# The Effect of Enterprise Systems Implementation on the Firm Information Environment*

CARLOS-ALBERTO DORANTES, *Tecnológico de Monterrey, Querétaro Campus*

CHAN LI, *University of Pittsburgh*

GARY F. PETERS, *University of Arkansas*

VERNON J. RICHARDSON, *University of Arkansas*

## 1. Introduction

We examine the relation between the implementation of enterprise systems (ES) and improvements in the firm's information environment. ES are commercialized information systems that integrate and automate business processes across an entity's value chain located within and across organizations. ES are purported to improve a firm's internal information environment by enhancing the transparency of operations across business units with related improvements in managerial decision making (Davenport 2000; Sia, Tang, Soh, and Boh 2002; Hitt, Wu, and Zhou 2002). However, evidence about the relation between ES implementation and the internal information environment is limited and largely based upon management perceptions. We test whether ES implementations improve the manager's information environment by examining a product of management's access to internal information, namely the quality of management forecasts.

ES represent an increasingly popular technology investment in many worldwide organizations.[1] However, as one of companies' largest IT investments, ES implementation involves dramatic costs (e.g., time, money, and internal resources) and extraordinary technical and business risks (Hitt et al. 2002). These conditions raise the importance of documenting the benefits of information technology investments as emphasized in prior literature and in practice (ITGI 2005; Dehning and Richardson 2002; Hitt et al. 2002; Hunton et al. 2003; Melville, Kraemer, and Gurbaxani 2004). Prior empirical studies examining the benefits of ES primarily focus on broad operating performance measures and provide mixed evidence (e.g., Poston and Grabski 2001; Hitt et al. 2002; Hunton, Lippincott, and Reck 2003; Nicolaou 2004; Chapman and Kihn 2009).[2] In contrast, we focus on a more specific operating artifact coming out of the firm's internal information environment. Because a main purpose of ES is to accommodate the integration and support

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1. According to Gartner, Inc., worldwide enterprise software market has been recovering since 2009 and reached $267 billion in 2010. They predicted a worldwide market growth of about 9.5 percent in 2011 and continuous growth through 2015. The North America enterprise software market reached about $112.9 billion in 2010 and it is expected to surpass $158 billion in 2015 (Gartner Inc. 2011).

2. Specifically, studies generally find positive association between ES adoption and operating performance when comparing ES adopters to non-ES adopters (Hitt et al. 2002; Hunton et al. 2003; Nicolaou 2004). However, when comparing pre- and post-ES operating performance within the ES adopters, studies generally fail to find improved performance after the implementation of ES (Poston and Grabski 2001; Hitt et al. 2002).


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of the various business processes and information needs of a company (Davenport 1998; Klaus, Rosemann, and Gable 2000), whether ES implementation improves the firm's internal information environment provides important evidence on the benefit of ES.

Most prior research attempting to document the information benefits of ES is based primarily on vendor-provided cases and surveys of management perceptions of their internal information environments (e.g., Shang and Seddon 2002; Spathis 2006). We study a distinct management decision-making outcome, namely management earnings forecast. We choose to examine management earnings forecast for two reasons. First, management forecast represents a key voluntary disclosure mechanism that managers use to mitigate information asymmetry problems and to improve a firm's reputation for transparent and credible reporting (e.g., Coller and Yohn 1997; Graham, Harvey, and Rajgopal 2005). Second and more importantly, management generally bases its forecasts on accounting and nonaccounting information provided by the firm's internal systems. Thus, the issuance and quality of management forecasts have direct links to the firm's internal information quality, which provides us a distinct measurable outcome of the firm's information system.

Disclosure theory suggests that as managers receive better internal information they are motivated to provide voluntary disclosures about the firm's operations in an attempt either to reduce agency costs or signal their ability to manage the organization (e.g., Diamond 1985; Trueman 1986; Verrecchia 1990). Given these incentives and the purported enhancements to internal information environments provided by ES, we hypothesize that after an ES implementation, management forecast disclosures will occur more often and be more specific and accurate. We test our hypothesis using a sample of firms announcing the completion of ES implementations from 1995 to 2008.

Our tests include both a matched control sample and a within-firm design to test the differences between the pre- and post-ES implementation. Consistent with disclosure theory and improvements in the firm's internal information environment, we find that, after ES implementation, ES firms are more likely to issue management forecasts and issue more accurate forecasts than the matched control sample. After controlling for known determinants of management forecast disclosure and forecast accuracy, such as financial performance and volatility, ES implementers have 1.24 times the odds of issuing forecasts than the matched-control sample after the ES implementation period. ES implementers also have 36 percent smaller forecasts errors (as deflated by stock price) after the implementation period compared to the matched-control sample. In contrast to the above results, we find no difference in forecast issuance and accuracy between the two groups *prior* to the ES implementation periods. Although we do not find differences in forecast specificity after ES implementation, we find that ES firms issued less specific forecasts prior to implementation compared to the control sample. To mitigate potential self-selection and endogeneity concerns, we also compare ES firms three years prior to ES implementation with themselves three years after implementation. The results are similar to those we obtain using a matched control sample.

One alternative explanation on the positive associations between ES implementation and management forecast properties is the potential that ES allow managers to manipulate accounting data more easily in order to meet reported forecasts.[3] To rule out this alternative explanation, we also test whether ES implementations are subsequently associated with greater indications of earnings management. The lack of an increase in earnings management would support the argument that management's access to improved internal information drives improved management forecast quality after ES implementation, rather than the increased propensity to manage earnings. The results provide no support for the

3. Because we measure forecast accuracy as the scaled absolute value of the difference between reported earnings and management forecast, accuracy is also influenced by the reported earnings.

contention that ES enhance the ability of managers to manage earnings. In fact, for several earnings management proxies, our tests are consistent with a decrease in earnings management after the ES implementation (as proxied by lower propensity to meet or beat analyst forecasts, fewer financial misstatements, and enhanced earnings informativeness).

Our paper contributes to an ongoing literature stream in accounting, auditing and information systems that addresses the impact of technology on a firm's internal information environment. For example, recent studies document improved financial reporting quality resulting from implementation of technology related to the controls over financial reporting such as internal control monitoring technology (Hunton, Mauldin, and Wheeler 2008; Masli, Peters, Richardson, and Sanchez 2010), and from implementation of financial reporting technology, such as XBRL (Hodge, Kennedy, and Maines 2004). In contrast, our study considers accounting and operational technology that incorporates functions not only related to the financial statement reporting, but also internal information regarding ongoing operating decisions, which are instrumental in forming the projection of future earnings (as opposed to simply recording and reporting historical financial statements). Specifically, we provide new archival evidence about the positive effect of ES technology on management forecast quality, which is consistent with the argument that ES improve the internal information that managers use to form their earnings forecasts.

Beyond issuing financial statement forecasts, we note that such internal information is also the basis for many day-to-day operational decisions. Therefore, our findings should also be of interest to readers who desire a greater understanding of the effect of ES on not only financial statement data but also other operational management decisions. For example, Chapman (2005) argues that even if the use of enterprise systems is well established amongst practitioners, academic research holds value to the extent that it extends our knowledge about how such systems impact the nature of management control or operational decisions. To our knowledge, this study is the first to provide archival evidence of the impact of ES on a specific management control outcome — forecasts of companies' future earnings, as forecasts also reflect decisions that management will make with respect to operational choices.

Finally, our study also has implications for management forecast disclosure literature. Most prior studies examining the determinants of forecast quality have focused primarily on the incentives for management forecasts, such as litigation concerns and insider trading motives. Prior archival research places little attention upon the technology or information available to management in making its voluntary disclosure decisions. For example, Hirst, Koonce, and Venkataraman (2008) identify a distinct gap in the management forecast literature regarding the antecedents of the voluntary disclosure decision, which includes the nature of management's access to internal information. Previous studies uses internal control disclosures to proxy for the quality of information that management uses in making forecasts (Feng, Li, and McVay 2009; Li, Peters, Richardson, and Watson 2011). We extend these studies by considering the nature of the system where controls reside, as opposed to a focus on the reported presence of individual material control weaknesses.

The paper is organized as follows. First, we develop our hypothesis, following a brief review of the ES literature and information quality. Then, we describe our methodology and sample. Finally, we discuss the results and conclude the study.

## 2. Literature review and hypothesis development

### *Enterprise systems and firm's internal information environment*

Enterprise Systems (ES) reflect a variety of technology applications that integrate business functions and respond to real-time information (Davenport 1998; Spathis 2006). Hendricks, Singhal, and Stratman (2007) and Bendoly, Rosenzweig, and Stratman (2009) describe such systems as integrated transaction, planning, and resource management systems that coordinate information across enterprise functions. While ES technology

commonly includes enterprise resource planning (ERP) systems, prior research also views such systems as encompassing more than core ERP functionalities. Other forms of ES technology also include decision support functions such as supply chain or customer relationship management systems (Hendricks et al. 2007; Bendoly et al. 2009).[4] As ES capture increasingly wider ranges of business functions and larger and timelier transactional datasets, the firm should have fuller, broader, and more complete information sets.

Prior evidence regarding ES benefits often results from surveys of management perceptions. For example, using ES vendor-provided cases and interviews with managers of 34 companies adopting ES, Shang and Seddon (2002) find that with the centralized databases and built-in data analysis capabilities, managers perceive that ES aid planning activities. They also document perceptions by managers who think that ES help organizations to achieve better resource management, improved decision making, and improved performance in different operating divisions of the organization. Similarly, based on a meta-analysis and survey of 12 academic experts, Klaus et al. (2000) find that the benefits of ES include enhanced completeness, transparency, and timeliness of information needed to manage an organization's business activities. Using a survey of 73 companies that implemented ES, Spathis (2006) identifies the top perceived information benefits from ES implementation as 1) improved quality of reports, 2) reduction of time for issuing of reports, and 3) improved decisions based on timely and reliable information.

