5%; \*\*\* significant at 1%

	(1) Generic Dis	(2) Types	(3) Sample w/o Banks/Fin	(4) Types w/o/ Banks/Fin
Dis	0.008 (0.790)		0.014 (0.697)	
Pro Msre (P)		-0.013 (0.763)		0.027 (0.652)
Ptn Vul (V)		0.057 (0.384)		0.063 (0.376)
Actl Brch (A)		0.765 (0.005)***		0.764 (0.005)***
PV		-0.012 (0.744)		-0.028 (0.518)
VA		-0.139 (0.425)		-0.139 (0.427)
PA		-0.274 (0.510)		-0.274 (0.511)
PVA		0.304 (0.102)		0.300 (0.107)
EPSS	-0.041 (0.020)**	-0.040 (0.026)**	-0.043 (0.017)**	-0.043 (0.020)**
ΔEPSS	0.114 (0.001)***	0.112 (0.001)***	0.118 (0.001)***	0.117 (0.001)***
ΔQ	0.001 (0.095)*	0.001 (0.100)*	0.001 (0.092)*	0.001 (0.099)*
Intercept	0.172 (0.000)***	0.172 (0.000)***	0.160 (0.000)***	0.160 (0.000)***
Obs	2,834	2,834	2,254	2,254
Adjstd R <sup>2</sup>	0.021	0.023	0.021	0.023

**Table 14**

**Pooled Stock Return Regression by Industry on Disclosures Proxies**

$$\text{Annret}_{it} = \alpha_0 + \alpha_1 * \text{Dis}_{it} + \alpha_2 * \text{EPSS}_{it} + \alpha_3 * \Delta \text{EPS}_{it} + \alpha_4 * \Delta \text{Q}_{it} + \varepsilon_{it}$$

- Annret<sub>it</sub> = Annual return of firm 'i' for year 't', cumulated 9 mnths before 't' to 3 mnths after
- EPSS<sub>it</sub> = Earnings per share for firm 'i' for year 't', scaled by previous year-end EPS
- ΔEPSS<sub>it</sub> = Change in EPS<sub>t-1</sub> scaled by previous year beginning EPS for firm 'i' for year 't'
- ΔQ<sub>it</sub> = Changes in Q (MV<sub>t</sub>/BV<sub>t</sub>) for each firm 'i' for year 't',
- Dis<sub>it</sub> = 1 if either potential vulnerability, or proactive measures or actual breach equals 1, 0 otherwise.
- Pro Msre (P) = 1 for a disclosure of proactive security activities only, 0 otherwise.
- Ptn Vul (V) = 1 for a disclosure of vulnerability only, 0 otherwise.
- Actl Brch (A) = 1 if there is a report of actual security incident only, 0 otherwise
- PV = 1 for joint disclosure of proactive security and potential vulnerability, 0 otherwise
- VA = 1 for joint disclosure of potential vulnerability and actual security breach, 0 otherwise
- PA = 1 for joint disclosure of proactive security and actual security breach, 0 otherwise
- PVA = 1 for joint disclosures of proactive security measures, potential vulnerability and actual security breach, 0 otherwise

p-values in parentheses are heteroscedastic corrected values  
 \* significant at 10%; \*\* significant at 5%; \*\*\* significant at 1%

**Panel A: Annual returns regression by industry on generic security disclosure**

	Disclosure	EPSS	ΔEPS	ΔQ	Intercept	N	Adj R <sup>2</sup>
Autos	0.175	-0.803	0.689 ***	-0.329 NS	0.004 NS	0.17 ***	298 0.032
Banks	0.002	-0.961	-0.034 NS	0.328 **	0.155 ***	0.241 ***	2832 0.145
BldMt	-0.223	-0.329	-0.114 NS	0.341 NS	0.053 NS	0.202 ***	387 0.086
Books	-0.208	-0.16	0.139 **	-0.153 **	0.007 NS	0.082 *	160 0.028
BusSv	0.169 (0.000)***	-0.005	NS	0.026 *	0.002 NS	-0.004 NS	2542 0.014
Chips	0.164	-0.122	-0.161 **	0.322 ***	0.02 **	0.034 NS	1092 0.077
Clths	-0.082	-0.525	0.358 ***	0.127 **	0.193 ***	0.227 ***	136 0.223
Cnstr	-0.191	-0.532	0.436 NS	0.324 NS	0.039 NS	0.26 ***	182 0.088
Coal	-0.05	-0.955	-0.728 NS	1.654 **	0.057 *	0.759 ***	24 0.22
Drugs	0.09	-0.534	-0.364 ***	0.306 ***	0.006 ***	0.067 ***	1525 0.036
Enrgy	-0.065	-0.923	0.121 **	0.141 **	0.035 ***	0.295 ***	751 0.06
Fin	-0.085	-0.297	0.138 NS	0.205 **	0.009 ***	0.237 ***	1291 0.07
Food	0.015	-0.877	1.261 ***	0.549 NS	0.004 NS	0.139 ***	277 0.142
Fun	0.162	-0.581	0.22 *	-0.268 NS	0.05 **	0.234 ***	213 0.061
Gold	0 (.)	0.019	NS	0.092 NS	0.261 ***	0.278 ***	217 0.211
Hlth	-0.062	-0.648	-0.26 NS	0.476 NS	0.134 ***	0.341 ***	290 0.165
Hshld	0.588 (0.000)***	-0.38	NS	1.431 ***	0.128 ***	0.209 ***	61 0.523
Insur	0.03	-0.573	0.179 NS	0.094 **	0.112 **	0.173 ***	769 0.123
LabEq	0.256	-0.28	-0.273 **	0.347 ***	0.002 NS	0.097 ***	929 0.029
Mach	0.206	-0.189	-0.034 NS	0.097 NS	0.012 *	0.09 ***	867 0.031
Meals	0.569 (0.065)*	-0.246	**	0.292 **	0.022 NS	0.172 ***	304 0.072
Mines	0 (.)	0.96	**	-0.476 NS	0.519 ***	0.147 **	38 0.518
Misc	0 (.)	0.148	***	-0.05 NS	0.059 **	0.004 NS	67 0.126
Not							
Classified	0.043	-0.939	0.419 ***	0.031 NS	0.138 **	0.124 ***	157 0.156
Paper	-0.006	-0.989	-0.505 ***	0.852 ***	0.002 NS	0.121 ***	188 0.259
PerSrv	-0.078	-0.77	0.526 *	0.315 *	0.008 NS	0.219 **	75 0.078
Rtail	0.117	-0.403	-0.01 NS	0.111 *	0.016 NS	0.257 ***	394 0.028
Smoke	4.092 (0.000)***	5.048	***	-0.155 NS	-0.007 NS	-0.011 NS	21 0.697
Steel	-0.332 (0.000)***	0.317	***	-0.11 ***	0.44 ***	0.236 ***	241 0.292
Telcm	0.209 (0.024)**	-0.016	NS	0.101 *	0 ***	-0.068 ***	714 0.039
Toys	-0.189	-0.291	0.618 ***	0.179 NS	0.139 ***	0.165 ***	144 0.206
Trans	-0.068	-0.362	0.218 NS	0.528 ***	0.036 *	0.264 ***	457 0.165
Txtls	0 (.)	0.803	*	-0.297 NS	0.599 ***	0.176 **	53 0.316
Util	-0.055	-0.61	0.615 ***	0.335 ***	0.062 NS	0.142 ***	672 0.156
Whlsl	-0.006	-0.963	-0.017 NS	0.157 **	0.008 NS	0.217 ***	470 0.02

