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The Effect of First Wave Mandatory XBRL Reporting across the Financial Information Environment

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ABSTRACT: This study examines the effect of mandatory XBRL disclosure across various aspects of the financial information environment. Our findings show an increase in information efficiency, a decrease in event return volatility, and a reduction of change in stock returns volatility for 428 firms (1,536 10-K and 10-Q filings) post-XBRL disclosure. In addition, this study shows that XBRL mitigates information risk in the market, especially when there is increased uncertainty in the information environment. Our results are robust to various alternative specifications and research modifications, such as a matched-pair control (326 XBRL versus 326 non-XBRL firms), current stock market condition, potential earnings releases, and corporate governance. This study contributes to the literature by systematically documenting evidence of how mandatory XBRL disclosure decreases information risk and information asymmetry in both general and uncertain information environments. Our evidence could potentially assist the SEC in their effort to expeditiously assess the benefits of XBRL.

Keywords: XBRL (eXtensible Business Reporting Language); interactive data; information risk; information asymmetry; information uncertainty; capital markets.

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Data Availability: The list of firms used in the study is available from Professor Lim upon request. All other data are available from sources identified in the body of the paper.

I. INTRODUCTION

On December 17, 2008, the U.S. Securities and Exchange Commission (SEC) adopted a new rule that requires publicly traded firms to disclose their financial statements using an interactive data format known as eXtensible Business Reporting Language (XBRL) (SEC 2009). XBRL is intended to provide a standard method to prepare, publish, and exchange business, especially financial information. Proponents of XBRL claim that interactive data make financial information more accessible and easy to analyze for analysts, investors, regulators, and any related parties. Furthermore, it is also said to assist in automating regulatory filings and business information processing (SEC 2009). XBRL is expected to improve the accuracy and efficiency of data analysis by eliminating costly manual processes and by standardizing financial disclosure, especially with detailed tagging. Enhanced efficiency in XBRL-tagged data could also translate into frictionless information flow and dissemination in the capital market for users who acquire, integrate, and combine financial information to make better-informed investment decisions (Gray and Miller 2009; Hodge et al. 2004; XBRL.US 2009).

A growing body of research pertaining to XBRL adoption aims to facilitate communication among market players and enhance the quality of stakeholder decisions. Research by Debreceny et al. (2005) shows that U.S. firms found XBRL disclosure to be a more robust and transparent format than HTML disclosure by reducing errors in stakeholder data input. This change has also improved access to management reporting data and corporate disclosure; for example, Hodge et al. (2004) show that financial statement users, especially nonprofessional users, can benefit by using search-facilitating technologies (e.g., XBRL). Yoon et al. (2011) argue that one of the main benefits of XBRL is that it improves information quality by reducing information asymmetry among larger and smaller issuers. In fact, by eliminating existing information asymmetries, XBRL has the potential to enable market democratization while increasing market efficiency (American Institute of Certified Public Accountants [AICPA] 2009; SEC 2009; Stantial 2007).

This study makes an empirical examination of the effect of mandated first-year XBRL disclosure (i.e., interactive data submissions)[1] across various aspects of the financial information environment. Specifically, we assess changes in the information quality (i.e., decreases in information risk and information asymmetry) of stock prices in pre- and post-XBRL disclosure periods. Following previous research (Heflin et al. 2003; Francis et al. 2006), we employ three proxies to measure information environment changes in the market: event returns volatility, information efficiency, and the change of standard deviation of daily stock returns around 10-K and 10-Q filing dates.[2] By examining the 1,536 first-year mandated interactive data submissions from 428 Phase 1 group firms, our cross-sectional analysis shows an increase in information efficiency, a decrease in event return volatility, and a reduction of change in stock returns volatility post-XBRL disclosure.

We also investigate whether the level of uncertainty (measured by earnings surprise) prior to 10-K and 10-Q filings is associated with our information risk measures. *Earnings surprise* indicates the gap between analysts' expectation and actual performance, illustrating the uncertainty in the information environment (i.e., understanding financial statements). In times of greater earnings

[1] The SEC uses the term interactive data, instead of XBRL. Throughout the paper, we use the terms *XBRL disclosure* and *interactive data submission* interchangeably.

[2] 10-Q is a comprehensive report that a company must submit quarterly to the SEC. 10-K is a comprehensive report that a company must submit annually to the SEC.

surprise, investors are more likely to be disadvantaged in forecasting future cash flows relative to managers. This information disadvantage triggers information asymmetry between investors and managers in the market. Our results show that XBRL disclosure decreases information risk, and that this decrease effect is more dominant when there is higher uncertainty. The results suggest that XBRL would reduce information asymmetry by providing uninformed investors with improved transparency of 10-K and 10-Q filings.

The results are robust to a matched-pair control (326 XBRL versus 326 non-XBRL adopters), indicating the aforementioned effect of XBRL on the information environment. This complementary approach consists of both within-group and across-group comparisons, allowing for greater exploration of differentiation with respect to variables and outcomes. As well, our results remain consistent after controlling for volatile stock market conditions, concurrent earnings releases, and corporate governance status.

This study contributes to the literature by systematically documenting evidence of how mandatory XBRL disclosure decreases information risk and information asymmetry in both general and uncertain information environments. Throughout this study, XBRL disclosure is shown to decrease information risk. Furthermore, XBRL disclosure mitigates the decrease in information efficiency due to information uncertainty. This study could potentially assist the SEC in their efforts to expeditiously assess the benefits of XBRL, especially given a range of concerns (e.g., XBRL is driven by regulators, not by markets, and it is an unstable technology due to the changes in XBRL specification, taxonomies, or governance requirements).

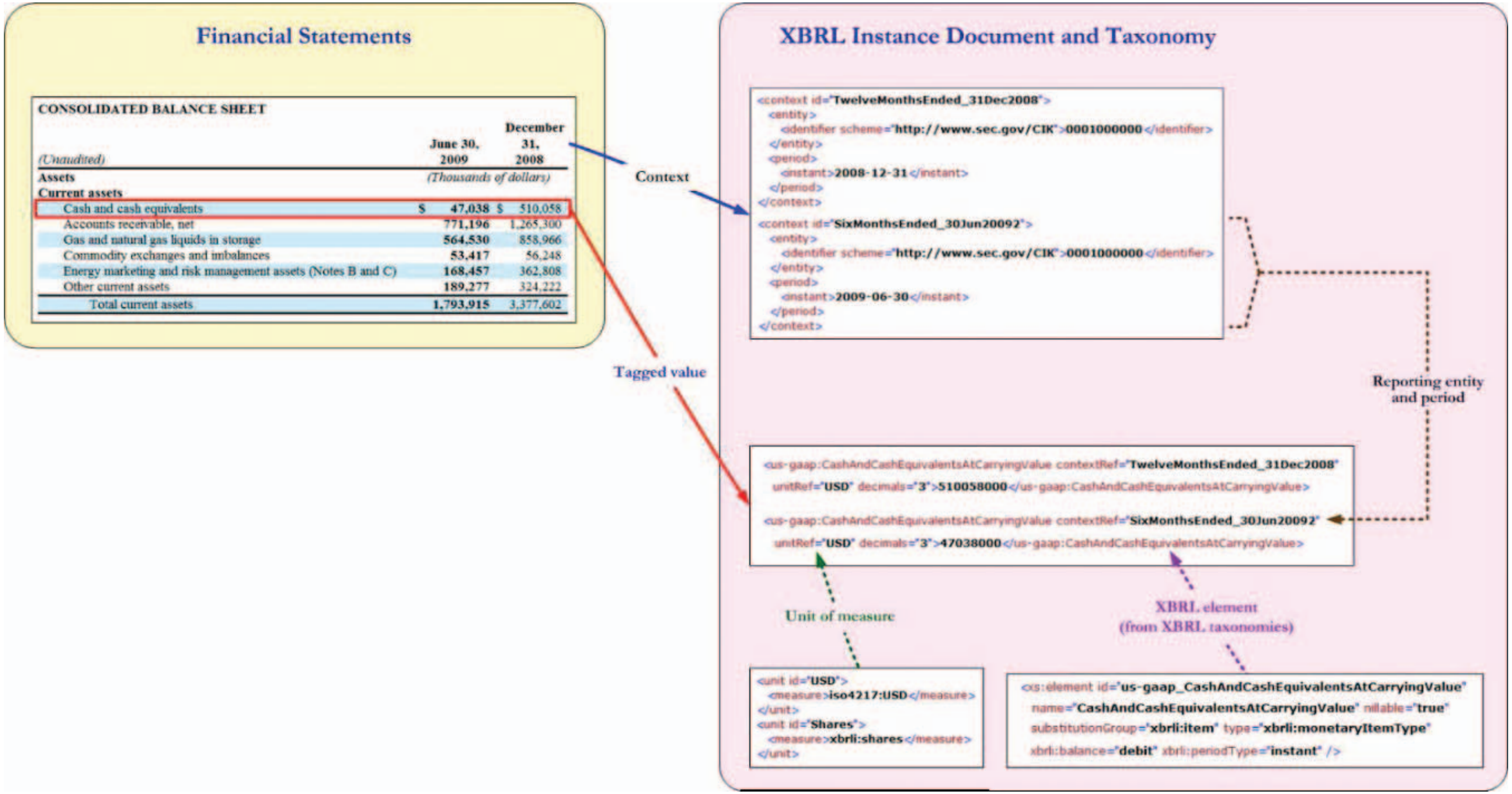
The remainder of this paper is structured as follows. Section II provides study background and hypothesis development. Section III outlines the methods employed in the study. Section IV reports the results of the statistical analysis of XBRL disclosure on the information risks of firms. Section V includes a summary with conclusions and recommendations for future research.