Beginning with the premise that better internal information should improve management decisions and thus firm performance, Chapman and Kihn (2009) argue that the link between the *perceived* internal information benefits of ES implementations and actual performance is not a direct relationship. In particular, their survey findings show that managers' perceptions of perceived ES success were a function of the extent of organizational integration created by the implementation of an ES, rather than business performance outcomes. On the other hand, their findings are consistent with a link between the presence of ES and management's confidence in their internal information. This link results from the improved integration of information across disparate business units. However, their study is limited in its ability to associate these linkages with distinct management decision outcomes, such as the formation of forecasts.

Despite prior survey findings, archival evidence of ES benefits is limited and mixed. Consistent with the prior literature of management's ES perceptions, Brazel and Dang (2008) argue that ES can positively impact internal information quality by providing management with real-time information concerning the financial condition of the company and eliminate barriers between accounting cycles allowing managers unprecedented access to information. Using a sample of firms from 1993–1999, they find a reduction in the time difference between the firm's actual earnings announcement date and fiscal year end after the implementation of an enterprise resource planning system, suggesting an improvement in the timeliness of information (Brazel and Dang 2008).[5]

4. Management forecasts need to incorporate nonaccounting information to be most accurate. For example, good relationships with customers can help managers predict sales more accurately, and good relationships with suppliers can help managers predict cost of goods sold more accurately; both items are very important inputs when managers form their forecasts (Fairfield, Sweeney, and Yohn 1996; Lundholm and Sloan 2006). Table 2 provides a description of the specific ES types identified in the current study.

5. In contrast to these benefits, Brazel and Dang (2008) also document an increase in earnings management indicators based on the sample of ERP implementations during 1993–1999. They acknowledge that earnings management results may be driven by the earliest waves of ES adoptions that were prone to disruptions to systems safeguards and internal controls. Consistent with this latter argument, Morris and Laksamana (2010) find a negative association between short-term discretionary accruals and ERP implementations between 1994 and 2003. We provide additional tests to address the potentially confounding impact of possible changes in earnings management behavior on our results in the additional analyses section.

Assuming linkages between internal information, management decisions, and firm performance, other studies attempt to test the link between ES implementations and firm-wide profitability measures (e.g., Poston and Grabski 2001; Hunton et al. 2003). However, these examinations provide either mixed or inconclusive evidence. More recent studies argue that the relation between ES and broad profitability measures are context-specific (e.g., Wier, Hunton, and HassabElnaby 2007; Kallunki, Laitinen, and Silvola 2010). Related to perceptions, studies consider the market reactions or experimental analysts' responses to announcements of ES implementations (Hayes, Hunton, and Reck 2001; Hunton, McEwen, and Wier 2002; Ranganathan and Brown 2006). In general, these studies find positive market reactions and analysts' responses to ES implementation announcements, which are consistent with the perceived internal information benefits documented in the survey-based literature. However, these studies do not examine the impact of ES on measures of information quality, which is instrumental for decision making.

In sum, prior research suggests that ES improve internal information quality by giving managers access to greater amounts of information, and timelier and more accurate information, which should enhance their ability and confidence in providing forecasts. However, despite the perceived benefits of such systems, it is still unclear whether such systems are actually tied to better management judgments and decision making (Bendoly et al. 2009). In the following section we examine the linkages between ES implementation and a distinct management decision outcome, namely management earnings forecasts resulting from the firm's information environment.

***Internal information environment, management forecasts, and enterprise systems***

Disclosure theory indicates that as managers receive better internal information they have incentives to provide voluntary disclosures about the firm's operations in an attempt either to reduce agency costs or signal their own ability to manage the organization (Diamond 1985; Trueman 1986; Verrecchia 1990). These disclosures coming from internal information can take the form of management earnings forecasts.[6] For example, Diamond (1985) argues that managers have incentives to release their internal information, including earnings forecasts, in an attempt to reduce costly private information acquisition on the part of shareholders. Trueman (1986) argues that managers will release earnings forecasts as a signal about their own superior management abilities. Moreover, Trueman asserts that this incentive is tied to the inherent quality of the internal information in improving management's ability to control the production decisions of the organization. Notable to the current study, Verrecchia (1990) suggests that an increase in the quality of internal information received by a manager will result in more voluntary disclosures. In addition, because managers are concerned about their forecasting reputations (Graham et al. 2005), and they face potential market penalties as a result of releasing poor-quality forecasts, managers' incentives to disclose their inside information about the firm's future prospects will also be tempered by the presence of poor internal information. Thus, managers who have access to lower quality internal information are more reluctant to provide forecasts and more prone to provide less specific forecasts (Feng et al. 2009).

Healy and Palepu (2001) assert that the extent to which management forecasts mitigate the information asymmetry in the capital market or provide signals about management's ability largely depends on the degree of accuracy of financial forecasts.

6. Prior studies suggest that investors and analysts use the information incorporated in management forecasts. For instance, the earnings surprise imbedded in a management forecast influences prices (Patell 1976; Penman 1980; Pownall and Waymire 1980; Waymire 1984) and alters investors' earnings expectations (Baginski and Hassell 1990; Jennings 1987; Williams 1996). Analysts also revise their forecasts in response to management forecasts, resulting in more accurate forecasts (Waymire 1986; Baginski and Hassell 1990).

Regardless of a manager's incentives or ability to compile information into a forecast, forecasts based on poor-quality inputs will likely be less accurate. Consistent with this argument, prior research find that the presence of material weaknesses in internal control over financial reporting is negatively associated with management forecast accuracy (Feng et al. 2009; Li et al. 2011).

As discussed above, we argue that management earnings forecasts depend on the quality of the internal information used by managers to form their forecasts. Because ES potentially enhance the completeness, transparency, and timeliness of data, managers of ES firms should have higher quality information to develop earnings forecasts. For example, a feature of ES is the ability to link sales forecasts to budgets and operations that could lead to an accurate forecast of company earnings (Davenport 1998). Thus, all else equal, a manager using more accurate, timely, and precise internal information should be more likely to provide earnings forecasts and be able to produce more specific and more accurate forecasts. Following disclosure theory and the purported internal information environment benefits of ES, our hypothesis is stated as:

HYPOTHESIS *ES implementation is associated with higher management forecast quality – as measured by forecast issuance, specificity, and accuracy.*

## 3. Research design

### *Sample selection*

We collected ES implementation media announcements between 1995 and 2008 from Lexis-Nexis Academic's Wire Service Reports. Following the definition of ES by Hendricks et al. 2007 and Bendoly et al. 2009, we consider a broad view of ES that includes Enterprise Resource Planning systems (ERP) and other types of ES, such as Supply Chain Management systems (SCM), and Customer Relationship Management systems (CRM).

Following prior ES research (e.g., Nicolaou 2004), we focus on the time of actual ES completion (i.e., went-live) instead of ES adoption, because there are large differences in the time length of ES implementations among companies.[7] We followed a systematic process to search for ES "went-live" announcements. To conduct the search, we used a combination of keywords including "implemented", "deployed", and "went-live" along with the names of popular enterprise system vendors. Similar to prior ES literature (e.g., Hayes et al. 2001; Nicolaou 2004), the sample includes vendors such as SAP, Oracle, PeopleSoft, Baan, Hyperion, QAD, and i2, among others.[8] The search yielded an initial sample of 5,790 announcements. Then every ES implementation announcement was read in detail to identify the actual "went live" announcement, which resulted in 1,384 announcements, among which 915 were related to public firms with a Global Vantage Key number (GVKey). We further deleted duplicate ES announcements. These procedures yielded 781 public firms that implemented ES.

Among the 781 ES implementation observations, COMPUSTAT covered 587 firms. To obtain the necessary management forecast data, we then required coverage of ES firms by the First Call database and availability of all necessary financial data. Our final test sample

7. Several media reports and research articles (e.g., Nicolaou 2004) have documented that the actual ES implementation can take from 6 months up to 6 years.
8. We conducted variants of the following searches in PR Newswire and BusinessWire to find ES firms: (ERP) or (SAP) or (Oracle) or (Peoplesoft) or (Baan) or (Hyperion) or (i2) or (Sage) or (Microsoft) or (CDC) or (Lawson) or (Epicor) or (Visma) or (QAD) or (Global Solutions) or (Agresso) or (Epicor) or (IFS) or (Enterprise systems) and (or within 25 words of) (implement) or (deploy*) or (went live) or (begin*) or (goes live).

consists of 353 unique firm ES implementations.[9,10] Table 1 panel A lists the observations resulting from the sample selection process by year. Table 2 panel A provides a listing of the observations by 1-digit SIC code. Heavy Manufactured Products and Light Manufactured Products have the largest number of ES firms, followed by Wholesale and Retail Trade. Table 2 panel B provides the observations by ES type. ERP is the most popular ES type, followed by Supply Chain Management.

Our tests include both matched-control firms and a pre/post within-sample designs. We define the year of implementation as the time period $t$, which we use as the base year for our matching procedure. We match each of the 353 firms with a control firm who did not implement an ES in the same period. Following matching criteria proposed by Barber and Lyon 1996, our matching criteria include industry and size. Industry was matched by 2-digit SIC code. Size was matched by the closest assets.[11] The matching procedure produced 353 ES firms matched with 353 non-ES firms with all the necessary data in year $t$ for the forecast disclosure analysis. We follow the same matching procedures for the forecast specificity and accuracy tests.

Following prior accounting literature, we perform a series of procedures similar to those described in Hunton et al. 2003, to ensure that non-ES firms included in the control sample had not implemented an ES before or during the sample period of a given ES firm.[12] First, we conduct a telephone survey to determine whether the identified non-ES firms had indeed implemented ES before or during our sample period.[13] With respect to nonresponding firms, we search through Lexis-Nexis and annual reports using a variety of search strings to identify ES adoptions or implementations to ensure there were no ES disclosures among our non-ES firms. As a result of the procedures, we find 21 non-ES firms in the forecast disclosure sample, and 8 non-ES firms in the forecast accuracy sample that implemented ES before or during our sample period. We thus exclude them and selected new matches. The new matches were subject to the telephone survey, Lexis-Nexis and annual report search procedure to ensure no ES disclosures, and none were found.