**Table 14 (Cont'd)**

**Panel B: Annual returns regression by industry on various types of security activities related disclosures**

Coefficients for EPSS, ΔEPSS, ΔQ, and Intercept are suppressed for readability

	P		V		A		PV		VA		PA		PVA		Obs	Adj R <sup>2</sup>
Autos	0.175	-0.803	0	(.)	0	(.)	0	(.)	0	(.)	0	(.)	0	(.)	298	0.032
Banks	-0.058	(0.067)*	0.09	-0.274	0	(.)	0.131	(0.011)**	0	(.)	0	(.)	0	(.)	2832	0.148
BldMt	-0.239	-0.465	-0.162	-0.803	0	(.)	0	(.)	0	(.)	0	(.)	0	(.)	387	0.083
Books	0.17	-0.382	-0.019	-0.952	0	(.)	-0.527	(0.000)***	0	(.)	0	(.)	0	(.)	160	0.043
BusSv	0.209	(0.031)**	0.208	(0.033)**	1.409	(0.022)**	0.117	(0.017)**	0	(.)	0.416	-0.631	0.467	(0.001)***	2542	0.016
Chips	0.087	-0.715	0.371	-0.15	0	(.)	0.119	-0.496	0	(.)	0	(.)	-0.06	-0.944	1092	0.075
Clths	0	(.)	-0.082	-0.525	0	(.)	0	(.)	0	(.)	0	(.)	0	(.)	136	0.223
Cnstr	-0.597	-0.43	0	(.)	0	(.)	0.229	-0.766	0	(.)	0	(.)	0	(.)	182	0.086
Coal	-0.05	-0.955	0	(.)	0	(.)	0	(.)	0	(.)	0	(.)	0	(.)	24	0.22
Drugs	0.056	-0.801	0.275	-0.455	0	(.)	0.021	-0.915	0	(.)	0	(.)	0	(.)	1525	0.035
Engry	-0.065	-0.923	0	(.)	0	(.)	0	(.)	0	(.)	0	(.)	0	(.)	751	0.06
Fin	-0.187	(0.096)*	-0.126	-0.558	0	(.)	-0.017	-0.885	0	(.)	0	(.)	0	(.)	1291	0.07
Food	0.067	-0.65	-0.036	-0.764	0	(.)	0	(.)	0	(.)	0	(.)	0	(.)	277	0.139
Fun	0.115	-0.769	0.115	-0.831	0	(.)	-0.39	-0.608	0	(.)	0	(.)	0.577	-0.284	213	0.052
Gold	0	(.)	0	(.)	0	(.)	0	(.)	0	(.)	0	(.)	0	(.)	217	0.211
Hlth	0.167	-0.574	0.243	-0.772	0	(.)	-0.241	-0.327	0	(.)	0	(.)	0	(.)	290	0.163
Hshld	0.588	(0.000)***	0	(.)	0	(.)	0	(.)	0	(.)	0	(.)	0	(.)	61	0.523
Insur	0.048	-0.491	-0.075	-0.59	0	(.)	0.028	-0.764	0.397	-0.386	0	(.)	0	(.)	769	0.121
LabEq	-0.201	-0.267	0.007	-0.96	0	(.)	0.616	-0.129	0	(.)	0	(.)	0	(.)	929	0.031
Mach	0.785	(0.017)**	-0.244	-0.638	0.346	-0.636	0.007	-0.966	0	(.)	0	(.)	1.028	(0.048)**	867	0.036
Meals	1.175	(0.094)*	0	(.)	0	(.)	0.379	-0.334	0	(.)	0	(.)	0	(.)	304	0.072
Mines	0	(.)	0	(.)	0	(.)	0	(.)	0	(.)	0	(.)	0	(.)	38	0.518
Misc	0	(.)	0	(.)	0	(.)	-8.347	(0.038)**	0	(.)	0	(.)	0	(.)	67	0.126
Not Classified	-18.595	(0.057)*	10.367	(0.000)***	0	(.)	0	(.)	0	(.)	0	(.)	0	(.)	157	0.156
Paper	0	(.)	32.389	(0.000)***	0	(.)	0	(.)	0	(.)	0	(.)	0	(.)	188	0.259

**Table 14 (Cont'd)**

*Panel B: Annual returns regression by industry on various types of security activities related disclosures*

	P		V		A		PV		VA		PA		PVA		Obs	Adj R <sup>2</sup>	
PerSrv	0	(.)	0	(.)	0	(.)	0.011	-0.969	-0.615	-0.365	0	(.)	0	(.)	75	0.075	
Rtail	0.136	-0.481	1.041	-0.18	0	(.)	0.065	-0.707	0	(.)	0	(.)	0	(.)	394	0.028	
Smoke	4.092	(0.000)***	0	(.)	0	(.)	0	(.)	0	(.)	0	(.)	0	(.)	21	0.697	
Steel	-0.321	-0.668	0	(.)	0	(.)	-0.344	-0.646	0	(.)	0	(.)	0	(.)	241	0.289	
Telcm	-0.05	-0.829	0.23	-0.115	0.452	-0.487	0.27	(0.009)***	0.157	-0.59	-	0.666	-0.306	0	(.)	714	0.037
Toys	0	(.)	0	(.)	0	(.)	-0.189	-0.291	0	(.)	0	(.)	0	(.)	144	0.206	
Trans	-0.056	-0.702	-0.064	-0.746	0	(.)	-0.116	-0.53	0	(.)	0	(.)	0.21	-0.716	457	0.16	
Txtls	0	(.)	0	(.)	0	(.)	0	(.)	0	(.)	0	(.)	0	(.)	53	0.316	
Util	-0.055	-0.61	0	(.)	0	(.)	0	(.)	0	(.)	0	(.)	0	(.)	672	0.156	
Whlsl	-0.271	-0.27	-0.076	-0.843	0	(.)	0.137	-0.417	-0.426	-0.58	0	(.)	0.109	-0.841	470	0.016	