II. BACKGROUND AND HYPOTHESIS DEVELOPMENT

The SEC issued a new rule that mandates the use of an interactive data format known as XBRL in financial reporting by 2011. The main objective of the new mandate is to assist financial users, including SEC staff members, in retrieving and analyzing financial information in a more efficient and less costly manner. Furthermore, XBRL disclosure aims to improve regulatory filings and business information processing by increasing the speed, accuracy, and usability of financial disclosure (SEC 2009). The SEC mandate requires firms to tag their primary financial statements, company identification information, schedules, and footnote disclosures using the most recent official XBRL taxonomies. With XBRL, all financial facts in financial statements are tagged to identify each individual item of data using machine-readable XBRL elements defined in its taxonomies. An XBRL taxonomy is a dictionary of XBRL elements that represent financial terms used in preparing financial statements or other business reports. It defines individual reporting concepts (e.g., total assets), as well as the relationships between concepts (e.g., the human-readable label of each concept, and how concept values should sum up from one to another).

Figure 1 illustrates how financial facts are tagged using XBRL elements. An XBRL instance document is created by mapping financial facts (e.g., cash and cash equivalents) in financial statements to corresponding XBRL elements (e.g., CashAndCashEquivalentsAtCarryingValue) in XBRL taxonomies. Specifically, each financial fact (the arrows labeled "Tagged value" and "Context" in Figure 1) is identified using the corresponding element (the dotted arrow labeled "XBRL element" in Figure 1), along with additional information: the unit in which a financial fact has been measured (the dotted arrow labeled "Unit of measure" in Figure 1), reporting entity, reporting period, and the accuracy of the facts (the dotted arrow labeled "Reporting entity and period" in Figure 1). For example, the code block in Figure 1 specifies that $510,058,000 is related to "Cash and Cash Equivalents" account on December 31, 2008, whereas $47,038,000 indicates "Cash

FIGURE 1
XBRL Tagging Example



and Cash Equivalents" account on June 30, 2009. In addition, the unit of measurement is the U.S. dollar, and the decimal of 3 indicates that the value is known to be correct to three decimal places.

Figure 2 also shows an example that illustrates how investors use XBRL-tagged data for ratio analysis. Currently, investors can obtain financial information from most firms over the Internet and use it for their analysis. In particular, the EDGAR site ("The SEC EDGAR System" in Figure 2) provides both official financial statements and XBRL disclosures (i.e., interactive data). For instance, an investor seeking to perform a ratio analysis may obtain official SEC filings ("HTML or PDF version of Financial Information" in Figure 2) from the EDGAR system. However, the HTML or PDF version of financial information often cannot be easily incorporated into spreadsheets and other analysis software, requiring tedious, costly, and error-prone cutting and pasting or transcription. Alternatively, the investor can obtain XBRL disclosures ("XBRL Instance Document" in Figure 2) and use them for his or her analysis. Since XBRL is a machine-readable format, the investor may need to use a rendering tool ("Interactive Data Viewer" in Figure 2) that transforms XBRL-tagged information into a presentation that can be interpreted by him or her. Furthermore, the investor can import the XBRL-tagged information into analysis software ("Excel" in Figure 2) and easily perform the ratio analysis.[3]

Prior Research on XBRL

A considerable body of research has been conducted to address a wide range of issues with XBRL (for a review, see Roohani et al. 2010). These XBRL research issues can be summarized into three areas: (1) the general and technical aspects of XBRL and implementation issues, (2) the quality and assurance issues of XBRL, and (3) the role of XBRL for stakeholders.

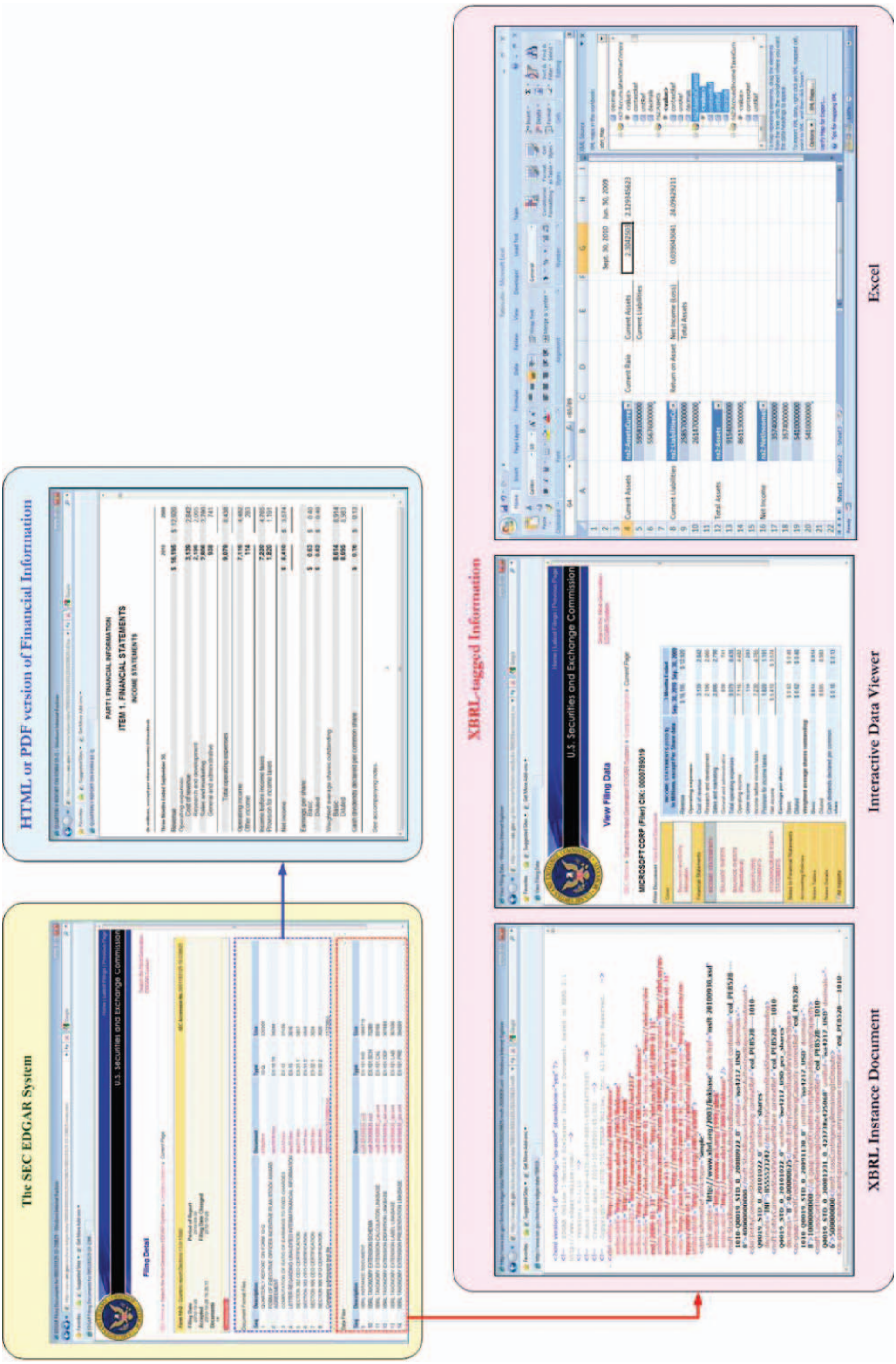
Along with a growing trend of XBRL usage around the world, early research focuses on technical aspects of XBRL, such as taxonomy and XBRL adoption and implementation issues (e.g., Bovee et al. 2002; Garbellotto 2009; Pinsker and Li 2008; Sledgianowski et al. 2010). For instance, Bovee et al. (2002) examine whether the year 2000 XBRL U.S. GAAP C&I (Commercial and Industrial) taxonomy parallels with preferred reporting practices of firms. They found that, on average, the U.S. GAAP C&I taxonomy provides a good fit overall, but is lacking the requisite elements to cover preferred reporting practices for certain financial statements and industries. Garbellotto (2009) introduces three XBRL implementation approaches (i.e., bolt-on, built-in, and embedded) and discussed the advantages and disadvantages of each approach. Pinsker and Li (2008) conduct interviews with four business managers from Canada, Germany, South Africa, and the U.S. who have been involved in XBRL adoption by their organizations. Several findings about companies adopting XBRL emerged: all companies used XBRL for external purposes (financial reporting), as opposed to internal purposes (internal reporting); all received assistance from a Big 4 CPA firm and software vendor during the XBRL implementation; each indicated cost savings as the main benefit of XBRL adoption; and each cited potential financial information transparency gained from adoption. Sledgianowski et al. (2010) further address the currently available XBRL implementation approaches and identify several characteristics, such as client-vendor relationship, task complexity, and vendor's skills, that accountants should consider when they develop XBRL implementation plans and make insourcing and outsourcing decisions.

At present, there are no requirements for independent assurance on the XBRL version of the official financial statements,[4] which, in turn, leads to concerns about the quality of XBRL

[3] See Tribunella and Tribunella (2010) for a more detailed and comprehensive example.

[4] Under the SEC's mandate, the filers of interactive data are subject to limited liability during the company's first two years of required interactive data reporting. During this period, interactive data submissions will be deemed to be furnished, not filed, for the liability provisions of Security Acts and Security Exchange Act, and not subject to specified antifraud provisions if inaccurate XBRL-related documents are provided in good faith and are promptly corrected after the filer becomes aware of the inaccuracy (SEC 2009).

FIGURE 2
An Example: Ratio Analysis using XBRL-Tagged Information



disclosures. Debreceny et al. (2010) find that the first filings under the SEC's mandatory XBRL filing program contained a significant number of errors, such as inappropriate use of XBRL elements and reporting incorrect negative values where positive values should have been entered. Questions about the reliability and quality of XBRL-tagged data led several researchers to further examine assurance issues related to the use of XBRL (e.g., Boritz and No 2009; Plumlee and Plumlee 2008; Srivastava and Kogan 2010). Boritz and No (2009) show mock assurance procedures on United Technologies Corporation's 10-Q instance document, and discuss assurance issues, such as validation errors and the use of taxonomy extensions, that might need to be addressed by auditors if they were asked to provide assurance on XBRL-tagged data. Plumlee and Plumlee (2008) discuss unresolved assurance issues, such as materiality, statistical sampling, and controls over financial reporting, involved in providing assurance on XBRL-tagged data, and suggest several future research areas, including the type of technical knowledge needed in an XBRL assurance engagement and the potential costs and benefits of providing assurance on XBRL-tagged data. To assist auditors in performing assurance procedures on XBRL instance documents, Srivastava and Kogan (2010) develop a conceptual framework consisting of a set of assertions determining the quality of an XBRL instance document.