Prior studies normally examine three years after the ES implementation because it normally takes several years for the benefits of ES implementation to accrue (e.g., Hunton et al. 2003; Nicolaou 2004). To help rule out the alternative explanation that ES firms are different from non-ES firms initially, we also compare ES firms with non-ES firms in the three years prior to the ES implementation. Thus, our firm-year observations

9. An untabulated review of the final sample shows that the average number of reported ES modules implemented by a firm was two.

10. We conduct $t$-tests to compare assets, ROA, and leverage at the end of ES implementation year of the 353 ES firms with the original 587 ES firms (459 firms have necessary financial data from COMPUSTAT). There is no difference in any of the three measures between the two groups. We also compare the industry difference between the final ES sample and the original sample based on 1-digit SIC code. The percentage of firms in each industry is very similar between the two groups except for Finance, Insurance and Real Estate (1-digit SIC code = 6), where 3.4 percent of the ES sample but 7.2 percent of the original sample is in that industry.

11. One major event that did not affect all public companies equally is SOX Section 404 reports, as only firms with public floats of $75 million or greater are required to comply. Based on the internal control data in Audit Analytics, we find that 99 ES firms have complied with Section 404 during our sample period, and all their matches have also complied.

12. Non-ES firms could implement ES after our sample period, which should have no impact on our results.

13. The phone survey generally proceeded in this way:
"I'm a researcher with the University of XXX and we are studying the benefits of having an enterprise system."
"Does your company have an enterprise system?"
"Did you make any significant (or major) changes or have any significant (or major) updates to that system from 20XX-20XX?"
Usually they would give a date, "Yes, we completely revamped the system in Nov 20XX" or "No, I'm not aware of any significant changes during that time."

TABLE 1
Sample selection process

**Panel A:** Distribution of ES implementations by year

| Year | ES announcements of public firms | Firms that announced ES implementation | Covered by COMPUSTAT | Firms with available data |
|---|---|---|---|---|
| 1995 | 22 | 22 | 18 | 8 |
| 1996 | 20 | 20 | 19 | 4 |
| 1997 | 50 | 44 | 31 | 22 |
| 1998 | 87 | 74 | 41 | 29 |
| 1999 | 174 | 140 | 92 | 47 |
| 2000 | 143 | 108 | 69 | 44 |
| 2001 | 151 | 105 | 83 | 52 |
| 2002 | 59 | 59 | 56 | 32 |
| 2003 | 34 | 34 | 26 | 18 |
| 2004 | 42 | 42 | 36 | 26 |
| 2005 | 23 | 23 | 18 | 13 |
| 2006 | 26 | 26 | 23 | 16 |
| 2007 | 51 | 51 | 46 | 26 |
| 2008 | 33 | 33 | 29 | 16 |
| Total | 915 | 781 | 587 | 353 |

**Panel B:** Sample selection and data sources

| | Number of firms | Number of firm-years |
|---|---|---|
| Sample of firms with ES implementation from 1995–2008 covered by COMPUSTAT | 587 | |
| Less: firms are not covered by First Call in the year of implementation | 163 | |
| Sample of firms with ES implementation from 1995 to 2008 covered by COMPUSTAT and First Call in the year of implementation | **424** | |
| Less: observations without necessary data from COMPUSTAT | 30 | |
| Less: observations without market return data from CRSP | 17 | |
| Less: observations without analysts following data from First Call | 24 | |
| *Final ES sample for forecast disclosure* | **353** | **2,104** |
| Less: observations without any annual forecast from First Call | 219 | |
| Less: observations without analysts forecast prior to the management forecast | 8 | |
| *Final ES sample for forecast specificity* | **126** | **563** |
| Less: observations without any point or range annual forecast from First Call | 36 | |
| *Final ES sample for forecast accuracy* | **90** | **416** |

include three years prior to the ES implementation and three years after the ES implementation. For the forecast disclosure sample of 353 ES firms, we have 2,104 ES firm-year observations, and 2,002 non-ES firm-year observations.[14] Among the 2,104 ES

14. The firm-year observations are not exactly the same for ES and non-ES firms because firms may not have necessary data in all years. We only require ES and non-ES firms to have necessary data in the matching year, which is the ES implementation year *t*.

TABLE 2
ES Firms by industry and ES type

**Panel A:** ES firms by industry

| 1-digit SIC code | Industry | ES firms |
|---|---|---|
| 0 | Agriculture, Forestry and Fishing | 1 |
| 1 | Mining and Construction | 7 |
| 2 | Light Manufactured Products | 75 |
| 3 | Heavy Manufactured Products | 127 |
| 4 | Transportation, Communications & Utilities | 30 |
| 5 | Wholesale and Retail Trade | 45 |
| 6 | Finance, Insurance and Real Estate | 12 |
| 7 | Services | 49 |
| 8 | Health Services | 6 |
| 9 | Public Administration and Non-classified | 1 |
| | Total | 353 |

**Panel B:** Firms by ES type

| ES Type | ES firms |
|---|---|
| Enterprise Resource Planning (ERP) | 194 |
| Supply Chain Management system (SCM) | 49 |
| Business Intelligence system (BI) | 39 |
| Customer Relationship Management system (CRM) | 38 |
| E-business platform | 32 |
| Enterprise Integration Application | 1 |
| Total | 353 |

observations, 850 are in the pre-ES implementation period, and 1,254 are in the post-ES implementation period. Using the similar procedures, we obtain 126 ES firms with necessary data in year *t* for forecast specificity analyses, matched with 126 non-ES firms, which translates to 563 ES firm-year observations, and 592 non-ES firm-year observations. For forecast accuracy analysis, we have 90 ES firms, 416 ES firm-year observations, and 450 non-ES firm-year observations. Table 1 panel B provides a summary of our sample selection process.[15]

### *Model specifications*

To test the association between ES implementation and management forecast quality, we focus on several aspects of management forecasts: forecast issuance, forecast specificity, and forecast accuracy. We construct the following regression models to test our hypothesis:

15. We conduct *t*-tests to compare assets, ROA and leverage at the end of ES implementation year of the 126 (90) ES forecast firms with the original 587 ES firms (458 firms have necessary financial data from COMPUSTAT). The ES forecast firms (both specificity sample and accuracy sample) are larger and have marginally higher ROA, which is consistent with the literature that larger firms and financially healthy firms are more likely to issue forecasts. There is no difference in leverage between the ES forecast firms and the original ES firms. We also compare the industry difference between the forecast sample and the original sample based on 1-digit SIC code. The percentage of firms in each industry is very similar between the two groups except for Wholesale and Retail Trade (1-digit SIC code = 5) and Finance, Insurance and Real Estate (1-digit SIC code = 6). The percentages of firms in those two industries are 10.7 percent and 7.2 percent, respectively, in the original sample, while the percentages of firms in those two industries are 14.3 percent and 2.4 percent, respectively, in the forecast sample.

$$\begin{aligned} DISCLOSURE = {} & b_0 + b_1 ES + b_2 LNAT + b_3 ANALYST + b_4 AGE + b_5 BETA \\ & + b_6 ABSCHGROA + b_7 AF\_STD + b_8 INST\_HOLDING \\ & + b_9 NEWEQUITY + b_{10} VOLATILITY + b_{11} ORG.\ CHANGE \\ & + b_{12} COMPLEXITY + b_{13} FIN.\ CHALLENGES + b_{14} REGFD \\ & + YEAR\ DUMMIES + \varepsilon \end{aligned} \quad (1)$$

$$\begin{aligned} SPECIFICITY = {} & b_0 + b_1 ES + b_2 LNAT + b_3 ANALYST + b_4 AGE + b_5 BETA \\ & + b_6 ABSCHGROA + b_7 AF\_STD + b_8 INST\_HOLDING \\ & + b_9 NEWEQUITY + b_{10} VOLATILITY + b_{11} ORG.\ CHANGE \\ & + b_{12} COMPLEXITY + b_{13} FIN.\ CHALLENGES + b_{14} REGFD \\ & + b_{15} HORIZON + YEAR\,DUMMIES + \varepsilon \end{aligned} \quad (2)$$

$$\begin{aligned} ERROR = {} & b_0 + b_1 ES + b_2 LNAT + b_3 ANALYST + b_4 AGE + b_5 BETA \\ & + b_6 ABSCHGROA + b_7 AF\_STD + b_8 INST\_HOLDING \\ & + b_9 NEWEQUITY + b_{10} VOLATILITY + b_{11} ORG.\ CHANGE \\ & + b_{12} COMPLEXITY + b_{13} FIN.\ CHALLENGES + b_{14} REGFD \\ & + b_{15} HORIZON + b_{16} SURPRISE + YEAR\,DUMMIES + \varepsilon \end{aligned} \quad (3)$$

We define the dependent variables as follows:

*DISCLOSURE* = 1 if the firm issued an earnings forecast during the fiscal period, and 0 otherwise.

*SPECIFICITY* = 1 if the forecast is a point forecast, and 0 if the forecast is a range, minimum/maximum or qualitative forecast. If a firm issues multiple forecasts in a given year, we use the average of forecast specificity throughout the year.

*ERROR* = the absolute value of the management forecast error (realized earnings less the management forecast) / stock price at the end of year $t - 1$. If a firm issues multiple forecasts in a given year, we use the average of forecast error throughout the year.