**Table 15**

**Treatment Regression of Stock Price on Disclosure Proxies**

$$D_{it} = \gamma_0 + \gamma_1 * \text{Logasset}_{it} + \gamma_2 * \text{ROA}_{it} + \gamma_3 * \text{CI}_{it} + \gamma_4 * \text{Volat}_{it} + \gamma_5 * \text{Turnover}_{it} + \gamma_6 * \text{Hold}_{it} + \gamma_7 * \text{Anal}_{it} + \sum \alpha_j * \text{Indus}_{it} + \upsilon_{it}$$

$$P_{it} = \alpha_0 + \alpha_1 * \text{Dis}_{it} + \alpha_2 * \text{BVPS}_{it} + \alpha_3 * \text{EPS}_{it} + \alpha_4 * \text{Q}_{it} + \alpha_5 * \text{Mills}_{it} + \sum \alpha_k * \text{Year}_{it} + \sum \alpha_j * \text{Indus}_{it} + \varepsilon_{it}$$

- Logasset<sub>it</sub> = Log of total assets of the firm 'i' for year 't', at year end
  - ROA<sub>it</sub> = Operating income before extraordinary items / assets for firm 'i' for year 't'
  - CI<sub>it</sub> = Long term assets / assets for firm 'i' for year 't', at year end
  - Volat<sub>it</sub> = Standard deviation of monthly returns, 9 months before 't' to 3 months after 't'
  - Turnover<sub>it</sub> = Shares turnover as [1 - Π<sub>t</sub>(1 - volume traded / total shares<sub>t</sub>)] 9 months before 't' to 3 months after 't'
  - Hold<sub>it</sub> = Percentage of shares held by institutions for firm 'i' for year 't' over total shares outstanding
  - Anal<sub>it</sub> = Number of analyst following for firm 'i' for year 't' from I/B/E/S detail file
  - PRC - 3M<sub>it</sub> = Stock price of firm 'i' for year 't', 90 days after fiscal year close
  - EPS<sub>it</sub> = Earnings per share (basic excluding special items) for firm 'i' for year 't', year-end
  - BVPS<sub>it</sub> = Book value of equity divided by No. of shares outstanding for firm 'i' for year 't', year-end
  - Q<sub>it</sub> = Ratio of Mkt Val / Book Val for firm 'i' for year 't'
  - Mills<sub>it</sub> = Inverse Mills Ratio for each firm estimated from the first stage (i.e., disclosure Eq.)
  - Dis<sub>it</sub> = 1 if either potential vulnerability, or proactive measures or actual breach equals 1, 0 otherwise.
  - Pro Msre (P) = 1 for a disclosure of proactive security activities only, 0 otherwise.
  - Ptn Vul (V) = 1 for a disclosure of vulnerability only, 0 otherwise.
  - Actl Brch (A) = 1 if there is a report of actual security incident only, 0 otherwise
  - PV = 1 for joint disclosure of proactive security and potential vulnerability, 0 otherwise
  - VA = 1 for joint disclosure of potential vulnerability and actual security breach, 0 otherwise
  - PA = 1 for joint disclosure of proactive security and actual security breach, 0 otherwise
  - PVA = 1 for joint disclosures of proactive security measures, potential vulnerability and actual security breach, 0 otherwise
  - Year<sub>it</sub> = 1 if current year, 0 otherwise
  - Indus<sub>it</sub> = 1 if current industry, 0 otherwise
- Coefficient for year and industry variables are suppressed  
p-values in parentheses are heteroscedastic corrected values  
\* significant at 10%; \*\* significant at 5%; \*\*\* significant at 1%

**Panel A: Regression on generic security disclosure controlling for selection**

	First Stage		Price Model	
Logasset	0.037	0.000***		
ROA	-0.096	0.070*		
CI	-0.521	0.000***		
Volat	0.043	0.774		
Turnover	0.722	0.000***		
Hold	-0.225	0.001***		
Analys	0.006	0.010***		
Dis			36.691	0.000***
EPS			3.192	0.000***
BVPS			1.015	0.000***
Q			0.213	0.000***
Mills ratio			-18.315	0.000***
Intercept	-2.908	0.000	3.526	0.000***
Obs		17,690		17,690
LR chi2(41)	1,503			
Prob > chi2	0.0000			
Pseudo R2	0.1495			
Log Likelihood	-4,274			
Adjstd R <sup>2</sup>				0.5911

**Table 15 (Cont'd)**

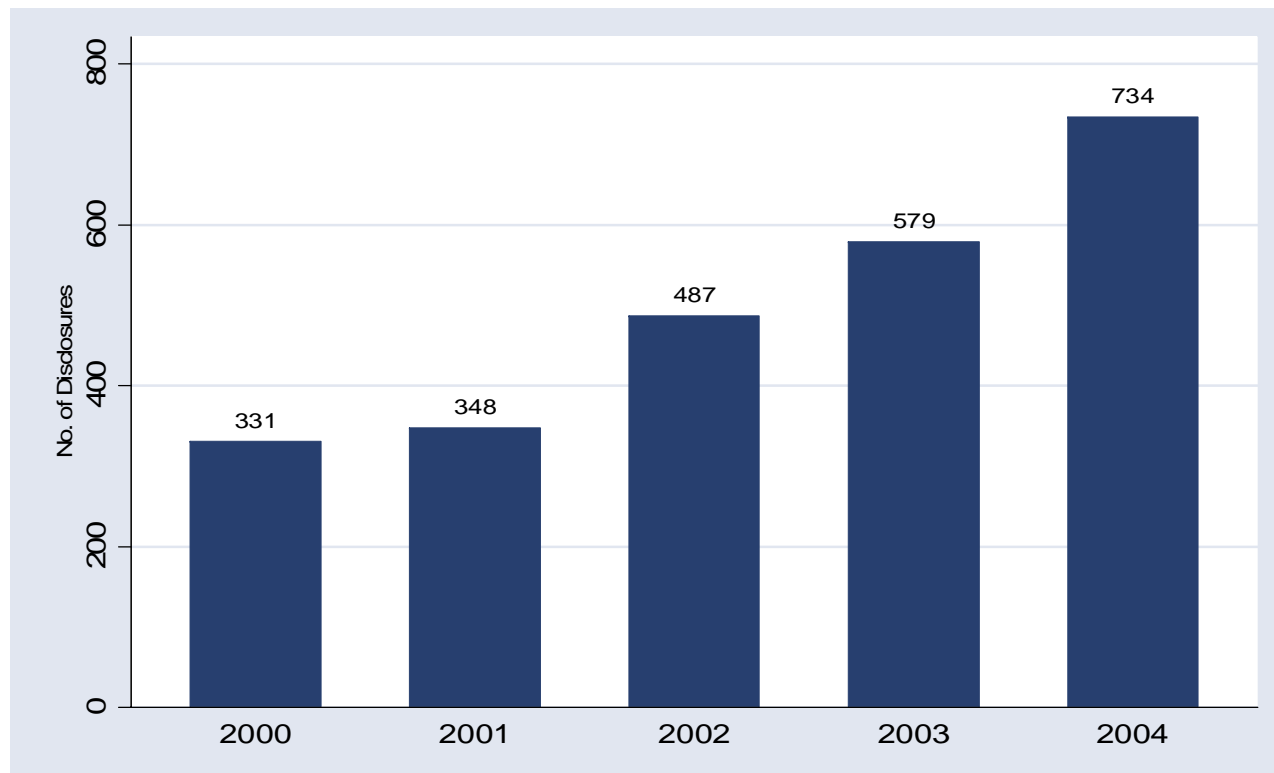
*Panel B: Treatment regression on individual types of security disclosure controlling for selection*