Notwithstanding their concerns, recent empirical studies examine the role of XBRL for information users and in capital markets. Hodge et al. (2004) claim that financial statement users can benefit by using standardized XBRL filings. Specifically, they show that nonprofessional users are more likely to benefit from the efficiencies of search-facilitating technologies such as XBRL for analyzing financial statements and footnotes than professional users. In addition, since XBRL provides a standardized method to prepare and exchange business information (Bergeron 2003; XBRL International 2011a), XBRL is capable of reducing information asymmetry resulting from incompatible reporting formats. Yoon et al. (2011) indicate that XBRL adoption led to the reduction of information asymmetry in the Korean stock market, and that this effect is stronger for large-sized companies than for medium-sized and small-sized companies. This international finding (from a period of only nine months) argues for accelerating the adoption of XBRL in other countries. However, an empirical examination in the U.S. capital market remains to be completed to determine if, for example, XBRL filings will pay off in terms of improving an organization's information environment.

XBRL and Information Risk

XBRL assists stakeholders, such as companies, investors, and regulators, in integrating information by providing a standardized format for preparing and exchanging data. Using the consolidated data gathered in XBRL, companies can produce uniform filings from various reports using varying subsets of the data with minimum effort. For instance, when the U.S. Federal Deposit Insurance Corporation (FDIC) implemented XBRL for the quarterly collection of financial data (i.e., Call Reports) from approximately 8,200 U.S. banks at the end of 2005, the improved process allowed the FDIC to gather and analyze cleaner, more accurate data and publish more timely information for the banking industry (Federal Financial Institutions Examination Council [FFIEC] 2006).

Due to its machine-readable format, where each piece of business and financial data is tagged, XBRL will reduce stakeholders' time outlay and cost of accessing information by minimizing manual processes, particularly those involved in the assembly and reentry of data. Stakeholders, therefore, can focus more effort on analyzing data, rather than collecting and manipulating data (Apostolou and Nanopoulos 2009; Burnett et al. 2006; Cohen et al. 2005). In particular, the XBRL-enhanced search engines can enable investors to simultaneously view similarly tagged financial information. This simultaneous presentation helps to improve analytical capabilities by revealing discrepancies and enabling comparison of deeper sets of information (Gray and Miller 2009; XBRL.US 2009). Faster navigation of financial data across a market or industry also uncovers anomalies and eases preparation of updated reports (Cohen et al. 2005; Gray and Miller 2009; Premuroso and Bhattacharya 2008). In addition, regulators are able to immediately identify problems with filings through XBRL software that automatically checks and verifies the data (XBRL International 2011b), resulting in improved accuracy and reliability of financial data.

Accordingly, XBRL disclosure can provide more effective communication tools for stakeholders, thereby improving investor relations through the provision of more transparent and user-friendly information. This, in turn, allows the present study to examine whether the effects of XBRL are expected to improve information quality. In other words, higher information efficiency and lower information risks (measured by event return volatility and by the changes in daily stock return volatility around 10-K and 10-Q filing dates) are expected in the market after XBRL disclosures. This leads to the following hypotheses:

H1a: XBRL disclosure decreases levels of event return volatility around filing dates.

H1b: XBRL disclosure increases levels of information efficiency around filing dates.

H1c: XBRL disclosure reduces change in return volatility around filing dates.

XBRL and Information Uncertainty

Firms announce earnings after the fiscal year-end, but before the SEC filing date (e.g., 10-K and 10-Q filing dates), to satisfy investors' demand for timely earnings announcement in the market. Kim and Verrecchia (1994) document the effect of accurate and timely information before a public announcement on investors' market reaction. In times of higher uncertainty, investors face ambiguity about the distribution of a firm's future cash flow, but the uncertainty would decrease over time as more information becomes available in the market. Before the SEC filing dates, investors receive a large volume of information regarding current firm performance (e.g., financial analysts' reports and the firm's voluntary disclosure and earnings announcement). However, the information structure of current firm performance is incomplete because full sets of financial statements are unavailable until the SEC filing dates.

Earnings surprise, which is the gap between the announced earnings figure and the investors' expectation, can be used to measure this information uncertainty. Francis et al. (2007) show that investors react differently to earnings announcements in cases of extremely high uncertainty (extremely large earnings surprise). The uncertainty of information structure, resulting from incomplete information, can lead to an increase in information risk, consequently decreasing information efficiency surrounding the earnings announcement. Furthermore, they document an association between earnings surprise and incompleteness of information measured by earnings quality, as suggested by Dechow and Dichev (2002). These findings indicate that in times of extremely high earnings surprise, firms with a lower earnings quality have larger abnormal returns around earnings announcements than firms with a higher earnings quality. Before the SEC filings, such as 10-K and 10-Q filings, are filed, investors have incomplete and uncertain information about firms' future cash flows, affecting their reaction around the SEC filings dates.

The information in SEC filings is characterized by its high volume and degree of complexity. If XBRL can level the playing field for all investors' information processing of SEC filings, including uninformed investors with access to similar information, then it could efficiently reduce information risk, even in a highly uncertain information environment. When there is a higher uncertainty (earnings surprise) before the SEC filings among investors, they are more likely to depend on the SEC filings to reduce the uncertainty. Therefore, with XBRL's transparency and speed of information dissemination, investors have greater information acquisition and integration that simplifies its complexity. This leads to the following hypotheses:

H2a: When higher uncertainty exists prior to filing dates, the XBRL disclosure is more effective in reducing event return volatility.

H2b: When higher uncertainty exists prior to filing dates, the XBRL disclosure is more effective in improving information efficiency.

H2c: When higher uncertainty exists prior to filing dates, the XBRL disclosure is more effective in mitigating the change in return volatility.

III. METHODOLOGY

Sample Selection

The SEC rule that mandates the use of interactive data in financial reporting applies to domestic and foreign companies using U.S. GAAP, and will apply to foreign companies using International Financial Reporting Standards (IFRS) in the near future. The SEC mandate phases in over a three-year period (SEC 2009). Domestic and foreign large accelerated filers using U.S. GAAP (i.e., companies with worldwide public common equity float above $5 billion) are subject to interactive data reporting for a quarterly report on Form 10-Q, or annual report on Form 20-F or Form 40-F[5] for fiscal periods ending on or after June 15, 2009. All other large accelerated filers are required to use interactive data reporting for fiscal periods ending on or after June 15, 2010. Finally, all remaining filers are required to use interactive data in their financial reporting for fiscal periods ending on or after June 15, 2011 (Phase 3 Group in Figure 3). Figure 3 illustrates how the sample consists of the first four quarters of interactive data submissions from the Phase 1 group. The sample used is identified through three steps.

Step 1: The Interactive Data Submissions

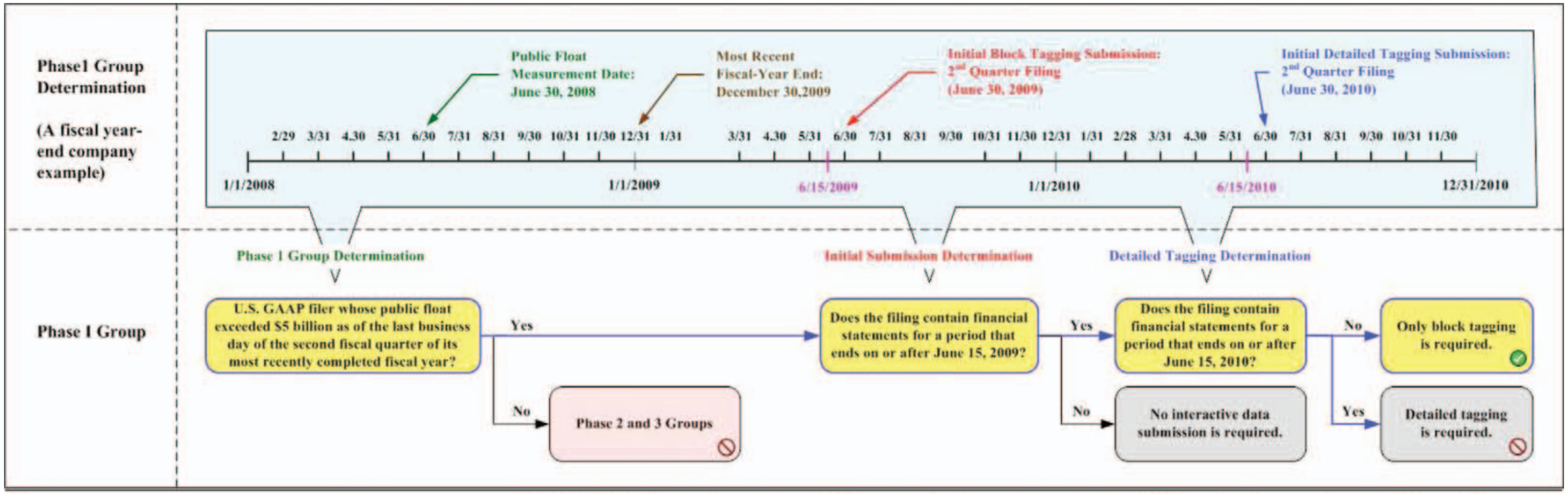
Due to the lack of a publicly available list of interactive data submissions for the Phase 1 group, we first obtain 4,842 interactive data submitted to the SEC between June 15, 2009, and December 31, 2010, using the EDGAR RSS (Really Simple Syndication) feed's monthly archives (available at: http://www.sec.gov/Archives/edgar/monthly/).[6] Next, using a software agent (i.e., a computer program),[7] further information about each interactive data submission is collected (e.g., EDGAR URL, company name, form type, filing date, additional company information such as fiscal year-end, Standard Industrial Code [SIC], and Central Index Key). Since certain information in the EDGAR system (e.g., filing data and fiscal year-end) is incorrect for a considerable number of interactive data submissions, one author and two research assistants conduct manual validation for each interactive data submission in the EDGAR system (see Figure 2). As a result, one interactive data submission is incorrectly displayed in both 2010-05 and 2010-06 monthly RSS feeds, and 163 errors are fixed with respect to the period of report and fiscal year-end posted on the EDGAR

[5] 20-F is a form issued by the SEC that must be submitted annually by a foreign private issuer with listed equity shares on exchanges in the U.S. 40-F is an annual report that must be submitted by Canadian companies with listed equity shares on exchanges in the U.S.