Our primary test variable (*ES*) is an indicator variable specified as 1 if a firm is the ES firm, 0 if a firm is the matched non-ES firm. We track the implementation announcement year for each ES firm, and compare the pre-ES and post-ES implementation periods. Consistent with our hypothesis, to the extent that ES improve management's internal information environment, we expect management ability and confidence in providing forecasts to increase. Therefore, we expect that after the ES implementation (the post-ES implementation period), ES firms are more likely to issue management earnings forecasts (*DISCLOSURE*), issue more specific forecasts (*SPECIFICITY*), and their forecasts will exhibit smaller errors (*ERROR*). To rule out the possible explanations that ES firms tend to have a better information environment than the matched firms initially, or that better information environment firms are more likely to implement ES, we also conduct the analyses for the pre-ES implementation period, and then compare ES firms that have not yet announced ES implementation to their matched non-ES firms. We expect there are no differences in the various forecast properties for ES firms and the match firms prior to the ES implementation. Finally, we extend our tests by considering a strictly within-firm design whereby we measure the associations three years before and three years after ES implementation for only firms that implement ES. We report *t*-statistics or chi-squares based on robust standard errors in all our models to control for firm clustering effects following Petersen 2009.

Following prior literature, we include additional independent variables to control for other possible determinants of management forecast properties. Table 3 describes the variable definitions. Firm size (*LNAT*) is expected to be positively associated with management forecast quality (e.g., Kasznik and Lev 1995), as larger firms tend to have more experienced and knowledgeable staff. Previous studies have documented that analyst following (*ANALYST*) is positively related to voluntary disclosure frequency (e.g., Lang and Lundholm 1996). We include firm age (*AGE*), because mature firms might be more experienced at providing guidance (Feng et al. 2009). We also control for *BETA*, as Ajinkya, Bhojraj, and Sengupta (2005) find *BETA* is negatively associated with management forecast quality.

We next include variables that are related to the expected difficulty of predicting earnings (Feng et al. 2009). *ABSCHGROA* is the absolute value of the change in return on assets. *AF_STD* is defined as the standard deviation of analysts' forecasts at the beginning of year *t* in (1), and defined as the standard deviation of analyst forecasts for year *t*, prior to the management forecast for year *t* in (2) and (3) where management forecast is available. Both variables are expected to be negatively associated with forecast quality. We also control for institutional ownership and new equity offering. Prior studies find firms with higher institutional shareholdings are more likely to issue forecasts and issue higher quality forecasts (Karamanou and Vafeas 2005). Firms that plan to issue new equity also have stronger incentives to provide forecasts (Frankel, McNichols, and Wilson 1995), although Kross, To, and Suk (2011) find insignificant association between new equity offerings and forecast quality.

Following Feng et al. 2009, we perform a principal component analysis on 14 variables selected to proxy for the firm's underlying volatility and innate uncertainty, as firms with high volatility and uncertainty are expected to have poorer management forecast quality. The principal component analysis identifies four factors: *VOLATILITY*, *ORGANIZATIONAL CHANGE*, *COMPLEXITY*, and *FINANCIAL CHALLENGES*. Appendix 1 contains detailed discussions on the formation of the four factors.

Finally, we control for the passage of Regulation FD (*REGFD*) in all three models, forecast horizon (*HORIZON*) in forecast specificity and accuracy model, and magnitude of the revision suggested by the management forecast (*SURPRISE*) in the forecast accuracy model (Ajinkya et al. 2005). *REGFD* should be positively associated with management forecast quality. *HORIZON* is expected to be negatively associated with forecast specificity and accuracy, and *SURPRISE* is expected to be negatively associated with forecast accuracy.

## 4. Results

### *Univariate results*

Table 3 presents the univariate results for ES firms and matched non-ES firms. Panel A shows the results for the pre-ES implementation period, and panel B shows the post-ES implementation period. As indicated in panel A, the only difference we observe in the management forecast properties between ES firms and non-ES firms before the ES implementation is that the ES firms tend to issue *less* specific forecasts ($p$-value = 0.069). However, we observe more differences between the two groups in the post-ES implementation period (panel B). Compared to non-ES firms, ES firms are more likely to issue management forecasts ($p$-value = 0.006) and issue more accurate forecasts after the ES implementation ($p$-value = 0.036). Related to specificity, in the pre-ES implementation period ES firms tend to issue less specific forecasts than non-ES firms, while in the post-ES implementation period there is no significant difference between ES and non-ES firms.

With regard to control variables, ES firms and non-ES firms have very similar size. In addition, ES firms are not different from non-ES firms in many other dimensions, such as

TABLE 3
Descriptive statistics

| | **Panel A:** Pre-ES implementation period | | | **Panel B:** Post-ES implementation period | | |
|---|---|---|---|---|---|---|
| | *ES* = 1 Mean | *ES* = 0 Mean | *t*-stat. | *ES* = 1 Mean | *ES* = 0 Mean | *t*-stat. |
| Dependent variables | | | | | | |
| *DISCLOSURE* | 0.359 (*N* = 850) | 0.360 (*N* = 817) | −0.04 | 0.496 (*N* = 1,254) | 0.441 (*N* = 1,185) | 2.75*** |
| *SPECIFICITY* | 0.230 (*N* = 184) | 0.303 (*N* = 203) | −1.82* | 0.207 (*N* = 379) | 0.213 (*N* = 389) | −0.22 |
| *ERROR* | 0.008 (*N* = 130) | 0.009 (*N* = 148) | −0.46 | 0.009 (*N* = 286) | 0.013 (*N* = 302) | −2.11** |
| Forecast Controls | (*N* = 850) | (*N* = 817) | | (*N* = 1,254) | (*N* = 1,185) | |
| *LNAT* | 7.682 | 7.647 | 0.42 | 7.886 | 7.864 | 0.32 |
| *ANALYST* | 1.894 | 1.821 | 2.00** | 1.988 | 1.848 | 4.38*** |
| *AGE* | 2.986 | 2.833 | 3.54*** | 3.037 | 2.919 | 3.58*** |
| *BETA* | 0.938 | 0.922 | 0.38 | 1.073 | 0.959 | 2.51** |
| *ABSCHGROA* | 0.079 | 0.066 | 1.22 | 0.074 | 0.069 | 0.55 |
| *AF_STD* | 0.117 | 0.117 | −0.04 | 0.132 | 0.128 | 0.40 |
| *INST_HOLDING* | 0.569 | 0.496 | 5.27*** | 0.624 | 0.557 | 5.92*** |
| *NEWEQUITY* | 0.862 | 0.810 | 2.88*** | 0.851 | 0.785 | 4.25*** |
| *VOLATILITY* | −0.221 | −0.278 | 3.21*** | −0.118 | −0.175 | 3.39*** |
| *ORG. CHANGE* | 0.171 | 0.153 | 0.63 | −0.007 | 0.033 | −2.23** |
| *COMPLEXITY* | 0.461 | 0.372 | 2.52** | 0.732 | 0.572 | 4.61*** |
| *FIN. CHALLENGES* | −0.169 | −0.155 | −0.86 | −0.094 | −0.113 | 1.35 |
| *HORIZON* | 4.959 | 5.085 | −1.36 | 5.060 | 4.988 | 1.19 |
| *SURPRISE* | 0.004 | 0.003 | 1.20 | 0.003 | 0.004 | −1.89* |

(The table is continued on the next page.)

TABLE 3 (Continued)

**Notes:**

All *p*-values are two-tailed. *, **, and *** represent significance levels of 0.10, 0.05, and 0.01 respectively.
Variable definitions:
*ES* = 1 if a firm has announced ES implementation in year *t*, and 0 otherwise.
*DISCLOSURE* = 1 if the firm issued an earnings forecast during the fiscal period, and 0 otherwise.
*SPECIFICITY* = the average of forecast specificity during the fiscal period. Forecast specificity is measured as 1 if the forecast is a point forecast, and 0 otherwise.
*ERROR* = the average of forecast error during the fiscal period. Forecast error is measured as the absolute value of the management forecast error (realized earnings less the management forecast) / lagged stock price.
*LNAT* = natural logarithm of total assets at the end of year *t*.
*ANALYST* = natural logarithm of the number of analysts following at the end of year *t*.
*AGE* = the natural logarithm of the number of years that a company is covered by CRSP.
*BETA* = the slope coefficient from estimating Sharpe's 1964 market model using daily return data from year $t - 1$.
*ABSCHGROA* = the absolute value of the change in ROA (earnings before extraordinary items scaled by lagged total assets) from year $t - 1$ to year *t*.
*AF_STD* = the standard deviation of the individual analyst forecasts at the beginning of year *t* (*DISCLOSURE* model) / the standard deviation of the individual analyst forecasts for year *t*, prior to the management forecast for year *t* (*SPECIFICITY* and *ERROR* models where management forecast is available).
*INST_HOLDING* = the percentage of institutional shareholdings.
*NEWEQUITY* = 1 if a firm issues new equity or new debt in the following year, and 0 otherwise.
*VOLATILITY* = a factor comprised of cash flow volatility, earnings volatility, and sales volatility.
*ORG. CHANGE* = a factor comprised of asset growth, sales growth, leverage, and merger and acquisition activity.
*COMPLEXITY* = a factor comprised of the number of segments, the existence of foreign transactions, and the existence of a restructuring.
*FIN. CHALLENGES* = a factor comprised of return on assets, losses, research and development, and special items.
*REGFD* = 1 if the observation is related to the post-Reg FD period (after 2000), and 0 otherwise.
*HORIZON* = the natural logarithm of the number of days prior to the fiscal period-end in which the management forecast is issued, where a larger number indicates a more timely forecast.
*SURPRISE* = absolute value of (management forecast − pre-existing median analyst forecast) / stock price at the end of year $t - 1$.

change in ROA, analysts forecast dispersion, financial conditions, and forecast horizon. However, compared to non-ES firms, in both pre- and post-ES periods, ES firms have more analysts followings, are older firms, have higher institutional shareholdings, are more likely to issue new equity, and are more volatile and complex.[16] Because these features are also associated with forecast properties, it is important to control for them in the regression models. In general, the univariate results prior to the ES implementation indicate the ES firms are generally similar to the matched firms in the management forecast properties. However, after they implement ES, several of the forecast quality measures of our test firms become better than the matched control firms.