P	79.29 0.000***						
V		33.63 0.000***					
A			-45.05 0.275				
PV				27.01 0.000***			
VA					-67.47 0.000***		
PA						82.30 0.053*	
PVA							95.74 0.000***
EPS	3.12 0.000***	3.19 0.000***	3.19 0.000***	3.22 0.000***	3.19 0.000***	3.18 0.000***	3.17 0.000***
BVPS	0.99 0.000***	1.03 0.000***	1.03 0.000***	1.03 0.000***	1.03 0.000***	1.03 0.000***	1.03 0.000***
Q	0.21 0.000***	0.22 0.000***	0.22 0.000***	0.22 0.000***	0.22 0.000***	0.22 0.000***	0.21 0.000***
Mills	-33.88 0.000***	-13.41 0.000***	14.41 0.296	-12.79 0.000***	26.06 0.000***	-27.12 0.049	-34.93 0.000***
Intercept	3.86 0.000***	3.63 0.000***	3.65 0.000***	3.51 0.000***	3.69 0.000***	3.65 0.000***	3.72 0.000***
Wald chi <sup>2</sup>	12,235.37	22,897.75	24,163.80	22,281.34	23,862.74	24,084.31	21,568.36
Prob > chi <sup>2</sup>	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Adjstd R <sup>2</sup>	0.5899	0.5783	0.5777	0.5818	0.5781	0.5777	0.5812