[6] Since the filing date (i.e., the date that a firm submits its filing to the SEC) of each submission is usually 20 to 90 days after the filing period (i.e., the period of report), December 31, 2010, is used to take this period into account. Thus, there is adequate time to allow us to identify the first four quarters of submissions from each Phase 1 group.

[7] A software agent was developed to collect information using the EDGAR RSS feeds.

FIGURE 3
Sample Selection Procedure



Interactive data submissions that are covered in the study
Interactive data submissions that are not covered in the study

* SEC (2009): Phase 1 group (approximately 500 firms), Phase 2 group (approximately 1,000 firms), and Phase 3 group (approximately 8,700 firms).

* Adapted from Deloitte (2010)

system. To further validate the information captured by the software agent, we also compare the information with the EDGAR Dashboard (available at: http://edgardashboard.xbrlcloud.com), resulting in eight additional interactive data submissions that are not listed in the RSS feeds. The comprehensive data validation of the first step yields 4,849 interactive data submissions from 1,529 firms.

Step 2: The First-Year Interactive Data Submissions by the Phase 1 Group

To identify firms in the Phase 1 group, we calculate the worldwide public common equity float of each firm on the last business day of its most recently completed second fiscal quarter. For example, a calendar year-end (i.e., December 31) firm is required to measure its worldwide public common equity float on June 30, 2008 (Phase 1 Group Determination in Figure 3). If the public float exceeds the $5 billion threshold as of June 30, 2008, the firm belongs to the Phase 1 group and is required to submit its first interactive data with its June 30, 2009, Form 10-Q filing. Any subsequent filings containing a quarterly or annual report (i.e., 10-Q and 10-K) also need to include an interactive data file. Block tagging is required for this initial interactive data submission ("Initial Block Tagging Submission" in Figure 3). However, detailed tagging is first required for the firm's June 30, 2010, Form 10-Q filings because the interactive data submission includes financial statements for a period ending after June 15, 2010 ("Initial Detailed Tagging Submission" in Figure 3).

From our initial sample of 4,849 interactive data submissions from 1,529 firms, we exclude 2,367 submissions which are not qualified for the Phase 1 group.[8] We further exclude 53 submissions that are 8-K,[9] 20-F, and 40-F, as well as 681 detailed tagging submissions by the Phase 1 group. Of these interactive data submissions, 212 submissions are deleted because of missing values in Compustat, CRSP, or I/B/E/S. The resulting sample size is 1,536 first-year interactive submissions from 428 Phase 1 group firms ("Interactive data submissions that are covered in the study" in Figure 3). The sample period, based on the period report, is between June 15, 2009, and June 14, 2010.

Step 3: Pre-XBRL and Post-XBRL Periods

To effectively control for potential compounding effects of firm characteristics, we match the quarterly or annual reporting period of each interactive data submission to the firm's corresponding quarter two years prior to the date of the submission. Therefore, we compare the SEC filing effects between non-XBRL and XBRL disclosure quarters (i.e., 1,536 pre-XBRL versus 1,536 post-XBRL). Panel A of Table 1 summarizes our sample selection procedure and the sample distribution by quarters.

Panel B of Table 1 provides a summary of the sample distribution based on industry distribution by two-digit SIC code. The 1,536 XBRL 10-K and 10-Q filings cover ten industry groups. Among them, the Metal, Machinery and Equipment, Instruments industry has the highest number of firms with XBRL disclosure, followed by the Banking and Finance, the Utility, Transportation, Mining, Oil and Gas industries, and finally, the Chemicals, Petroleum and Coal, and Rubber and Plastics industries.

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[8] Due to the change in their worldwide public common equity floats, 95 submissions from 95 companies were moved from the Phase 1 group to the Phase 2 group, whereas 11 submissions from 11 firms were moved from the Phase 2 group to the Phase 1 group. The 2,367 submissions represent the interactive data submissions from the Phase 2 group, and consist of 2,283 Phase 2 submissions and 84 ($= 95 - 11$) submissions that belong to the Phase 2 group due to the change in worldwide public common equity float.

[9] 8-K is a report used to notify unscheduled material events or corporate changes to shareholders or the SEC.

TABLE 1

Sample

Panel A: Sample Selection Procedure

Procedure	Details		n
Step 1	Start from the EDGAR RSS Feeds (Jun. 15, 2009–Dec. 31, 2010)		4,842
	Exclude any duplicated submission that incorrectly appeared in RSS feeds		(1)
	Include submissions that are not listed in RSS feeds		8
			4,849
Step 2	Exclude from		
	Interactive data submissions from the Phase 2 group		(2,367)
	Interactive data submissions from the Phase 2 group	(2,283)	
	Status changes (= 95 − 11)	(84)	
	Changed from the Phase 1 group to the Phase 2 group: 95		
	Changed from the Phase 2 group to the Phase 1 group: 11		
	Not 10-Q and 10-K interactive data submissions (e.g., 8-K, 20-F, and 40-F)		(53)
	Detailed tagging interactive data submissions by the Phase 1 group		(681)
	Missing values from Compustat, CRSP, or I/B/E/S		(212)
			1,536
Step 3	Pre-XBRL versus Post-XBRL		
	Post-XBRL: The first-year interactive data submissions by the Phase 1 group		1,536
	First Quarter (10-Q): 390		
	Second Quarter (10-Q): 383		
	Third Quarter (10-Q): 386		
	Fourth Quarter (10-K): 377		
	Pre-XBRL: Corresponding quarter two years prior to the each submission		1,536

Panel B: Distribution of Sample by Two-Digit SIC

Two-Digit SIC	Industry	n	%
10-19	Mining, Oil and Gas, and others	163	10.6
20-27	Food, Kindred, Printing and Publishing	101	6.6
28-29	Chemicals, Petroleum and Coal, Rubber and Plastics	157	10.2
30-39	Metal, Machinery and Equipment, Instruments	361	23.5
40-49	Utility, Transportation	199	13.0
50-59	Wholesale, Retails	142	9.2
60-69	Banking and Finance	261	17.0
70-79	Business Service, Auto Repair, Recreation	121	7.9
80-89	Health, Engineering and Management Service	27	1.8
99	Others	4	3.0
Total		1,536	100.0

Information Risk Measures

Following the recommendation of previous literature (Francis et al. 2006), this study uses the following three measures of public information effects: event returns volatility, information efficiency, and standard deviation of daily stock returns.

The volatility of event returns is measured around the firm's 10-Q filing date by estimating the sum of the absolute values of daily abnormal return (Bailey et al. 2003; Heflin et al. 2003; Francis et al. 2006):

$$\text{Event Returns Volatility } (ERV) = \sum\nolimits_{t=-1}^{+1} |AR_t|,$$

where AR_t^2 = firm's abnormal return on day *t*, and abnormal returns are calculated using the market model over the one-year period ending the day before the start of the pre-XBRL quarter. Our estimation period of days is (−255, −55). The lower the event returns volatility, then the lower chance of information risk in the market.

The measure of information efficiency (IE) determines the gap between the full information stock price and a pre-event price. We follow the calculation of this measurement by prior studies (Heflin et al. 2003; Francis et al. 2006), which is the absolute deviation between actual return and the expected return by the market model over *h* days prior to the XBRL disclosure:

$$\text{Information Efficiency } (IE) = \left| \prod_{t=-p}^{+2} [1 + AR_t] - 1 \right|,$$

where $h = 1$ (or $= 2$) [e.g., IE ($h = -1$) or IE ($h = -2$)]. The smaller deviation implies a superior information environment. The abnormal returns are estimated using the market model over days (−255, −55). The above three measures investigate information environment around the XBRL disclosures, whereas for the next two measures, we examine the information environment 30 days after the SEC filing event, because market participants may delay their reaction to the event.

The change of standard deviation of daily stock return (*VR*) before and after the disclosure filing dates indicates the infrequency of information reaching the market and the degree of information asymmetry among market participants (Kothari et al. 2009). In fact, more informative disclosures can reduce market uncertainty for a firm's cash flows and decrease return volatility. We measure the standard deviation of returns using daily return data for 30 days before and after the filing date. Then, the change is estimated by the standard deviation of returns for 30 days after the filing dates, minus the standard deviation of returns for 30 days before the filing dates. The positive change indicates an increase after the filing dates. Finally, we compare the changes of the pre- versus post-XBRL years.

Control Variables

To evaluate the effect of pre- versus post-XBRL on information risk, the known factors that might be associated with the risk are controlled for: firm size (*SIZE*), market-to-book ratio (*MB*), leverage (*LEV*), loss indicator (*LOSS*), return volatility for the estimation period (*RETVAR*), absolute value of cumulative abnormal return for the corresponding quarter (*ABSCAR*), indicator of the negative sign of the cumulative abnormal return (*NEGCAR*), and earnings surprise (*ESUR*). Prior research supports the positive association between the extent of managers' disclosure and firm size due to a larger firm's ability to sustain a competitive advantage from its market power or positional advantages, as well as superior financial and human resources endowments (Ajinkya et al. 2005; Botosan 1997). We control for the size of the firm (*SIZE*) using the natural log of market capitalization at the end of the quarter (Kothari et al. 2009). Market-to-book ratio (*MB*) captures the growth potential perceived in the market, which is related to the information risk. *MB* is calculated as the market capitalization divided by total shareholders' equity at the end of the quarter to control for firm growth (Kothari et al. 2009).