### *Multivariate results*

#### *Matched-sample analysis*

Table 4 panel A (B) presents the regression results for management forecasts for ES firms and matched non-ES firms in the pre (post-) ES implementation period. We use logistic regression when the dependent variable is *DISCLOSURE*; otherwise we use OLS regressions. For the pre-implementation tests (panel A), in all regression models except for *SPECIFICITY* the ES firms are not different from non-ES firms in terms of management forecast disclosure and forecast errors. For *SPECIFICITY*, the ES firms tend to issue *less* specific forecasts than non-ES firms (*ES* coefficient = −0.083, *p*-value = 0.057). Thus, in general, the forecast properties of ES firms are similar to the matched non-ES firms prior to ES implementation. However, after the ES implementation (panel B), the forecast properties for ES and non-ES firms are quite different. Related to *DISCLOSURE*, ES firms are more likely to issue management forecasts (*ES* coefficient = 0.217, *p*-value = 0.011). In other words, in the post-ES implementation period the ES implementers had 1.24 times the odds of issuing forecasts than the matched-control sample.[17] For *ERROR*, we observe that if the ES firms issue forecasts, their forecasts tend to have less error or, in other words, be more accurate (*ES* coefficient = −0.004, *p*-value = 0.009). Economically, the ES firms had 36 percent smaller forecasts errors after the implementation period compared to the matched-control sample.[18] Before the ES implementation, the forecasts for ES firms are less specific compared to non-ES firms. However, after the implementation of ES, their forecast specificity is not different from non-ES firms (*p*-value = 0.646). The univariate and multivariate results combined support our hypothesis that firms are more likely to issue higher quality management forecasts after the implementation of ES.[19]

For our control variables in both panels, larger, less volatile, and less complex firms, firms with more analysts following, lower betas, smaller analysts forecast dispersions, larger institutional shareholdings, and new equity issuance are more likely to issue forecasts. In the pre-ES period (panel A), firms in the post-Reg FD period are also more likely to issue forecasts. In the post-ES period (panel B), older firms are more likely to issue

16. This may help explain why ES firms issue less specific forecasts in the pre-ES period, as prior studies find forecast specificity is negatively associated with volatility and complexity (Ajinkya et al. 2005; Feng and Koch 2010).
17. The odds ratio is calculated as $e^{\beta}$ or $e^{0.217}$ (see Table 4 panel B for coefficients).
18. ES firms have management forecast errors (as deflated by stock price) that are 0.004 smaller on average. This represents a 36.4 percent difference, considering that the mean forecast error was 0.011 ([0.009 + 0.013]/2, see mean *ERROR*s in Table 3 panel B) in the post-ES implementation period.
19. When we control for the number of forecasts in the prior year to proxy for the forecasting experience, our results remain qualitatively the same. We also control for the past forecast quality measured as whether the company meets its own forecast in the prior year (Feng and Koch 2010). The sample for forecast occurrence is significantly reduced (to only 33 percent) because it requires the company to have issued point or range forecasts in the prior year. The untabulated results show that the forecast occurrence is insignificant in either pre- or post-ES period. However, our results for forecast specificity and forecast error remain unchanged after controlling for the past forecast quality.

TABLE 4
Management forecast properties and ES implementation for ES and matched non-ES firms

**Panel A:** Pre-ES implementation

| | DV = *DISCLOSURE* | | | DV = *SPECIFICITY* | | DV = *ERROR* | | |
|---|---|---|---|---|---|---|---|---|
| | +/− | Coeff. | Chi-Sqr | Coeff. | *t*-stat. | +/− | Coeff. | *t*-stat. |
| Intercept | ? | −3.705 | 51.13*** | 0.202 | 0.86 | ? | 0.013 | 1.36 |
| *ES* | ? | −0.050 | 0.18 | −0.083 | −1.91* | ? | −0.001 | −0.74 |
| *LNAT* | + | 0.151 | 8.54*** | −0.025 | −1.22 | − | 0.000 | 0.18 |
| *ANALYST* | + | 0.197 | 3.99** | 0.031 | 0.73 | − | 0.005 | 1.65* |
| *AGE* | + | 0.109 | 1.58 | 0.067 | 2.14** | − | −0.002 | −1.68** |
| *BETA* | − | −0.285 | 10.07*** | 0.005 | 0.13 | + | 0.001 | 0.60 |
| *ABSCHGROA* | − | 0.017 | 0.01 | −0.008 | −0.68 | + | −0.005 | −0.49 |
| *AF_STD* | − | −2.060 | 13.42*** | −0.121 | −0.47 | + | 0.054 | 2.65*** |
| *INST_HOLDING* | + | 0.460 | 3.75** | 0.169 | 1.40* | − | −0.013 | −2.22** |
| *NEWEQUITY* | + | 0.474 | 6.33*** | −0.039 | −0.61 | ? | −0.001 | −0.40 |
| *VOLATILITY* | − | −0.366 | 1.83* | −0.013 | −0.12 | + | 0.005 | 1.06 |
| *ORG. CHANGE* | − | 0.082 | 0.51 | 0.088 | 1.73* | + | 0.001 | 0.27 |
| *COMPLEXITY* | − | −0.131 | 2.36* | −0.011 | −0.36 | + | 0.000 | −0.02 |
| *FIN. CHALLENGES* | − | 0.085 | 0.18 | 0.038 | 0.17 | + | 0.028 | 1.90** |
| *REGFD* | + | 1.298 | 7.48*** | 0.326 | 1.72** | ? | −0.004 | −0.54 |
| *HORIZON* | − | | | −0.043 | −1.49* | + | 0.002 | 1.34* |
| *SURPRISE* | | | | | | + | 0.385 | 2.29** |
| Year dummies | | Included | | Included | | | Included | |
| Total *N* | | 1,667 | | 387 | | | 278 | |
| ES *N* | | 850 | | 184 | | | 130 | |

(The table is continued on the next page.)

TABLE 4 (Continued)

**Panel A:** Pre-ES implementation

| | DV = *DISCLOSURE* | DV = *SPECIFICITY* | DV = *ERROR* |
|---|---|---|---|
| Likelihood ratio | 282.980 | | |
| Pseudo $R^2$ | 0.214 | | |
| *F*-value | | 1.69 | 3.82 |
| Adjusted $R^2$ | | 0.045 | 0.216 |

**Panel B:** Post-ES implementation

| | DV = *DISCLOSURE* | | | DV = *SPECIFICITY* | | DV = *ERROR* | | |
|---|---|---|---|---|---|---|---|---|
| | +/− | Coeff. | Chi-Sqr | Coeff. | *t*-stat. | +/− | Coeff. | *t*-stat. |
| Intercept | ? | −4.150 | 28.12*** | 0.893 | 7.50*** | ? | −0.005 | −0.34 |
| *ES* | + | 0.217 | 5.19** | −0.012 | −0.46 | − | −0.004 | −2.38*** |
| *LNAT* | + | 0.146 | 12.08*** | 0.045 | 3.60*** | − | 0.000 | 0.52 |
| *ANALYST* | + | 0.147 | 3.70** | −0.021 | −0.85 | − | 0.011 | 2.29** |
| *AGE* | + | 0.266 | 13.70*** | −0.030 | −1.60 | − | 0.001 | 0.72 |
| *BETA* | − | −0.146 | 5.44*** | −0.025 | −1.26 | + | −0.003 | −1.46 |
| *ABSCHGROA* | − | 0.406 | 2.68 | 0.053 | 0.28 | + | −0.023 | −1.38 |
| *AF_STD* | − | −3.645 | 42.85*** | 0.065 | 0.30 | + | 0.105 | 3.51*** |
| *INST_HOLDING* | + | 0.719 | 13.02*** | 0.142 | 2.07** | − | −0.005 | −0.77 |
| *NEWEQUITY* | + | 0.498 | 12.72*** | 0.032 | 0.90 | ? | −0.004 | −1.09 |
| *VOLATILITY* | − | −0.573 | 14.38*** | 0.002 | 0.03 | + | 0.012 | 2.05** |
| *ORG. CHANGE* | − | 0.074 | 0.38 | 0.039 | 0.72 | + | −0.002 | −0.67 |
| *COMPLEXITY* | − | −0.109 | 3.09** | −0.008 | −0.43 | + | −0.002 | −1.70* |
| *FIN. CHALLENGES* | − | −0.007 | 0.02 | 0.141 | 1.06 | + | 0.027 | 2.51*** |

(The table is continued on the next page.)

TABLE 4 (Continued)

**Panel B:** Post-ES implementation

| | DV = *DISCLOSURE* | | | DV = *SPECIFICITY* | | DV = *ERROR* | | |
|---|---|---|---|---|---|---|---|---|
| | +/− | Coeff. | Chi-Sqr | Coeff. | *t*-stat. | +/− | Coeff. | *t*-stat. |
| *REGFD* | + | −0.181 | 0.05 | 0.859 | 15.99*** | ? | −0.003 | −0.61 |
| *HORIZON* | − | | | −0.023 | −1.13 | + | 0.004 | 2.55*** |
| *SURPRISE* | | | | | | + | 0.733 | 3.49*** |
| Year dummies | | Included | | Included | | | Included | |
| Total *N* | | 2,439 | | 768 | | | 588 | |
| ES *N* | | 1,254 | | 379 | | | 286 | |
| Likelihood Ratio | | 508.283 | | | | | | |
| Pseudo $R^2$ | | 0.251 | | | | | | |
| *F*-value | | | | 4.98 | | | 16.46 | |
| Adjusted $R^2$ | | | | 0.119 | | | 0.433 | |

**Notes:**

One-tailed *p*-value for signed expectations and two-tailed *p*-value for unsigned expectations. *, **, and *** represent significance levels of 0.10, 0.05, and 0.01 respectively. All chi-square and *t*-statistics are standard error adjusted for firm clustering effects.

Variable definitions:

*ES* = 1 if a firm has announced ES implementation in year *t*, and 0 otherwise.