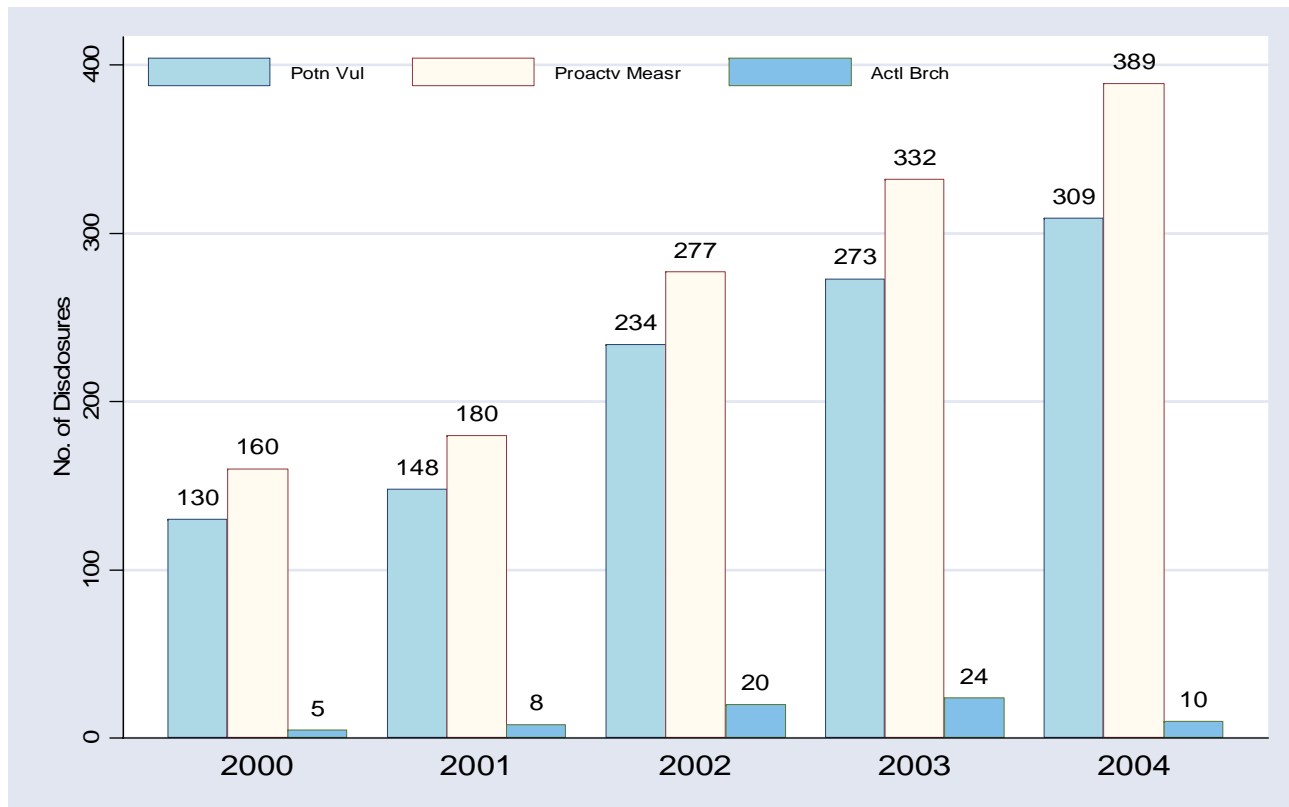
**Figure 1**

**Number of Disclosures by Years**



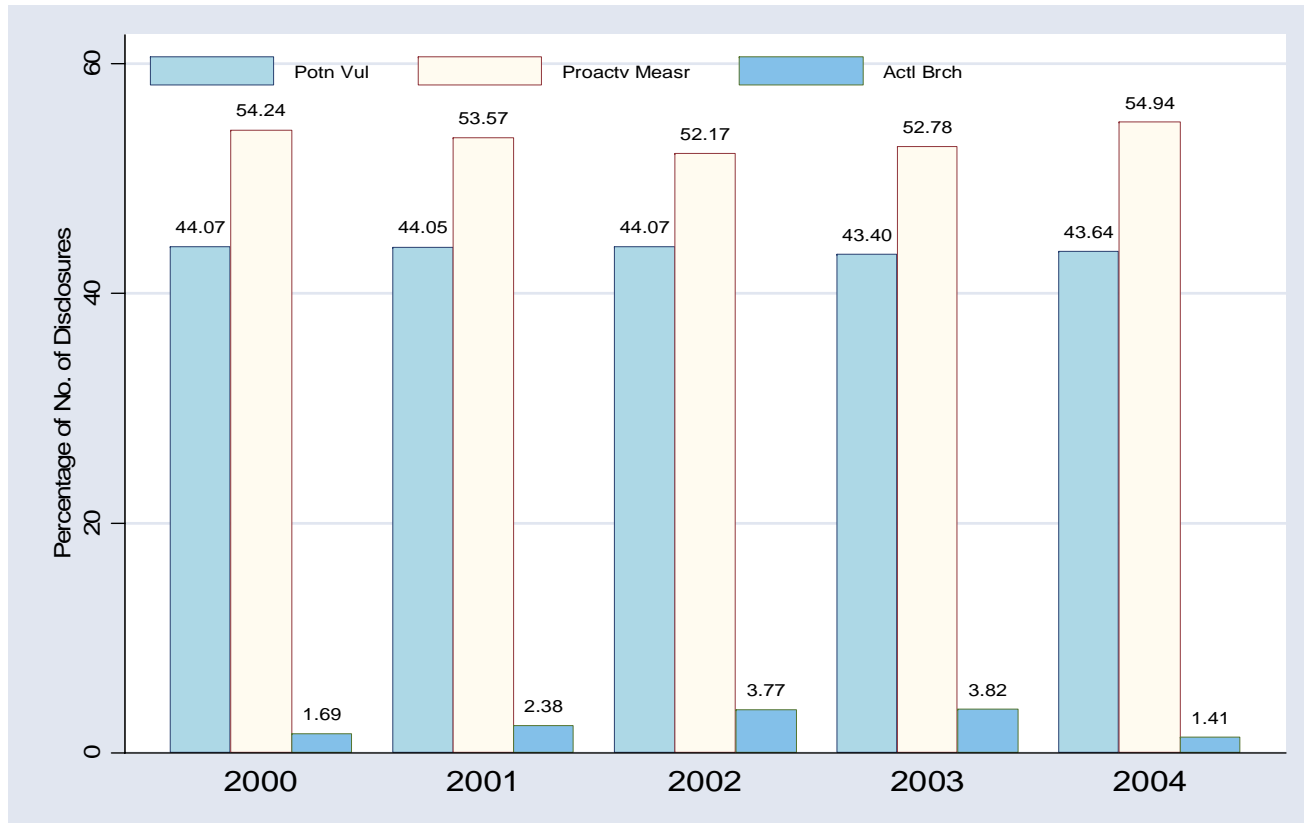
**Figure 2**

**Types of Disclosures by Years**



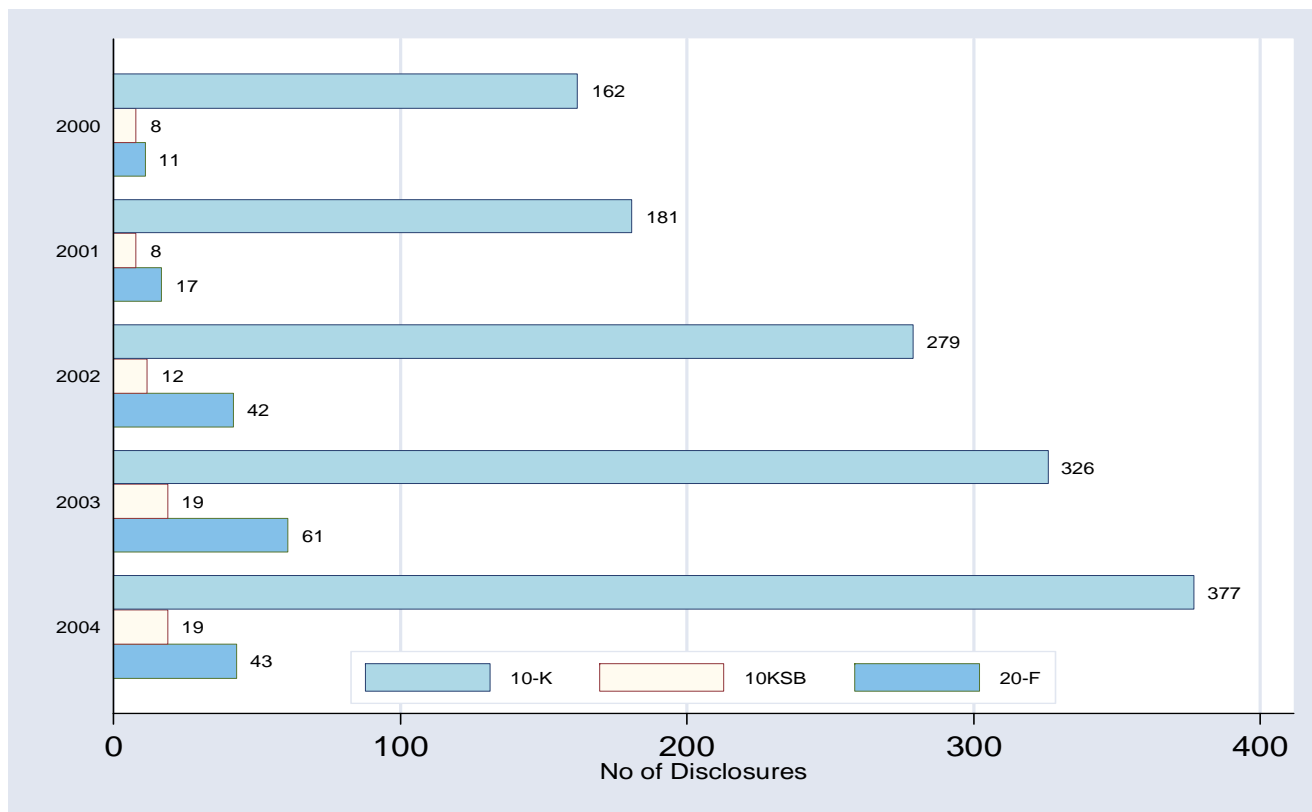
**Figure 3**

**Percentage of Types of Disclosures by Year**



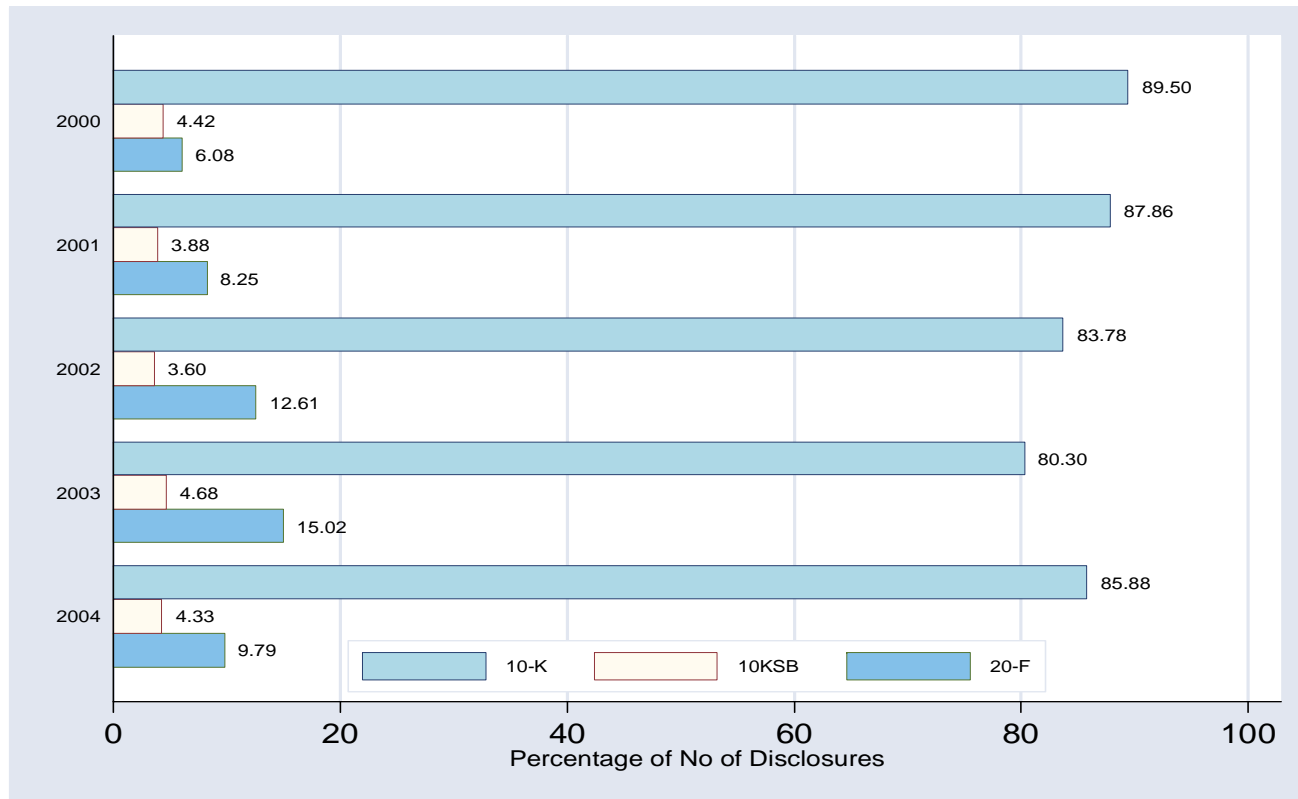
**Figure 4**

**Number of Disclosures by Types of Filers by Year**



**Figure 5**

**Percentage of Disclosures by Types of Filers by Year**



## Bibliography

- [1] Anderson, R., (2001), “Why Information Security is Hard: An Economic Perspective” In: 17th Annual Computer Security Applications Conference
- [2] Aboody, D., M. E. Barth, and R. Kasznik. 2004a. Firms' Voluntary Recognition of Stock-Based Compensation Expense. *Journal of Accounting Research* 42 (2):123-150.
- [3] ———. 2004b. Sfas No. 123 Stock-Based Compensation Expense and Equity Market Values. *Accounting Review* 79 (2):251-275.
- [4] Aboody, D., J. Hughes, and J. Liu. 2002. Measuring Value Relevance in a (Possibly) Inefficient Market. *Journal of Accounting Research* 40 (4):965-986.
- [5] Aboody, D., and B. Lev. 1998. The Value Relevance of Intangibles: The Case of Software Capitalization. *Journal of Accounting Research* 36 (3):161-191.
- [6] Adams, M., and M. Hossain. 1998. Managerial Discretion and Voluntary Disclosure: Empirical Evidence from the New Zealand Life Insurance Industry. *Journal of Accounting & Public Policy* 17 (3):245-281.
- [7] Akerlof, G. A. 1970. The Market for "Lemons": Quality Uncertainty and the Market Mechanism. *Quarterly Journal of Economics* 84 (3):488-500.

- [8] Amir, E. 1996. The Effect of Accounting Aggregation on the Value-Relevance of Financial Disclosures: The Case of Sfas No. 106. *Accounting Review* 71 (4):573-590.
- [9] Amir, E., and B. Lev. 1996. Value-Relevance of Nonfinancial Information: The Wireless Communications Industry. *Journal of Accounting & Economics* 22 (1-3):3-30.
- [10] Barth, M. E. 1991. Relative Measurement Errors among Alternative Pension Asset and Liability Measures. *Accounting Review* 66 (3):433-463.
- [11] ———. 1994. Fair Value Accounting: Evidence from Investment Securities and the Market Valuation of Banks. *Accounting Review* 69 (1):I-25.
- [12] ———. 2000. Valuation-Based Accounting Research: Implications for Financial Reporting and Opportunities for Future Research. *Accounting & Finance* 40 (1):7.
- [13] Barth, M. E., W. H. Beaver, and W. R. Landsman. 1992. The Market Valuation Implications of Net Periodic Pension Cost Components. *Journal of Accounting & Economics* 15 (1):27-62.