Another determinant of adopting XBRL is associated with a firm's financial status. Past research found that financial reporting errors are negatively associated with performance (DeFond and Jiambalvo 1991), and that the existence of a loss is positively associated with impairing the market's ability to forecast the upcoming earnings number (Heflin et al. 2003). We control for a firm's financial loss (*LOSS*), measured as 1 if the income before extraordinary items is less than zero, otherwise 0. In addition, financial risks increase as a firm's financial leverage increases (Kothari et al. 2009), and highly leveraged firms tend to disclose more financial information to reassure creditors and to signal their confidence to the public security markets (Malone et al. 1993). Thus, we include the ratio of long-term debt divided by total assets (*LEV*).

Further, inherent price variability is controlled (Heflin et al. 2003), such as return volatility (*RETVAR*), which measures the standard deviation of a firm's daily stock returns during the market model estimation period for the relevant pre-XBRL quarter, and also controls for firm-specific inherent price variability. We include the absolute cumulative abnormal return during the entire quarter (*ABSCAR*), as firm-quarters with larger total information flow are expected to have a larger information gap at any given time (Heflin et al. 2003). For another dimension of price variability, we control for the negative sign of the cumulative abnormal return (*NEGCAR*), as evidence suggests greater price movements in down markets than in up markets (Christie 1982; Heflin et al. 2003). Following You and Zhang (2009), consideration is given to the earnings surprise (*ESUR*), which affects future stock returns. We first calculate *ESUR* from analysts' forecasts, which is the actual EPS minus I/B/E/S consensus forecasts scaled by stock price at the end of the quarter. To reduce the possibility that inferences are influenced by extreme observations, we winsorize all continuous variables at the 99th percentiles of the distributions of their absolute values.

Research Design

Regression models in Equations (1) and (2) are used to test the sets of first hypotheses (H1a, H1b, and H1c), which assess the effects of XBRL disclosure in various information risks (see Panel A of Table 4):

$$ERV(or\ IE) = \alpha_1 + \alpha_2 XBRL + \alpha_3 SIZE + \alpha_4 MB + \alpha_5 LOSS + \alpha_6 LEV + \alpha_7 RETVAR + \alpha_8 ABSCAR + \alpha_9 NEGCAR + \alpha_{10} \sum INDUSTRY + \varepsilon_t. \quad (1)$$

$$VR = \alpha_1 + \alpha_2 XBRL + \alpha_3 SIZE + \alpha_4 MB + \alpha_5 LOSS + \alpha_6 LEV + \alpha_7 RETVAR + \alpha_8 \sum INDUSTRY + \varepsilon_t. \quad (2)$$

Our primary variable of interest is *XBRL*, which equals 1 if the firm submitted its XBRL disclosures during the first year of mandatory filing; otherwise, it will be 0. We compare the effect of 10-K and 10-Q filing in the pre- versus post-XBRL periods on information risks. For each of the 1,536 submissions, we find a corresponding non-XBRL quarter two-year prior to the XBRL quarters. The non-XBRL quarters are used as benchmarks. We expect a negative coefficient on *XBRL*, which indicates that XBRL adopters (post-XBRL) have lower information risk measures than the same firms two-year prior to the XBRL disclosure quarters (pre-XBRL).

The set of second hypotheses (H2a, H2b, and H2c) examines the impact of XBRL disclosure on information uncertainty in Equations (3) and (4) (see Panel B of Table 4). To proxy the uncertainty, we use the absolute value of earnings surprise for the corresponding quarter (*ESUR_ABS*). Next, we introduce the two-way interaction terms of firm *ESUR_ABS* with indicator variable *XBRL* (*ESUR_ABS_X*) to distinguish the persistence of firm *ESUR_ABS* for firms of XBRL disclosures (see Panel B of Table 4):

$$ERV(or\ IE) = \alpha_1 + \alpha_2 XBRL + \alpha_3 SIZE + \alpha_4 MB + \alpha_5 LOSS + \alpha_6 LEV + \alpha_7 RETVAR + \alpha_8 ABSCAR + \alpha_9 NEGCAR + \alpha_{10} ESUR\_ABS + \alpha_{11} ESUR\_ABS\_X + \alpha_{12} \sum INDUSTRY + \varepsilon_t. \quad (3)$$

$$VR = \alpha_1 + \alpha_2 XBRL + \alpha_3 SIZE + \alpha_4 MB + \alpha_5 LOSS + \alpha_6 LEV + \alpha_7 RETVAR + \alpha_8 ESUR\_ABS + \alpha_9 ESUR\_ABS\_X + \alpha_{10} \sum INDUSTRY + \varepsilon_t. \quad (4)$$

A positive coefficient is expected on *ESUR_ABS* because the information risk measures would be higher when the information environment is more uncertain. The variable of interest is the interaction term of *ESUR_ABS* and *XBRL* as *ESUR_ABS_X*. We expect a negative coefficient on *ESUR_ABS_X* because firms that adopted XBRL are expected to mitigate the increase in the information risk measures, especially when information in the market is complex.

IV. RESULTS

Descriptive Results

Table 2 presents the descriptive statistics of the sample, comparing the split between each firm's XBRL disclosure (post-XBRL) with each of the same firm's corresponding quarter two years prior to the date of the XBRL disclosure (pre-XBRL).[10] This analysis presents statistical tests of differences in the cross-sectional mean and median of *ERV*, *IE* ($h = -1$), *IE* ($h = -2$), and *VR* between the pre- and post-XBRL disclosure. If XBRL improves the information environment by reducing information risk and information asymmetry, we predict declines in returns volatility and increases in information efficiency. Consistent with our expectation, we find significant decreases in *ERV*, *IE* ($h = -1$), *IE* ($h = -2$), and *VR* at $p = 0.01$ (or better, two-tailed). Table 2 also shows means and medians for our control variables in both our pre- and post-XBRL periods. The post-XBRL means and medians are significantly different ($p = 0.01$ or better, two-tailed) from their pre-XBRL counterparts for all control variables. In summary, our univariate results provide some evidence that XBRL improves information efficiency and mitigates information asymmetry.

Table 3 presents Pearson correlations for the variables in the study. Our dependent variables represent a different type of information risk measures. Thus, the high correlations among them are expected. All dependent variables are highly correlated. The correlation between *ERV* and *IE* ($h = -1$) is 0.698, and the correlation between *ERV* and *VR* is 0.138. None of the correlations among the independent variables are above 0.65, and the highest variance inflation factor (VIF) in our regression is only 3.96, which is well below the suggested multicollinearity problem threshold of 10 (Marquardt 1980; Gujarati and Porter 2009). Our examination of the standard errors and size of the coefficients also shows that they are not sensitive to the inclusion or exclusion of the highly correlated variables, indicating that multicollinearity is unlikely to be problematic (Hosmer and Lemeshow 1989).

Regression Results

Panel A of Table 4 presents results from estimating Equations (1) and (2). Our variable of interest is *XBRL*. Consistent with H1a, the post-XBRL coefficient is negative and significant (t-statistic $= -7.68$, $p < 0.01$), suggesting that *ERV* is significantly lower after XBRL disclosure, given controlling for numerous factors that relate to *ERV*, including industry effect. We find similar results for H1b when the dependent variable is information efficiency, both *IE* ($h = -1$) and *IE* ($h = -2$), suggesting that the information gap actually declines after XBRL disclosure (t-statistic $= -5.54$, $p < 0.01$; t-statistic $= -5.49$, $p < 0.01$, respectively). The result of H1c shows that the post-

[10] The results also remain unchanged; the post-XBRL means and medians are significantly different ($p = 0.01$ or better, two-tailed) from their pre-XBRL counterparts in the corresponding quarter one year prior to the date of XBRL disclosure for all control variables.

TABLE 2

Descriptive Statistics
After SEC Filing Dates Before and After XBRL Required
(Pre- versus Post-XBRL Disclosure)

	Pre-XBRL (n = 1,536)			Post-XBRL (n = 1,536)			p-value for the Test of Difference in	
	Mean	**Median**	**S.D.**	**Mean**	**Median**	**S.D.**	**Means**	**Median**
ERV	0.050	0.041	0.039	0.043	0.034	0.037	0.000	0.000
IE ($h = -1$)	0.033	0.025	0.031	0.029	0.020	0.028	0.001	0.000
IE ($h = -2$)	0.036	0.027	0.033	0.031	0.022	0.031	0.000	0.000
VR	0.000	−0.000	0.009	−0.001	−0.002	0.010	0.000	0.000
XBRL	0	0	0	1	1	0	NA	NA
SIZE	9.583	9.529	1.103	9.325	9.218	1.095	0.000	0.000
MB	4.252	3.160	3.777	2.923	2.226	2.978	0.000	0.000
LOSS	0.048	0	0.213	0.114	0	0.318	0.000	0.000
LEV	0.193	0.166	0.155	0.210	0.195	0.157	0.002	0.001
RETVAR	0.021	0.019	0.008	0.023	0.020	0.013	0.000	0.008
ABSCAR	0.145	0.109	0.133	0.198	0.135	0.187	0.000	0.000
NEGCAR	0.368	0	0.483	0.561	1	0.495	0.000	0.000
ESUR	0.001	0.000	0.004	0	0.001	0.043	0.875	0.000
ESUR_ABS	0.002	0.001	0.004	0.005	0.001	0.043	0.000	0.000
ESUR_ABS_X	0	0	0	0.005	0.001	0.043	0.000	0.000

Variable Definitions:
ERV = sum of absolute abnormal returns on one day prior to the SEC filing date, on the SEC filing date, and on one day after the SEC filing date;
IE ($h = -1$) = absolute abnormal return from one day prior to the SEC filing date to two days after the SEC filing date;
IE ($h = -2$) = absolute abnormal return from two days prior to the SEC filing date to two days after the SEC filing date;
VR = change in standard deviation of daily stock returns over 30 days before and after the SEC filing date;
XBRL = indicator equal to 1 if the observation belongs to the XBRL filing period, otherwise 0;
SIZE = log of the market value of firm at the end of the quarter;
MB = market-to-book ratio at the end of the quarter;
LOSS = indicator variable equal to 1 for observations with negative earnings before extraordinary items in the quarter, 0 otherwise;
LEV = long-term debt divided by total assets;
Return volatility (*RETVAR*) = standard deviation of daily stock return for a one-year period starting from 55 days prior to the filing date;
ABSCAR = absolute value of cumulative abnormal return for the corresponding quarter. It is used to control the amount of information inflow for the period;
NEGCAR = sign of the cumulative abnormal return used for *ABSCAR*;
EA = 1 if the earnings is announced on the date of SEC filing, otherwise 0;
ESUR = actual earnings minus the mean of analysts' forecasts divided by stock price at the end of a fiscal quarter;
ESUR_ABS = absolute value of *ESUR*; and
ESUR_ABS_X = interaction between *ESUR_ABS* and *XBRL*.