*DISCLOSURE* = 1 if the firm issued and earnings forecast during the fiscal period, and 0 otherwise.

*SPECIFICITY* = the average of forecast specificity during the fiscal period. Forecast specificity is measured as 1 if the forecast is a point forecast, and 0 otherwise.

(The table is continued on the next page.)

TABLE 4 (Continued)

*ERROR* = the average of forecast error during the fiscal period. Forecast error is measured as the absolute value of the management forecast error (realized earnings less the management forecast) / lagged stock price.
*LNAT* = natural logarithm of total assets.
*ANALYST* = natural logarithm of the number of analysts following.
*AGE* = the natural logarithm of the number of years that a company is covered by CRSP.
*BETA* = the slope coefficient from estimating Sharpe's 1964 market model using daily return data from year $t - 1$.
*ABSCHGROA* = the absolute value of the change in ROA (earnings before extraordinary items scaled by lagged total assets) from year $t - 1$ to year $t$.
*AF_STD* = the standard deviation of the individual analyst forecasts at the beginning of year $t$ (*DISCLOSURE* model) / the standard deviation of the individual analyst forecasts for year $t$, prior to the management forecast for year $t$ (models with management forecast).
*INST_HOLDING* = the percentage of institutional shareholdings.
*NEWEQUITY* = 1 if a firm issues new equity or new debt in the following year, and 0 otherwise.
*VOLATILITY* = a factor comprised of cash flow volatility, earnings volatility, and sales volatility.
*ORG. CHANGE* = a factor comprised of asset growth, sales growth, leverage, and merger and acquisition activity.
*COMPLEXITY* = a factor comprised of the number of segments, the existence of foreign transactions, and the existence of a restructuring.
*FIN. CHALLENGES* = a factor comprised of return on assets, losses, research and development, and special items.
*REGFD* = 1 if the observation is related to the post-Reg FD period (after 2000), and 0 otherwise.
*HORIZON* = the natural logarithm of the number of days prior to the fiscal period-end in which the management forecast is issued, where a larger number indicates a more timely forecast.
*SURPRISE* = absolute value of (management forecast − pre-existing median analyst forecast) / stock price at the end of the prior year.

forecasts. For forecast specificity, in both panels, firms with larger institutional shareholdings and in the post-Reg FD period tend to issue more specific forecasts. Older firms and firms with more organizational changes and shorter forecast horizons also issue more specific forecasts in the pre-ES period, while larger firms issue more specific forecasts in the post-ES period. Finally, for forecast accuracy, firms with more analysts following, larger analysts forecast dispersion, more financial challenges, longer forecast horizons, and larger forecast surprises have larger forecast errors in both periods. Younger firms, and firms with fewer institutional shareholdings in the pre-ES period, and volatile but less complex firms in the post-ES period also have larger forecast errors.

In sum, our regression results on management forecast properties suggest that there is generally no difference between the ES firms and matched non-ES firms in various forecast properties *prior* to an ES implementation period. However, after the ES implementation, ES firms are significantly better in most of the forecast quality measures compared to the matched firms. Thus, our results are consistent with the argument that ES improve firms' internal information environments, which leads to better quality management forecasts.

*Within-firm analyses*

Our matched-sample tests are subject to certain limitations. First, similar to prior research, we cannot completely eliminate the risk that a control firm was incorrectly labeled as a non-ES firm. Second, some firm innate characteristics, such as volatility, could affect both ES implementation decisions and management forecasts. In addition, firms' ES implementation and disclosure policies are endogenously determined. To minimize the concerns from these limitations, we also conduct within-firm analyses. In these analyses, we compare ES firms' forecast quality in the three years prior and three years after the ES implementation. By using ES firms as their own control, and to the extent that firm innate characteristics do not change significantly before and after ES implementation, our within-firm analyses help to mitigate the potential concerns associated with endogeneity, self-selection, and correlated omitted variables as in all cross-sectional designs.

Table 5 reports the results for management forecast properties comparing ES firms three years after the ES implementation with ES firms three years before the ES implementation. Our test variable, *POSTES* equals one if it is in the three years after the ES implementation, zero if it is in the three years prior to the ES implementation. It is significantly positive in the forecast disclosure (*POSTES* coefficient = 0.327, $p$-value = 0.001), and significantly negative in the forecast error regression (*POSTES* coefficient = −0.002, $p$-value = 0.092). Thus, consistent with our hypothesis, ES firms are more likely to issue forecasts, and issue more accurate forecasts in the first three years after the ES implementation compared to the three years before the implementation. We find no significant improvement in the forecast specificity, which could be attributable to an overall low likelihood of issuing specific point forecast in general.[20]

***Additional analyses***

*Alternative earnings management explanations*

Our hypothesis relies on the assumption that the improvements in management forecast quality are a function of improvements in the firm's internal information environment attributable to the implementation of ES. However, our documented improvements in management forecasts properties could also be due to an increase in management's

20. The percentage of point forecast in the whole First Call sample is low (7 percent). If we examine point or range forecast, which both can be transferred to a specific forecast number (First Call takes the middle point of the range forecast as the forecast number), our results show that firms are more likely to issue point or range forecast after the ES implementation (*POSTES* coefficient = 0.034 , $p$-value = 0.077).

TABLE 5
Forecast properties for ES firms three years prior and three years after the implementation

| | DV = *DISCLOSURE* | | | DV = *SPECIFICITY* | | DV = *ERROR* | | |
|---|---|---|---|---|---|---|---|---|
| | +/− | Coeff. | Chi-Sqr | Coeff. | *t*-stat. | +/− | Coeff. | *t*-stat. |
| Intercept | ? | −3.311 | 73.28*** | 0.152 | 1.11 | ? | 0.002 | 0.35 |
| *POSTES* | + | 0.327 | 9.50*** | −0.025 | −0.96 | − | −0.002 | −1.33* |
| *LN_AT* | + | 0.106 | 6.08*** | 0.015 | 1.30* | − | −0.001 | −2.71*** |
| *ANALYST* | + | 0.099 | 1.67* | −0.009 | −0.44 | − | 0.000 | −0.19 |
| *AGE* | + | 0.256 | 11.10*** | −0.004 | −0.24 | − | −0.002 | −1.62* |
| *BETA* | − | −0.182 | 5.44*** | −0.009 | −0.83 | + | 0.002 | 1.77** |
| *ABSCHGROA* | − | 0.368 | 1.25 | −0.076 | −1.10 | + | −0.004 | −1.26 |
| *AF_STD* | − | −2.619 | 22.47*** | −0.062 | −0.35 | + | 0.101 | 3.40*** |
| *INST_HOLDING* | + | 1.116 | 21.86*** | −0.008 | −0.13 | − | −0.004 | −0.98 |
| *NEWEQUITY* | + | 0.244 | 2.63* | −0.019 | −0.48 | ? | −0.001 | −0.42 |
| *VOLATILITY* | − | −0.412 | 4.20** | 0.083 | 1.74* | + | 0.005 | 1.39* |
| *ORG. CHANGE* | − | 0.043 | 0.10 | 0.029 | 0.84 | + | 0.001 | 0.30 |
| *COMPLEXITY* | − | −0.076 | 1.23 | 0.009 | 0.53 | + | −0.001 | −1.12 |
| *FIN. CHALLENGES* | − | −0.032 | 0.02 | 0.010 | 0.16 | + | −0.006 | −2.05** |
| *REGFD* | + | 0.841 | 41.79*** | −0.182 | −4.61*** | ? | −0.001 | −0.39 |
| *HORIZON* | − | | | 0.035 | 1.65* | + | 0.004 | 4.14*** |
| *SURPRISE* | | | | | | + | 0.186 | 2.77*** |
| Year dummies | | Included | | Included | | | Included | |
| Total *N* | | 1,998 | | 861 | | | 632 | |
| ES *N* | | 1,090 | | 541 | | | 401 | |
| Likelihood ratio | | 327.202 | | | | | | |
| Pseudo $R^2$ | | 0.202 | | | | | | |
| *F*-value | | | | 3.89 | | | 16.03 | |
| Adjusted $R^2$ | | | | 0.048 | | | 0.276 | |

(The table is continued on the next page.)

TABLE 5 (Continued)

**Notes:**

One-tailed *p*-value for signed expectations and two-tailed *p*-value for unsigned expectations. *, **, and *** represent significance levels of 0.10, 0.05, and 0.01 respectively. All chi-square and *t*-statistics are standard error adjusted for firm clustering effects.

Variable definitions:

*POSTES* = 1 if it is after the ES implementation; 0 if it is before the ES implementation.

*DISCLOSURE* = 1 if the firm issued and earnings forecast during the fiscal period, and 0 otherwise.

*SPECIFICITY* = the average of forecast specificity during the fiscal period. Forecast specificity is measured as 1 if the forecast is a range or point forecast, and 0 otherwise.

*ERROR* = the average of forecast error during the fiscal period. Forecast error is measured as the absolute value of the management forecast error (realized earnings less the management forecast) / lagged stock price.

*LNAT* = natural logarithm of total assets.

*ANALYST* = natural logarithm of the number of analysts following.

*AGE* = the natural logarithm of the number of years that a company is covered by CRSP.

*BETA* = the slope coefficient from estimating Sharpe's 1964 market model using daily return data from year $t - 1$.

*ABSCHGROA* = the absolute value of the change in ROA (earnings before extraordinary items scaled by lagged total assets) from year $t - 1$ to year $t$.

*AF_STD* = the standard deviation of the individual analyst forecasts at the beginning of year $t$ (*DISCLOSURE* model) / the standard deviation of the individual analyst forecasts for year $t$, prior to the management forecast for year $t$ (models with management forecast).

*INST_HOLDING* = the percentage of institutional shareholdings.

*NEWEQUITY* = 1 if a firm issues new equity or new debt in the following year, and 0 otherwise.

*VOLATILITY* = a factor comprised of cash flow volatility, earnings volatility, and sales volatility.