- [14] ———. 1998. Relative Valuation Roles of Equity Book Value and Net Income as a Function of Financial Health. *Journal of Accounting & Economics* 25 (1):1-34.

- [15] ———. 2001. The Relevance of the Value-Relevance Literature for Financial Accounting Standard Setting: Another View. *Journal of Accounting & Economics* 31 (1-3):77-104.
- [16] Barth, M. E., and G. Clinch. 1996. International Accounting Differences and Their Relation to Share Prices: Evidence from U.K., Australian, and Canadian Firms. *Contemporary Accounting Research* 13 (1):135-170.
- [17] Barth, M. E., and G. J. Clinch. 2005. Scale Effects in Capital Markets-Based Accounting Research. London Business School Accounting Subject Area No. 017. <http://ssrn.com/abstract=201228>, March.
- [18] Barth, M. E., J. A. Elliott, and M. W. Finn. 1999. Market Rewards Associated with Patterns of Increasing Earnings. *Journal of Accounting Research* 37 (2):387-413.
- [19] Barth, M. E., and S. Kallapur. 1996. The Effects of Cross-Sectional Scale Differences on Regression Results in Empirical Accounting Research. *Contemporary Accounting Research* 13 (2):527-567.
- [20] Barth, M. E., and W. R. Landsman. 1995. Fundamental Issues Related to Using Fair Value Accounting for Financial Reporting. *Accounting Horizons* 9 (4):97-107.
- [21] Berinato, S., and L. C. Ware. 2003. The State of Information Security 2003. *CIO*, October 15, 79-93.



- [22] Bernard, V. L. 1987. Cross-Sectional Dependence and Problems in Inference in Market-Based Accounting Research. *Journal of Accounting Research* 25 (1):1-48.
- [23] Bhojraj, S., W. G. Blacconiere, and J. D. D'Souza. 2004. Voluntary Disclosure in a Multi-Audience Setting: An Empirical Investigation. *Accounting Review* 79 (4):921-947.
- [24] Bhojraj, S., C. M. C. Lee, and D. K. Oler. 2003. What's My Line? A Comparison of Industry Classification Schemes for Capital Market Research. *Journal of Accounting Research* 41 (5):745-774.
- [25] Botosan, C. A. 1997. Disclosure Level and the Cost of Equity Capital. *Accounting Review* 72 (3):323.
- [26] Botosan, C. A., and M. A. Plumlee. 2002. A Re-Examination of Disclosure Level and the Expected Cost of Equity Capital. *Journal of Accounting Research* 40 (1):21-40.
- [27] Cagnemi, M. 2001. Top Technology Issues. *Information Systems Control Journal* 4 (6).
- [28] Campbell, K., L. A. Gordon, M. P. Loeb, and L. Zhou. 2003. The Economic Cost of Publicly Announced Information Security Breaches: Empirical Evidence from the Stock Market. *Journal of Computer Security* 11 (3):431.