XBRL coefficient is also significantly negative (t-statistic = −5.48, $p < 0.01$), suggesting that post-XBRL is different from pre-XBRL when *VR* is used as a dependent variable. Taken together, these results lend support to the set of H1 hypotheses, and support the view that XBRL improves information quality (i.e., decreases information risk and information asymmetry).

Panel B of Table 4 reports the regression results from Equations (3) and (4). To test H2a, H2b, and H2c, the interaction between *XBRL* and *ESUR_ABS* is included as *ESUR_ABS_X*. In the *ERV* model reported in the first column, the post-XBRL coefficient is negative and significant (t-statistic

TABLE 3

Pearson Correlation Matrix
(Pre-XBRL versus Post-XBRL, 1,536 obs.)

Panel A: Variables *ERV* to *MB*

Variables	*ERV*	*IE* (*h* = −1)	*IE* (*h* = −2)	*VR*	*XBRL*	*SIZE*	*MB*
ERV	1.000						
IE (*h* = −1)	0.698***	1.000					
IE (*h* = −2)	0.626***	0.844***	1.000				
VR	0.138***	0.075***	0.059***	1.000			
XBRL	−0.093***	−0.073***	−0.069***	−0.100***	1.000		
SIZE	−0.221***	−0.179***	−0.183***	0.082***	−0.117***	1.000	
MB	0.059**	0.048***	0.042**	−0.031*	−0.192***	0.068***	1.000
LOSS	0.081***	0.070***	0.066***	−0.017	0.122***	−0.179***	−0.089***
LEV	−0.022	−0.015	−0.025	0.046**	0.056***	−0.127***	0.004
RETVAR	0.292***	0.252***	0.241***	−0.154***	0.099***	−0.351***	−0.062***
ABSCAR	0.186***	0.154***	0.141***	−0.102***	0.160***	−0.215***	−0.046**
NEGCAR	0.025	0.026	0.032*	−0.096***	0.193***	−0.063***	−0.097***
ESUR	−0.162***	−0.090***	−0.056**	−0.056***	−0.003	0.035*	0.014
ESUR_ABS	0.189***	0.120***	0.079***	0.035**	0.061***	−0.102***	−0.064***

Panel B: Variables *LOSS* to *ESUR_ABS*

Variables	*LOSS*	*LEV*	*RETVAR*	*ABSCAR*	*NEGCAR*	*ESUR*	*ESUR_ABS*
LOSS	1.000						
LEV	0.136***	1.000					
RETVAR	0.287***	0.029	1.000				
ABSCAR	0.138***	0.023	0.433***	1.000			
NEGCAR	0.036**	0.014	0.133***	0.129***	1.000		
ESUR	−0.099***	−0.076***	−0.090***	−0.021	−0.015	1.000	
ESUR_ABS	0.158***	0.125***	0.238***	0.080***	0.011	−0.634***	1.000

*, **, *** Significant at the 0.10, 0.05, and 0.01 levels, respectively, using a two-tailed t-test.

= −7.02, $p < 0.01$), and *ESUR_ABS* and the interaction term (*ESUR_ABS_X*) are significant (t-statistic = 4.60, $p < 0.01$ and t-statistic = −3.69, $p < 0.05$). This result supports H2a, stating that XBRL disclosure mitigates the increase in return volatility resulting from a higher uncertainty. In the information efficiency models *IE* ($h = -1$) and *IE* ($h = -2$), *XBRL* is negative and significant (t-statistic range between −5.31 and −5.00, $p < 0.01$), but *ESUR_ABS* (*ESUR_ABS_X*) is positive (negative) and insignificant. The positive coefficient of *ESUR_ABS* implies that information efficiency decreases when higher uncertainty exists. The negative coefficient of *ESUR_ABS_X* means that XBRL disclosure decreases the effect of uncertainty around the 10K and 10-Q filing dates and, consequently, information efficiency increases. Similarly, in the *VR* model, *XBRL* is negative and significant (t-statistic = −3.66, $p < 0.01$), but the coefficient estimate *ESUR_ABS_X* in Equation (4) is insignificant, which means that our results do not support H2c. Our evidence marginally supports the set of H2 hypotheses, suggesting that XBRL disclosure mitigates the increase in information risk due to uncertainty.

TABLE 4

Regression of Information Risk Measures on XBRL and Control Variables

Panel A: Effect of XBRL

	ERV		*IE* (*h* = −1)		*IE* (*h* = −2)		*VR*	
	Coeff.	**t-statistic**	**Coeff.**	**t-statistic**	**Coeff.**	**t-statistic**	**Coeff.**	**t-statistic**
Intercept	0.084	6.08***	0.050	5.12***	0.061	6.18***	0.010	3.89***
XBRL	−0.009	−7.68***	−0.006	−5.54***	−0.006	−5.49***	−0.002	−5.48***
SIZE	−0.006	−5.39***	−0.003	−4.15***	−0.004	−4.93***	−0.000	−0.75
MB	0.001	2.48**	0.001	1.88*	0.001	1.98**	−0.000	−1.32
LOSS	0.000	0.03	0.000	0.03	0.000	−0.08	0.001	0.84
LEV	−0.016	−2.34**	−0.011	−2.00**	−0.014	−2.50**	0.002	0.87
RETVAR	0.592	4.46***	0.459	4.99***	0.452	4.54***	−0.207	−9.64***
ABSCAR	0.017	2.80***	0.010	2.33**	0.009	1.87**		
NEGCAR	0.000	0.28	0.001	0.57	0.001	0.97		
Industry	Yes		Yes		Yes		Yes	
F-value	9.90***		6.53***		6.35***		5.40***	
Adj. R^2	0.159		0.105		0.102		0.107	
Obs. #	3,072		3,072		3,072		3,072	

Panel B: Effect of XBRL and Uncertainty

	ERV		*IE* (*h* = −1)		*IE* (*h* = −2)		*VR*	
	Coeff.	**t-statistic**	**Coeff.**	**t-statistic**	**Coeff.**	**t-statistic**	**Coeff.**	**t-statistic**
Intercept	0.083	6.07***	0.050	5.14***	0.060	6.18***	0.010	3.76***
XBRL	−0.008	−7.02***	−0.006	−5.31***	−0.006	−5.00***	−0.001	−3.66***
SIZE	−0.006	−5.39***	−0.003	−4.12***	−0.004	−4.92***	−0.000	−0.66
MB	0.001	2.73***	0.001	1.99**	0.001	2.07**	−0.000	−0.98
LOSS	−0.002	−0.64	−0.001	−0.32	−0.001	−0.31	−0.000	0.54
LEV	−0.020	−3.11***	−0.012	−2.36**	−0.015	−2.79***	0.001	0.50
RETVAR	0.487	3.54***	0.412	4.48***	0.424	4.05***	−0.220	−8.73***
ABSCAR	0.018	2.83**	0.010	2.34**	0.009	1.87*		
NEGCAR	0.001	0.46	0.001	0.72	0.001	1.02		
ESUR_ABS	0.843	4.60***	0.206	1.32	0.295	1.62	0.212	1.32
ESUR_ABS_X	−0.668	−3.69**	−0.118	−0.76	−0.251	−1.40	−0.194	−1.22
Industry	Yes		Yes		Yes		Yes	
F-value	10.86***		6.72***		6.27***		5.15***	
Adj. R^2	0.177		0.111		0.103		0.081	
Obs. #	3,072		3,072		3,072		3,072	

*, **, *** Significant at the 0.10, 0.05, and 0.01 levels, respectively, using a two-tailed t-test.
All regressions use Huber-White standard errors adjusted for clustering at the firm level.
Variables are as defined in Table 2.

Collectively, the effects of XBRL are expected to improve information quality.[11] Our results show an increase in information efficiency, a decrease in event return volatility, and a reduction of change in stock returns volatility for the Phase 1 group (1,536 10-K and 10-Q filings) post-XBRL disclosure. In addition, XBRL mitigates information risk in the market, especially when there is increased uncertainty in the information environment.

Additional Analyses

To assess the robustness of our results, we use an alternative sample and different methods for measuring our variables, as well as considering for stock market condition, potential earnings releases, and corporate governance.