*ORG. CHANGE* = a factor comprised of asset growth, sales growth, leverage, and merger and acquisition activity.

*COMPLEXITY* = a factor comprised of the number of segments, the existence of foreign transactions and the existence of a restructuring.

*FIN. CHALLENGES* = a factor comprised of return on assets, losses, research and development, and special items.

*REGFD* = 1 if the observation is related to the post-Reg FD period (after 2000), and 0 otherwise.

*HORIZON* = the natural logarithm of the number of days prior to the fiscal period-end in which the management forecast is issued, where a larger number indicates a more timely forecast.

*SURPRISE* = absolute value of (management forecast − pre-existing median analyst forecast) / stock price at the end of the prior year.

propensity or innate ability to manipulate reported earnings to meet their forecasts after the implementation of ES. For example, Brazel and Dang (2008) find an increased level of abnormal discretionary accruals after the implementation of an enterprise resource planning system during the 1993–1999 time period. Thus, we provide additional tests to address this alternative explanation. To the extent that ES are not associated with increases in earnings management, we infer that our documented improvements in management earnings forecasts are due to higher quality internal information available to management as opposed to enhanced earnings management.

We test the association between ES implementation and earnings management proxies identified in prior research, including the likelihood of reported earnings meeting or just beating analyst's forecasts, the extent of abnormal accruals, and the likelihood of earnings misstatements. Adapted from prior research (e.g., Frankel et al. 2002; Ashbaugh, LaFond, and Mayhew 2003), the specifications of the regressions that test the association between ES implementation and each of the earnings quality measures are as follows:

$$\begin{aligned} MEETBEAT = {} & b_0 + b_1 ES + b_2 LNAT + b_3 ROA + b_4 LEVERAGE + b_5 LOSS \\ & + b_6 RETURN + b_7 LCACCR + b_8 CFO + b_9 MA + b_{10} FINANCING \\ & + b_{11} LITIGATE + b_{12} MB + b_{13} VOLATILITY + b_{14} INST\_HOLDING \\ & + b_{15} BIG\ N + b_{16} TENURE + YEAR\ DUMMIES + \varepsilon \end{aligned} \tag{4}$$

$$\begin{aligned} |AA_{j,t}| = {} & b_0 + b_1 ES + b_2 LNAT + b_3 ROA + b_4 LEVERAGE + b_5 LOSS + b_6 RETURN \\ & + b_7 LCACCR + b_8 CFO + b_9 MA + b_{10} FINANCING + b_{11} LITIGATE \\ & + b_{12} MB + b_{13} VOLATILITY + b_{14} INST\_HOLDING + b_{15} BIG\ N \\ & + b_{16} TENURE + YEAR\ DUMMIES + \varepsilon \end{aligned} \tag{5}$$

$$\begin{aligned} MISSTATE = {} & b_0 + b_1 ES + b_2 LNAT + b_3 ROA + b_4 LEVERAGE + b_5 LOSS \\ & + b_6 CFO + b_7 MA + b_8 FINANCING + b_9 LITIGATE + b_{10} MB \\ & + b_{11} VOLATILITY + b_{12} INST\_HOLDING + b_{13} BIG\ N + b_{14} TENURE \\ & + YEAR\ DUMMIES + \varepsilon \end{aligned} \tag{6}$$

We define the dependent variables as follows:

*MEETBEAT* = 1 if earnings are equal to or one cent greater than the medium I/B/E/S consensus forecast of period *t* earnings made during the period starting two months before the corresponding actual earnings announcement and ending three days before the announcement, and 0 otherwise.

$|AA_{j,t}|$ = the absolute value of the performance matched modified Jones 1991 measure of abnormal accruals. See Appendix 2 for detailed description of the calculation of $|AA_{j,t}|$.

*MISSTATE* = 1 if the firm has a material misstatement in the financial statement, and 0 otherwise.[21]

If our main inferences are explained by differences in earnings management, the estimated coefficients on ES should be significantly *positive* when regressed on our proxies for earnings management in the post-ES period. Table 6 summarizes the control variable definitions.

21. We use Audit Analytics to identify all financial statement misstatements after 2000, and use the misstatement data prior to 2000 from Palmrose, Scholz, and Richardson 2004 with thanks to Susan Scholz for providing the data.

TABLE 6
Earnings quality and ES implementation for ES and matched non-ES firms

**Panel A:** Pre-ES implementation

| | DV = *MEETBEAT* | | | DV = $\|AA_{j,t}\|$ | | | DV = *MISSTATE* | | |
|---|---|---|---|---|---|---|---|---|---|
| | +/− | Coeff. | Chi-Sqr | +/− | Coeff. | *t*-stat. | +/− | Coeff. | Chi-Sqr |
| Intercept | ? | −3.027 | 16.74*** | ? | 0.136 | 4.23*** | ? | −3.314 | 12.80*** |
| *ES* | ? | 0.005 | 0.01 | ? | 0.000 | −0.06 | ? | −0.202 | 1.67 |
| *LNAT* | − | 0.022 | 0.23 | − | −0.005 | −2.44*** | − | −0.154 | 9.98*** |
| *ROA* | + | −2.790 | 5.25** | − | 0.009 | 0.14 | − | 1.301 | 1.49 |
| *LEVERAGE* | − | −0.221 | 0.84 | + | 0.051 | 3.38*** | + | 0.266 | 2.34* |
| *LOSS* | − | −0.126 | 0.16 | + | 0.030 | 2.26** | + | 0.257 | 0.97 |
| *RETURN* | + | 0.020 | 0.04 | − | −0.002 | −0.42 | | | |
| *LCACCR* | − | −0.970 | 3.45* | − | −0.001 | −0.06 | | | |
| *CFO* | + | −1.507 | 2.90* | − | −0.029 | −0.55 | − | −0.207 | 0.07 |
| *MA* | + | −0.069 | 0.16 | + | −0.001 | −0.13 | + | 0.109 | 0.30 |
| *FINANCING* | + | 0.368 | 1.72* | + | 0.016 | 1.64* | + | −0.218 | 0.50 |
| *LITIGATE* | + | 0.180 | 1.30 | + | 0.015 | 1.91** | + | 0.221 | 1.70* |
| *MB* | + | −0.044 | 0.61 | + | 0.008 | 4.27*** | + | 0.016 | 0.17 |
| *VOLATILITY* | − | −0.574 | 1.78* | + | 0.015 | 0.66 | + | 0.623 | 2.77** |
| *INST_HOLDING* | + | −0.148 | 0.22 | − | −0.035 | −2.39*** | + | 0.720 | 4.68** |
| *BIG N* | − | 0.847 | 2.89* | − | −0.021 | −1.15 | − | 1.340 | 4.81** |
| *TENURE* | − | 0.147 | 2.70 | − | −0.001 | −0.37 | − | −0.128 | 1.96* |
| Year dummies | | Included | | | Included | | | Included | |

(The table is continued on the next page.)

TABLE 6 (Continued)

**Panel A:** Pre-ES implementation

| | DV = *MEETBEAT* | DV = $\|AA_{j,t}\|$ | DV = *MISSTATE* |
|---|---|---|---|
| Total *N* | 1,370 | 1,367 | 1,679 |
| ES *N* | 703 | 707 | 844 |
| Likelihood ratio | 49.122 | | 110.707 |
| Pseudo $R^2$ | 0.054 | | 0.119 |
| *F*-value | | 4.58 | |
| Adjusted $R^2$ | | 0.068 | |

**Panel B:** Post-ES implementation

| | DV = *MEETBEAT* | | | DV = $\|AA_{j,t}\|$ | | | DV = *MISSTATE* | | |
|---|---|---|---|---|---|---|---|---|---|
| | +/− | Coeff. | Chi-Sqr | +/− | Coeff. | *t*-stat. | +/− | Coeff. | Chi-Sqr |
| Intercept | ? | −3.581 | 8.07*** | ? | 0.105 | 3.62*** | ? | −20.292 | 9.70*** |
| *ES* | ? | −0.233 | 3.25* | ? | 0.004 | 0.91 | ? | −0.247 | 3.68* |
| *LNAT* | + | 0.079 | 3.61** | − | −0.005 | −2.78*** | − | −0.118 | 9.54*** |
| *ROA* | + | 3.787 | 9.38*** | − | −0.022 | −0.29 | − | −0.249 | 0.22 |
| *LEVERAGE* | − | −0.757 | 5.55*** | + | 0.046 | 2.86*** | + | 0.538 | 6.23*** |
| *LOSS* | − | 0.174 | 0.63 | + | 0.000 | 0.03 | + | 0.503 | 6.37*** |
| *RETURN* | + | 0.021 | 0.03 | − | 0.003 | 0.59 | | | |
| *LCACCR* | − | −0.936 | 1.98* | − | −0.012 | −0.39 | | | |
| *CFO* | + | −0.517 | 0.32 | − | −0.001 | −0.02 | − | 0.680 | 1.31 |

(The table is continued on the next page.)