- [29] Casey, E. 2004. Reporting Security Breaches - a Risk to Be Avoided or Responsibility to Be Embraced? *Digital Investigation* 1 (3):159-161.
- [30] Christie, A. A. 1987. On Cross-Sectional Analysis in Accounting Research. *Journal of Accounting & Economics* 9 (3):231-259.
- [31] A Chronology of Data Breaches Reported since the Choicepoint Incident 2006. Privacy Rights Clearing House, May 22 2006 [cited May 29 2006]. Available from <http://www.privacyrights.org/ar/ChronDataBreaches.htm#CP>.
- [32] Collins, D. W., and S. P. Kothari. 1989. An Analysis of Intertemporal and Cross-Sectional Determinants of Earnings Response Coefficients. *Journal of Accounting and Economics* 11 (2-3):143-181.
- [33] Collins, D. W., E. L. Maydew, and I. S. Weiss. 1997. Changes in the Value-Relevance of Earnings and Book Values over the Past Forty Years. *Journal of Accounting & Economics* 24 (1):39.
- [34] Core, J. E. 2001. A Review of the Empirical Disclosure Literature: Discussion. *Journal of Accounting and Economics* 31 (1-3):441-456.
- [35] Darrrough, M. N. 1993. Disclosure Policy and Competition Cournot Vs. Bertrand. *Accounting Review* 68 (3):534-561.
- [36] Darrrough, M. N., and N. M. Stoughton. 1990. Financial Disclosure Policy in an Entry Game. *Journal of Accounting & Economics* 12 (1-3):219-243.

- [37] Denning, D., and D. Branstad. 1996. A Taxonomy of Key Escrow Encryption Systems. *Communications of the ACM* 39 (3).
- [38] Dye, R. A. 2001. An Evaluation of "Essays on Disclosure" and the Disclosure Literature in Accounting. *Journal of Accounting and Economics* 32 (1-3):181-235.
- [39] Easton, P. D. 1998. Discussion of Revalued Financial, Tangible, and Intangible Assets: Association with Share Prices and Non-Market-Based Value Estimates. *Journal of Accounting Research* 36 (3):235-247.
- [40] ———. 1999. Security Returns and the Value Relevance of Accounting Data. *Accounting Horizons* 13 (4):399.
- [41] Easton, P. D., and M. E. Zmijewski. 1989. Cross-Sectional Variation in the Stock Market Response to Accounting Earnings Announcements. *Journal of Accounting & Economics* 11 (2/3):117-141.
- [42] Edwards, E. O., and P. W. Bell. 1961. *The Theory and Measurement of Business Income*. Berkeley, CA: University of California Press.
- [43] Einhorn, E. 2005. The Nature of the Interaction between Mandatory and Voluntary Disclosures. *Journal of Accounting Research* 43 (4):593-254.
- [44] Fama, E. F., and K. R. French. 1997. Industry Costs of Equity. *Journal of Financial Economics* 43 (2):153-193.

- [45] Field, L., M. Lowry, and S. Shu. 2005. Does Disclosure Deter or Trigger Litigation? *Journal of Accounting and Economics* 39 (3):487-507.
- [46] Freeman, R. N., and S. Y. Tse. 1992. A Nonlinear Model of Security Price Responses to Unexpected Earnings. *Journal of Accounting Research* 30 (2):185-209.
- [47] Gigler, F. 1994. Self-Enforcing Voluntary Disclosures. *Journal of Accounting Research* 32 (2):224-240.
- [48] Gordon, L. A., and M. P. Loeb. 2002a. The Economics of Information Security Investment. *ACM Transactions on Information and System Security* 5 (4):438-457.
- [49] ———. 2002b. Return on Information Security Investments: Myths Vs Realities. (Cover Story). *Strategic Finance* 84 (5):26-32.
- [50] ———. 2003. Expenditures on Competitor Analysis and Information Security: A Managerial Accounting Perspective. In *Management Accounting in the Digital Economy*, edited by A. Bhimani. Oxford: Oxford University Press, 95-111.
- [51] Gordon, L. A., M. P. Loeb, and W. Lucyshyn. 2003. Sharing Information on Computer Systems Security: An Economic Analysis. *Journal of Accounting & Public Policy* 22 (6):461.

- [52] Gordon, L. A., M. P. Loeb, W. Lucyshyn, and R. Richardson. 2005. Tenth Annual Csi/Fbi Computer Crime and Security Survey: Computer Security Institute, 1-26.
- [53] Grossman, S. J. 1981. The Informational Role of Warranties and Private Disclosure About Product Quality. *Journal of Law & Economics* 24 (3):461-483.
- [54] Hayn, C. 1995. The Information Content of Losses. *Journal of Accounting & Economics* 20 (2):125-153.
- [55] Healy, P. M., A. P. Hutton, and K. G. Palepu. 1999. Stock Performance and Intermediation Changes Surrounding Sustained Increases in Disclosure. *Contemporary Accounting Research* 16 (3):485-520.
- [56] Healy, P. M., and K. G. Palepu. 1995. The Challenges of Investor Communication the Case of Cuc International, Inc. *Journal of Financial Economics* 38 (2):111-140.
- [57] ———. 2001. Information Asymmetry, Corporate Disclosure, and the Capital Markets: A Review of the Empirical Disclosure Literature. *Journal of Accounting & Economics* 31 (1-3):405-440.
- [58] Heckman, J. J. 1978. Dummy Endogenous Variables in a Simultaneous Equation System. *Econometrica* 46 (4):931-959.

- [59] Holthausen, R. W., and R. L. Watts. 2001. The Relevance of the Value-Relevance Literature for Financial Accounting Standard Setting. *Journal of Accounting & Economics* 31 (1-3):3-75.
- [60] Ittner, C. D., and D. F. Larcker. 1998. Are Nonfinancial Measures Leading Indicators of Financial Performance? An Analysis of Customer Satisfaction. *Journal of Accounting Research* 36 (3):1-35.
- [61] ———. 2001. Assessing Empirical Research in Managerial Accounting: A Value-Based Management Perspective. *Journal of Accounting and Economics* 32 (1-3):349-410.
- [62] Kerstein, J., and S. Kim. 1995. The Incremental Information Content of Capital Expenditures. *Accounting Review* 70 (3):513-526.
- [63] Kormendi, R., and R. Lipe. 1987. Earnings Innovations, Earnings Persistence, and Stock Returns. *Journal of Business* 60 (3):323-345.
- [64] Kothari, S. P., and J. Shanken. 2003. Time-Series Coefficient Variation in Value-Relevance Regressions: A Discussion of Core, Guay, and Van Buskirk and New Evidence. *Journal of Accounting & Economics* 34 (1-3):69.
- [65] Kothari, S. P., and J. L. Zimmerman. 1995. Price and Return Models. *Journal of Accounting & Economics* 20 (2):155-192.
- [66] Kotulic, A. G., and J. G. Clark. 2004. Why There Aren't More Information Security Research Studies. *Information & Management* 41:597-607.