Alternative Control Group

The current research design uses all firms in Compustat that provide financial information from two different quarters of the same firm (e.g., the pre- versus post-XBRL periods) by controlling potential compounding within firm-level effects. However, the pre- versus post-XBRL same-firm comparison has the disadvantage of not considering different economic conditions. In other words, the effect for the same firm may be driven by different economic or market conditions at different time periods, rather than by XBRL. To test the generalizability of the results, we construct a matched-pair control group by the propensity score matching approach (PSM, hereafter) to match on a broad range of firm characteristics, and use attribute-based matching to examine whether the effect of XBRL disclosure can be attributed to specific firm characteristics. Propensity score matching models match observations based on the probability of undergoing the treatment, which, in our case, is the probability of submitting interactive data.[12]

By focusing on the first quarter of each firm with an XBRL filing, we first collect 366 filings. For each XBRL filing firm, we match to a non-XBRL filing firm from the same year using the propensity score. We estimate the propensity score model by including firm size (market capitalization), market-to-book ratio, profitability (ROA), industry (at two-digit SIC code), and fiscal year for the respective analysis. The firm size for the Phase 1 group limits our matching ability because all non-XBRL firms are below $5 billion of market capitalization, while the XBRL firms are equal to or have more than $5 billion of market capitalization. Although the firm size variable is a limitation of the matching model, we include it because it is a well-known variable used to show firm characteristics. We also include growth (market-to-book) and profitability variables to estimate the model, and to mitigate the limitation due to firm size. As a result, 40 observations are removed in the absence of a close match, without replacement. We match non-XBRL filings with XBRL filings that have the closest predicted value within a maximum distance of 10 percent, based upon the caliper distance. Therefore, we match approximately 10 percent of non-XBRL firms to XBRL

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[11] We thank the anonymous reviewer for this suggestion. Our results using 10-Q or 10-K independently are very similar to those when both 10-Q and 10-K are used. Results for individual 10-Q and 10-K are not shown for brevity.

[12] The propensity score matching models are commonly used in the accounting literature and have important features in our setting (Morsfield and Tan 2006; Heckman et al. 2004; Heckman 1979). First, these models generate samples in which the XBRL filing and non-XBRL filing firms are similar, providing a natural framework to parse out the effects of XBRL and firm characteristics on the information risk proxy. Second, matching models mitigate the potential impact of nonlinearities in estimating the treatment effects when the underlying functional form is nonlinear. Notwithstanding their benefits, our matching models have caveats. First, matching models rely on the assumption that unobservable effects are not pertinent to estimating treatment effects. Second, matching results in using subsamples of the population reflect a trade-off between identifying the treatment effects and generalizing the results to the full population. Third, the empirical inability to match on pre-treatment attributes and control for alternative treatments could result in a bias if the matching variables are affected by the XBRL disclosure.

firms considering size, growth (market-to-book), and profitability without discovering any statistical differences between the two groups.

Re-estimation is then made of the main models, and the results in Panel A of Table 5 yield virtually identical results to those reported in Panel A of Table 4, except for the *VR* model. In the *VR* model, *RETVAR* is dominantly significant. In Panel B of Table 5, we find that *ESUR_ABS_X* is negative and significant only in the information efficiency models *IE* (h = −1) and *IE* (h = −2). Using PSM, we might be able to compare between large firms and mid-sized (or small) firms. Therefore, the comparison between a firm's post-XBRL filing quarter and pre-XBRL filing quarter is better controlled for regarding any potential compounding firm-level effects in our setting relative to the PSM design.

Controlling the Stock Market Condition

Since the stock market has been volatile (i.e., the U.S. economic recession)[13] for the time period that contains the passage and implementation of XBRL (mandated effective date June 15, 2009), all the models controlling for market condition are rerun. First, the value-weighted market portfolio returns are collected from CRSP to account for the volatility of the stock market for the time period that contains the passage and implementation of XBRL. Second, for each corresponding quarter, the average of value-weighted market portfolio returns is estimated (*VWMKT*). This average is used as a control variable. Table 6 shows the results. Our main results are qualitatively similar. The coefficient on *VWMKT* is significantly positive, which implies that information risk is higher when there is a higher market return available.

In addition, we return all of the models after eliminating the quarters of firms in the financial industry (SIC codes 6000 to 6999). The inclusion of firms in the financial industry could bias our results, because they have struggled a great deal during our test period and their accounting policies are significantly different from others. After eliminating these firms, our untabulated results are qualitatively similar.

Potential Effect of Earnings Releases

Li and Ramesh (2009) document a stronger stock price movement when firms concurrently issue an earnings press release. To control for concurrent earnings releases, we add the indicator variable (*EA*), which is equal to 1 when the firm's earnings are concurrently announced on the date of SEC filing. Panel A of Table 7 shows that 73.7 percent[14] of firms in the sample announced earnings prior to the SEC filing date, while 26.3 percent of the firms concurrently announced earnings. The coefficient of *EA* is significantly positive in most of the models, which is consistent with the results of Li and Ramesh (2009). As shown in Table 7, the results indicate that XBRL disclosure reduces information risk, which is similar to the results in Table 4.

Accounting for Corporate Governance

We further examine whether corporate governance is associated with information risk in the market (e.g., Ajinkya et al. 2005; Kothari et al. 2009). For this examination, the percentage of

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[13] According to the National Bureau of Economic Research (NBER), the U.S. economy officially peaked (entered the recession) in December 2007 and reached its trough (end of recession) in June 2009 (NBER 2010). Following the practice of prior research (Gujarati and Porter 2009), we extended our analysis two years beyond the recession period because the economy was not yet in recovery state for a variety of reasons. The stock market and the economy suffered after the failures of massive financial institutions in the United States in September 2008 (Hilsenrath et al. 2008). Industries that lost jobs during the recession continued shrinking through the early stages of recovery. In general, economy-wide figures (unemployment statistics) and the stock market did not fully recover (reach its previous high) until the second half of 2009 (Felsenthal 2011).

[14] It counts only when earnings are announced more than three days prior to the 10-K and 10-Q filing dates.

TABLE 5

Alternative Control Group
(Using the Propensity Score Matching Sample)

Panel A: Effect of XBRL

	ERV		*IE* (*h* = −1)		*IE* (*h* = −2)		*VR*	
	Coeff.	**t-statistic**	**Coeff.**	**t-statistic**	**Coeff.**	**t-statistic**	**Coeff.**	**t-statistic**
Intercept	0.016	0.54	−0.011	−0.48	−0.021	−0.83	0.004	0.76
XBRL	−0.013	−2.98***	−0.010	−2.58**	−0.012	−2.68***	0.001	0.77
SIZE	−0.001	−0.47	0.001	0.44	0.001	0.60	0.000	0.89
MB	0.003	2.37**	0.002	1.78*	0.002	1.79*	0.000	−0.25
LOSS	0.003	0.47	0.006	1.22	0.006	1.12	0.001	0.89
LEV	−0.014	−1.09	−0.015	−1.31	−0.006	−0.44	0.000	−0.02
RETVAR	0.667	4.29***	0.504	4.20***	0.533	3.95***	−0.101	−3.07***
ABSCAR	0.012	1.24	0.004	0.53	0.007	0.84		
NEGCAR	−0.004	−0.87	0.003	0.73	−0.001	−0.19		
Industry	Yes		Yes		Yes		Yes	
F-value	2.27***		1.89***		2.02***		1.24	
Adj. R^2	0.1005		0.0723		0.0819		0.0196	
Obs. #	652		652		652		652	

Panel B: Effect of XBRL and Uncertainty

	ERV		*IE* (*h* = −1)		*IE* (*h* = −2)		*VR*	
	Coeff.	**t-statistic**	**Coeff.**	**t-statistic**	**Coeff.**	**t-statistic**	**Coeff.**	**t-statistic**
Intercept	0.017	0.61	−0.012	−0.52	−0.018	−0.72	0.003	0.68
XBRL	−0.013	−2.87***	−0.008	−2.10**	−0.009	−1.98**	0.000	0.19
SIZE	−0.001	−0.48	0.001	0.40	0.001	0.52	0.000	0.96
MB	0.003	2.44**	0.002	1.81*	0.002	2.04**	0.000	−0.40
LOSS	0.003	0.54	0.005	1.03	0.005	1.04	0.001	0.99
LEV	−0.013	−1.05	−0.016	−1.36	−0.006	−0.45	0.000	0.00
RETVAR	0.629	3.95***	0.520	4.26***	0.465	3.48***	−0.093	−2.64***
ABSCAR	0.012	1.23	0.003	0.44	0.005	0.65		
NEGCAR	−0.004	−0.79	0.003	0.81	0.001	0.21		
ESUR_ABS	0.120	0.32	0.279	0.99	0.809	2.87***	−0.111	−2.50**
ESUR_ABS_X	0.005	0.01	−0.356	−1.30	−0.633	−2.14**	0.098	2.39**
Industry	Yes		Yes		Yes		Yes	
F-value	2.21***		1.87***		2.16***		1.29*	
Adj. R^2	0.0989		0.0728		0.0955		0.0246	
Obs. #	652		652		652		652	

*, **, *** Significant at the 0.10, 0.05, and 0.01 levels, respectively, using a two-tailed t-test.
All regressions use Huber-White standard errors adjusted for clustering at the firm level.
Variables are as defined in Table 2.

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TABLE 6

Controlling the Stock Market Condition (Including Value-Weighted Market Portfolio Return)

Panel A: Effect of XBRL

	ERV		*IE* (*h* = −1)		*IE* (*h* = −2)		*VR*	
	Coeff.	**t-statistic**	**Coeff.**	**t-statistic**	**Coeff.**	**t-statistic**	**Coeff.**	**t-statistic**
Intercept	0.086	6.17***	0.052	5.35***	0.064	6.47***	0.010	3.96***
XBRL	−0.013	−7.87***	−0.010	−7.35***	−0.011	−7.80***	−0.002	−4.55**
SIZE	−0.006	−5.37***	−0.003	−4.12***	−0.004	−4.87***	0.000	−0.73
MB	0.001	2.45**	0.001	1.82*	0.001	1.91*	0.000	−1.34
LOSS	0.000	0.00	0.000	−0.01	0.000	−0.13	0.001	0.84
LEV	−0.015	−2.31**	−0.011	−1.97**	−0.014	−2.45**	0.002	0.88
RETVAR	0.611	4.52***	0.480	5.14***	0.478	4.72***	−0.207	−9.66***
ABSCAR	0.014	2.25**	0.007	1.57	0.005	1.03		
NEGCAR	0.000	−0.33	0.000	−0.28	0.000	−0.02		
VWMKT	2.438	3.14***	2.728	4.69***	3.293	5.01***	0.279	1.53
Industry	Yes		Yes		Yes		Yes	
F-value	9.93***		6.76***		6.68***		4.93***	
Adj. R^2	0.161		0.110		0.109		0.076	
Obs. #	3,072		3,072		3,072		3,072	