- [67] Landsman, W. R., and J. Magliolo. 1988. Cross-Sectional Capital Market Research and Model Specification. *Accounting Review* 63 (4):586-605.
- [68] Lang, M., and R. Lundholm. 1996a. The Relation between Security Returns, Firm Earnings, and Industry Earnings. *Contemporary Accounting Research* 13 (2):607-629.
- [69] Lang, M. H., and R. J. Lundholm. 1993. Cross-Sectional Determinants of Analyst Ratings of Corporate Disclosures. *Journal of Accounting Research* 31 (2):246-271.
- [70] ———. 1996b. Corporate Disclosure Policy and Analyst Behavior. *Accounting Review* 71 (4):467-492.
- [71] ———. 2000. Voluntary Disclosure and Equity Offerings: Reducing Information Asymmetry or Hying the Stock? *Contemporary Accounting Research* 17 (4):623-662.
- [72] Lee, W., W. Fan, M. Miller, S. J. Stolfo, and E. Zadok. 2002. Towards Cost-Sensitive Modeling for Intrusion Detection and Response. *Journal of Computer Security* 10:5-22.
- [73] Leuz, C., and R. E. Verrecchia. 2000. The Economic Consequences of Increased Disclosure. *Journal of Accounting Research* 38 (3):91-124.

- [74] Lev, B., and S. H. Penman. 1990. Voluntary Forecast Disclosure, Nondisclosure, and Stock Prices. *Journal of Accounting Research* 28 (1):49-76.
- [75] Lev, B., and T. Sougiannis. 1996. The Capitalization, Amortization, and Value-Relevance of R&D. *Journal of Accounting & Economics* 21 (1):107-138.
- [76] Maddala, G. S. 1983. *Limited-Dependent and Qualitative Variables in Econometrics*. Cambridge, MA: Cambridge University Press.
- [77] Milgrom, P. R. 1981. Good News and Bad News: Representation Theorems and Applications. *Bell Journal of Economics* 12 (2):380-391.
- [78] Nearon, B. H., J. Stanley, S. W. Tepler, and J. Burton. 2005. Life after Sarbanes-Oxley: The Merger of Information Security and Accountability. *Jurimetrics* 45 (4):379-412.
- [79] Ohlson, J. A. 1995. Earnings, Book Values, and Dividends in Equity Valuation. *Contemporary Accounting Research* 11 (2):661-687.
- [80] Peasnell, K. V. 1982. Some Formal Connections between Economic Values and Yields and Accounting Numbers. *Journal of Business Finance & Accounting* 9 (3):361-381.



- [81] Pownall, G., and G. Waymire. 1989. Voluntary Disclosure Credibility and Securities Prices: Evidence from Management Earnings Forecasts, 1969-73. *Journal of Accounting Research* 27 (2):227-245.
- [82] Sandhu, R., E. Coyne, H. Feinstein, and C. Youman. 1996. Role Based Access Control Models. *IEEE Computing* 29 (2).
- [83] Schechter, S. E., and D. Michael. 2003. How Much Security Is Enough to Stop a Thief? The Economics of Outsider Theft Via Computer Systems Networks. Paper read at Proceedings of the Financial Cryptography Conference,, January, 27-30, at Gosier, Guadeloupe.
- [84] Schultz, E., R. Proctor, M. Lien, and G. Salvendy. 2001. Usability and Security an Appraisal of Usability Issues in Information Security Methods. *Computer & Security* 20 (7):620-634.
- [85] SEC-2345. 2005. Regulation S-B: Part 228 - Integrated Disclosure Systems for Small Business Issuers. United States Security and Exchange Commission [cited November 3 2005]. Available from <http://www.sec.gov/about/forms/regs-b.pdf>.
- [86] Securities Exchange Act of 1934. United States Security and Exchange Commission [cited. Available from <http://www.sec.gov/divisions/corpfin/34act/index1934.shtml>.
- [87] SB-1386. 2002. Security Breach Information Act.

- [88] Sengupta, P. 1998. Corporate Disclosure Quality and the Cost of Debt. *Accounting Review* 73 (4):459-475.
- [89] Simmons, G. 1994. Cryptanalysis and Protocol Failures. *Communications of the ACM* 37 (11).
- [90] Skinner, D. J. 1994. Why Firms Voluntarily Disclose Bad News. *Journal of Accounting Research* 32 (1):38-60.
- [91] ———. 1997. Earnings Disclosures and Stockholder Lawsuits. *Journal of Accounting & Economics* 23 (3):249-282.
- [92] Straub, D. W. 1990. Effective Is Security: An Empirical Study. *Information Systems Research* 1 (3):255-276.
- [93] Straub, D. W., and R. J. Welke. 1998. Coping with Systems Risk: Security Planning Models for Management Decision Making. *MIS Quarterly* 22 (4):441-469.
- [94] Suijs, J. 2005. Voluntary Disclosure of Bad News. *Journal of Business Finance & Accounting* 32 (7/8):1423-1435.
- [95] Tanaka, H., K. Matsuura, and O. Sudoh. 2005. Vulnerability and Information Security Investment: An Empirical Analysis of E-Local Government in Japan. *Journal of Accounting and Public Policy* 24 (1):37-59.
- [96] Verrecchia, R. E. 1983. Discretionary Disclosure. *Journal of Accounting & Economics* 5 (3):179.

- [97] ———. 1990. Information Quality and Discretionary Disclosure. *Journal of Accounting & Economics* 12 (4):365-380.
- [98] ———. 2001. Essays on Disclosure. *Journal of Accounting and Economics* 32 (1-3):97-180.
- [99] Wagenhofer, A. 1990. Voluntary Disclosure with a Strategic Opponent. *Journal of Accounting & Economics* 12 (4):341-363.
- [100] White, H. 1980. A Heteroskedasticity-Consistent Covariance Matrix Estimator and a Direct Test for Heteroskedasticity. *Econometrica* 48 (4):817-838.
- [101] Wild, J. J. 1992. Stock Price Informativeness of Accounting Numbers: Evidence on Earnings, Book Values, and Their Components. *Journal of Accounting & Public Policy* 11 (2):119-154.
- [102] Wooldridge, J. M. 2002. *Econometric Analysis of Cross Section and Panel Data*. Cambridge, MA: MIT Press.
- [103] Work Place Security. 2003. *Wall Street Journal Special Report*, September Monday 29, R-3.
- [104] Wysocki, P. D. 1998. Real Options and the Informativeness of Segment Disclosures. UMBS Working Paper <http://ssrn.com/abstract=141044>.