Panel B: Effect of XBRL and Uncertainty

	ERV		*IE* (*h* = −1)		*IE* (*h* = −2)		*VR*	
	Coeff.	**t-statistic**	**Coeff.**	**t-statistic**	**Coeff.**	**t-statistic**	**Coeff.**	**t-statistic**
Intercept	0.085	6.16***	0.052	5.36***	0.063	6.46***	0.010	3.82***
XBRL	−0.012	−7.67***	−0.010	−7.11***	−0.011	−7.38***	−0.002	−4.19***
SIZE	−0.006	−5.36***	−0.003	−4.08***	−0.004	−4.86***	0.000	−0.64
MB	0.001	2.71***	0.001	1.94*	0.001	2.01**	0.000	−1.00
LOSS	−0.002	−0.68	−0.001	−0.37	−0.001	−0.37	0.000	0.52
LEV	−0.020	−3.09***	−0.012	−2.34**	−0.015	−2.77***	0.001	0.50
RETVAR	0.506	3.62***	0.432	4.64***	0.450	4.23***	−0.221	−8.73***
ABSCAR	0.015	2.28**	0.007	1.60	0.005	1.04		
NEGCAR	0.000	−0.14	0.000	−0.13	0.000	0.01		
ESUR_ABS	0.884	4.66***	0.250	1.51	0.350	1.78*	0.216	1.34
ESUR_ABS_X	−0.711	−3.77***	−0.165	−0.98	−0.308	−1.58	−0.198	−1.23
VWMKT	2.436	3.12***	2.689	4.63***	3.322	5.07***	0.306	1.59
Industry	Yes		Yes		Yes		Yes	
F-value	10.88***		6.32***		6.60***		5.12***	
Adj. R^2	0.180		0.135		0.110		0.081	
Obs. #	3,072		3,072		3,072		3,072	

*, **, *** Significant at the 0.10, 0.05, and 0.01 levels, respectively, using a two-tailed t-test.
All regressions use Huber-White standard errors adjusted for clustering at the firm level.
Variables are as defined in Table 2.
VWMKT is the value-weighted market portfolio return for the corresponding quarter.

TABLE 7

Potential Effect of Earnings Releases

Panel A: Effect of XBRL

	ERV		*IE* (*h* = −1)		*IE* (*h* = −2)		*VR*	
	Coeff.	**t-statistic**	**Coeff.**	**t-statistic**	**Coeff.**	**t-statistic**	**Coeff.**	**t-statistic**
Intercept	0.050	3.69***	0.025	2.77**	0.035	3.86***	0.006	2.01**
XBRL	−0.010	−8.29***	−0.006	−5.99***	−0.006	−6.00***	−0.002	−5.76***
SIZE	−0.005	−4.96***	−0.003	−3.82**	−0.003	−4.65***	0.000	−0.19
MB	0.001	2.27**	0.000	1.65	0.000	1.73*	0.000	−1.57
LOSS	0.000	0.17	0.000	0.17	0.000	0.04	0.001	0.91
LEV	−0.015	−2.66***	−0.011	−2.26**	−0.014	−2.88***	0.002	0.88
RETVAR	0.646	5.02***	0.500	5.66***	0.494	5.01***	−0.201	−9.27***
ABSCAR	0.017	2.75***	0.010	2.44**	0.009	1.94*		
NEGCAR	−0.001	−0.51	0.000	−0.13	0.000	0.29		
EA	0.024	10.69***	0.018	11.23***	0.018	11.44***	0.003	5.87***
Industry	Yes		Yes		Yes		Yes	
F-value	14.97***		10.53***		10.13***		5.91***	
Adj. R^2	0.231		0.170		0.164		0.093	
Obs. #	3,072		3,072		3,072		3,072	

Panel B: Effect of XBRL and Uncertainty

	ERV		*IE* (*h* = −1)		*IE* (*h* = −2)		*VR*	
	Coeff.	**t-statistic**	**Coeff.**	**t-statistic**	**Coeff.**	**t-statistic**	**Coeff.**	**t-statistic**
Intercept	0.051	3.70***	0.025	2.82***	0.035	3.87***	0.006	1.99**
XBRL	−0.009	−7.85***	−0.006	−5.88***	−0.006	−5.65***	0.001	−4.11***
SIZE	−0.005	−4.94***	−0.003	−3.80***	−0.003	−4.64***	0.000	−0.14
MB	0.001	2.52**	0.000	1.73*	0.000	1.79*	0.000	−1.27
LOSS	−0.001	−0.40	0.000	−0.08	0.000	−0.08	0.001	0.64
LEV	−0.019	−3.34***	−0.012	−2.52*	−0.014	−3.01***	0.001	0.54
RETVAR	0.556	4.12***	0.464	5.20***	0.478	4.68***	−0.213	−8.50***
ABSCAR	0.017	2.77***	0.010	2.45**	0.009	1.94*		
NEGCAR	0.000	−0.27	0.000	0.02	0.000	0.32		
EA	0.023	10.22***	0.017	10.90***	0.018	11.28***	0.003	6.08***
ESUR_ABS	0.659	3.48***	0.065	0.34	0.148	0.81	0.188	1.28
ESUR_ABS_X	−0.507	−2.66***	0.003	0.02	−0.123	−0.68	−0.173	−1.18
Industry	Yes		Yes		Yes		Yes	
F-Value	15.58***		10.49***		9.87***		5.98***	
Adj. R^2	0.244		0.174		0.164		0.097	
Obs. #	3,072		3,072		3,072		3,072	

*, **, *** Significant at the 0.10, 0.05, and 0.01 levels, respectively, using a two-tailed t-test.
All regressions use Huber-White standard errors adjusted for clustering at the firm level.
Variables are as defined in Table 2.

outside directors is used, where a lower percentage indicates weaker corporate governance (e.g., Dey 2008). The results (not tabulated) show that the coefficient on the governance variable is negative in all models. It is marginally significant ($p < 0.10$) when *ERV* is used as the dependent variable, but is strongly significant ($p < 0.05$) when *IE* is used. The coefficient on *XBRL* is negatively significant, and *ESUR_ABS* is significantly positive, while *ESUR_ABS_X* is significantly negative in the same models. Overall, the results are similar to those in Table 4. Inclusion of the additional governance variable in our models did not influence our primary results.

V. CONCLUSIONS

Research on XBRL in the field of Accounting and Information Systems (AIS) shows the importance of a catalyst that brings together different parties to increase transparency, stewardship, and smooth functioning of capital markets. Since firms are required to provide their financial statements using the interactive data format known as XBRL, users can directly extract XBRL-tagged data from corporate or regulatory sites. XBRL is expected not only to reduce users' analysis preparation time and cost, but also to allow them to easily compare XBRL-tagged data across various organizations (AICPA 2009; Burnett et al. 2006; Pinsker and Li 2008; SEC 2009). The current investigation into XBRL and its capabilities leads us to believe that the improved accessibility and transparency yielded by XBRL as a standardized business reporting format makes it an essential tool for market participants.

This study explores the effects of mandatory XBRL disclosure on the financial information environment (i.e., event returns volatility, information efficiency, standard deviation of daily stock returns, and analysts' forecast errors). Findings suggest that XBRL disclosure has the potential to decrease information risk and information asymmetry through improved transparency. Our analysis also indicates that XBRL disclosure marginally mitigates the increase in information risk in the market when there is increased complexity in the information environment. The results are robust to alternative control groups (e.g., a matched-pair control group in the post-XBRL years), and after controlling for other characteristics such as potential earnings release and corporate governance. Overall, our findings are consistent with the notion that XBRL disclosure provides value-relevant information to the capital market by enhancing the transparency of corporate information and by mitigating information risk and information asymmetry.

Prior literature suggests that XBRL will improve the efficiency of data analysis, enhance information flow and dissemination in the capital market, and help users make better informed investment decisions (AICPA 2009; Gray and Miller 2009; Hodge et al. 2004; XBRL.US 2009). It should be noted that this study examined only the effect of mandatory XBRL disclosure across various aspects of the financial information environment. In other words, we investigated whether there are information environment changes in the market (e.g., information risk and information efficiency) due to mandatory XBRL disclosure. This study did not explore whether XBRL disclosure improves the efficiency of data analysis, thus, helping information users make informed decisions (i.e., the effect of mandatory XBRL disclosure on users' decisions).

As with any study, there are several limitations that must be considered when interpreting the findings. First, the sample consists of the 1,536 first-year mandated interactive data submissions from 428 publicly traded firms. The firms included in our analysis are large accelerated U.S. GAAP filers (i.e., the first phase-in group). Although we controlled several firm-specific factors (e.g., firm size and market-to-book ratio) in our analysis based on prior literature, there may still be other important factors not accounted for that could influence the results. Further research could be conducted by expanding this study to include the second and third phase-in groups. Second, firms that terminate their securities registration or delay the filing of their reports in XBRL are excluded from the sample. It is not clear how the addition of these firms would affect the results of the study.

Third, we cannot entirely rule out the possibility of omitted correlated variables. Potential unobserved factors (e.g., IT intensity, IT experience, and several new areas of IT investments) that are correlated with information risks may also drive the positive effects of these findings. Another avenue for future work is to confirm the findings of this study by incorporating such factors.

This study offers researchers, as well as professionals, insight as to how and why capital markets respond to a host of AIS issues. In particular, the results provide insight into the effect of XBRL disclosure on the financial information environment. For the AIS researcher, we find compelling evidence that XBRL disclosure reduces information risk and information asymmetry in both general and complex information environments. Our findings could establish an empirical and theoretical foundation for accelerating the adoption of XBRL in other countries. Additionally, the findings of this study should be important to business managers, particularly as the factors of decreased information risk suggest the means for enhancing valuation quality and decreasing capital costs for firms. Our evidence may also be of special interest to standard setters and regulators, who may seek empirical evidence for the benefits gained from XBRL adoption.

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