TABLE 6 (Continued)

**Panel B:** Post-ES implementation

| | DV = *MEETBEAT* | | | DV = $\|AA_{j,t}\|$ | | | DV = *MISSTATE* | | |
|---|---|---|---|---|---|---|---|---|---|
| | +/− | Coeff. | Chi-Sqr | +/− | Coeff. | *t*-stat. | +/− | Coeff. | Chi-Sqr |
| *MA* | + | 0.040 | 0.06 | + | 0.003 | 0.47 | + | −0.141 | 0.79 |
| *FINANCING* | + | 0.378 | 2.20* | + | 0.013 | 1.72** | + | 0.407 | 2.59* |
| *LITIGATE* | + | −0.022 | 0.02 | + | 0.021 | 3.54*** | + | 0.500 | 12.36*** |
| *MB* | + | 0.020 | 0.52 | + | 0.006 | 1.28 | + | −0.025 | 1.35 |
| *VOLATILITY* | − | −0.505 | 2.17* | + | 0.012 | 0.75 | + | −0.248 | 0.73 |
| *INST_HOLDING* | + | 0.082 | 0.08 | − | −0.010 | −0.87 | + | 0.705 | 7.43*** |
| *BIG N* | − | −0.657 | 2.68* | − | −0.025 | −1.59* | − | 0.598 | 1.87 |
| *TENURE* | − | 0.148 | 3.99** | − | −0.001 | −0.25 | − | 0.025 | 0.13 |
| Year dummies | | Included | | | Included | | | Included | |
| Total *N* | | 1,977 | | | 2,057 | | | 2,623 | |
| ES *N* | | 1,012 | | | 1,054 | | | 1,361 | |
| Likelihood ratio | | 103.499 | | | | | | 215.466 | |
| Pseudo $R^2$ | | 0.083 | | | | | | 0.145 | |
| *F*-value | | | | | 4.68 | | | | |
| Adjusted $R^2$ | | | | | 0.051 | | | | |

**Notes:**

One-tailed *p*-value for signed expectations and two-tailed *p*-value for unsigned expectations. *, **, and *** represent significance levels of 0.10, 0.05, and 0.01 respectively. All chi-square and *t*-statistics are standard error adjusted for firm clustering effects.

Variable definitions:

*MEETBEAT* = 1 if earnings are equal to or one cent greater than analyst's forecasts consensus, and 0 otherwise.

$|AA_{j,t}|$ = the absolute value of the performance matched resulting modified Jones 1991 measure.

*MISSTATE* = 1 if a firm has a material misstatement, and 0 otherwise.

(The table is continued on the next page.)

TABLE 6 (Continued)

*ES* = 1 if a firm has announced ES implementation, and 0 otherwise.
*LNAT* = natural logarithm of total assets.
*ROA* = earnings before extraordinary items / lagged total assets.
*LEVERAGE* = total liabilities / lagged total assets.
*LOSS* = 1 if the earnings before extraordinary items less than zero, and 0 otherwise.
*RETURN* = 12-month buy and hold return before the fiscal year end.
*LCACCR* = prior year's total current accruals (net income before extraordinary items + depreciation and amortization − operating cash flows) / lagged total assets.
*CFO* = cash flow from operations / lagged total assets.
*MA* = 1 if the company underwent a large merger or acquisition, and 0 otherwise.
*FINANCING* = 1 if a firm issues new equity or new debt in the following year, and 0 otherwise.
*LITIGATE* = 1 if the firm's main operations are in a high litigation industry [biotechnology (2833–2836 and 8731–8734), computers (3570–3577 and 7370–7374), electronics (3600–3674), and retail (5200–5961) industries, and 0 otherwise (based on Francis, Philbrick, and Schipper 1994)].
*MB* = market to book ratio.
*VOLATILITY* = a factor comprised of cash flow volatility, earnings volatility, and sales volatility.
*INST_HOLDING* = the percentage of institutional shareholdings.
*BIG N* = 1 if the firm is audited by Big N auditors, and 0 otherwise.
*TENURE* = natural logarithm of the number of years the auditor has been employed by the firm.

Table 6 reports the regression results for the earnings management tests in both pre-ES (panel A) and post-ES (panel B) implementation periods. Panel A shows that in the pre-ES implementation period there is no difference in the likelihood of meeting or just beating analyst forecasts, abnormal accruals, or the likelihood of materially misstated financial reports for the ES firms and their matches (see *ES* coefficients). However, after the implementation of ES (Table 6, panel B), the ES firms are actually significantly less likely to meet or just beat analysts forecast (*ES* coefficient = −0.233, *p*-value = 0.071) and less likely to issue misstated financial reports (*ES* coefficient = −0.247, *p*-value = 0.055). While we do not find a significant association between ES and abnormal accruals in both pre- and post-ES periods, our findings are consistent with Morris and Laksamana 2010 in that we find no evidence of an increase in earnings management after ES implementations.[22] Thus, the above results fail to support the alternative explanation concerning the impact of ES implementation on the quality of management forecast being attributable to increases in earnings management.

We also extend the test of potential earnings management from an investor perspective by examining earnings informativeness, measured by the responsiveness of returns to reported earnings or Earnings Response Coefficient (ERC) (Fan and Wong 2002; Wang 2006). To the extent that reported earnings suffer from increased earnings management we would expect the informativeness of those earnings to decline. We adapt a test and regression model specified by Fan and Wong 2002 and Wang 2006 for our sample, as follows:

$$\begin{aligned} RET = {} & b_0 + b_1 ROA + b_2 ES * ROA + b_3 LNAT * ROA + b_4 LEVERAGE * ROA \\ & + b_5 LOSS * ROA + b_6 CFO * ROA + b_7 MB * ROA + b_8 INST\_HOLDING * ROA \\ & + b_9 BIG\ N * ROA + b_{10} TENURE * ROA + YEAR\ DUMMIES + \varepsilon. \end{aligned} \quad (7)$$

We define the dependent variable as *RET* = 12-month cumulative return ending three months after the fiscal year-end. If our main results are indicative of greater earnings management as manifested by a decrease in earnings informativeness, the interaction between *ES* and *ROA* ($b_2 ES{*}ROA$) should be significantly *negative* after the ES implementation compared to those firms who did not implement ES in the same period.

Table 7 reports the tests concerning the differential earnings informativeness of ES firms and non-ES firms. The coefficient on the test variable (*ES*ROA*) is not significant in the pre-ES period, but it becomes significantly positive in the post-ES period (*p*-value = 0.049). This suggests that, contrary to the alternative earnings management explanation, the earnings informativeness increases rather than decreases for ES firms after the ES implementation.

We also perform similar within-firm 3-year pre-ES and 3-year post-ES analyses for earnings management. The results (untabulated) show that, compared to the three years before the ES implementation, firms are less likely to just meet or beat analysts forecast (*p*-value = 0.107), have lower abnormal accruals (*p*-value = 0.112), are less likely to have earnings misstatements (*p*-value = 0.018), and have higher ERC (*p*-value = 0.002) in the first three years after the implementation. These results provide further support to our inference that ES firms do not experience increased levels of earnings management after the ES implementation. In contrast, for several earnings management proxies, our results are consistent with a decrease in earnings management after the ES implementation.

22. Morris and Laksamana (2010) focus strictly on abnormal accrual behavior after enterprise resource planning system implementations. Thus our findings complement prior literature by also extending the analysis to other earnings management indicators. We believe this strengthens the primary incremental contribution of our paper related to management forecasts and the impact of ES on the firms' information environment.

TABLE 7
Earnings response coefficient and ES implementation for ES and matched non-ES firms

| | | **Panel A:** Pre-ES implementation | | **Panel B:** Post-ES implementation | |
|---|---|---|---|---|---|
| | | DV = *RET* | | DV = *RET* | |
| | +/− | Coeff. | *t*-stat. | Coeff. | *t*-stat. |
| Intercept | ? | 0.210 | 4.59*** | 0.051 | 1.29 |
| *ROA* | + | 1.253 | 1.98** | 1.250 | 2.58*** |
| *ES*ROA* | ? | 0.040 | 0.43 | 0.192 | 1.97** |
| *LNAT*ROA* | + | −0.004 | −0.14 | 0.009 | 0.24 |
| *LEVERAGE*ROA* | − | −0.016 | −1.33* | −0.126 | −2.27** |
| *LOSS*ROA* | − | −1.003 | −4.11*** | −0.885 | −3.35*** |
| *CFO*ROA* | + | 0.018 | 0.76 | 0.196 | 2.19** |
| *MB*ROA* | + | −0.029 | −1.35 | 0.057 | 2.48*** |
| *INST_HOLDING*ROA* | + | −0.763 | −1.97** | −0.017 | −0.09 |
| *BIG N*ROA* | + | −0.308 | −0.54 | 0.334 | 0.88 |
| *TENURE*ROA* | + | 0.191 | 2.41*** | −0.276 | −2.37** |
| Year dummies | | Included | | Included | |
| Total *N* | | 1,721 | | 2,495 | |
| ES *N* | | 899 | | 1,279 | |
| *F*-value | | 14.79 | | 38.96 | |
| Adjusted $R^2$ | | 0.150 | | 0.268 | |

**Notes:**

One-tailed *p*-value for signed expectations and two-tailed *p*-value for unsigned expectations. *, **, and *** represent significance levels of 0.10, 0.05, and 0.01 respectively. All chi-square and *t*-statistics are standard error adjusted for firm clustering effects.

Variable definitions:

*RET* = 12-month cumulative return ending three months after the fiscal year-end.
*ES* = 1 if a firm has announced ES implementation, and 0 otherwise.
*LNAT* = natural logarithm of total assets.
*ROA* = earnings before extraordinary items / lagged total assets.
*LEVERAGE* = total liabilities / lagged total assets.
*LOSS* = 1 if the earnings before extraordinary items less than zero, and 0 otherwise.
*CFO* = cash flow from operations / lagged total assets.
*MB* = market to book ratio.
*INST_HOLDING* = the percentage of institutional shareholdings.
*BIG N* = 1 if the firm is audited by Big N auditors, and 0 otherwise.
*TENURE* = natural logarithm of the number of years the auditor has been employed by the firm.

As an aside, the collective earnings management results are consistent with a decrease in the likelihood of information manipulation and the rate of error in processing information after ES implementation. This association is also consistent with the asserted internal benefits of ES implementations, which include business process re-engineering, enhanced internal transparency, and the centralized and standardized automation of business transaction processing (Davenport 1998; Sia et al. 2002; Ignatiadis and Nandhakumar 2007). These benefits are purported to reduce the possibility of manipulating business transaction information and concealing the modification of information within the organization, thus enhancing information transparency.

*Self-selection bias*

As mentioned previously, we use firms as their own control to try to mitigate self-selection problems. In this section, we further examine potential self-selection bias associated with the decision to implement ES by using both Heckman two-stage models (Heckman 1979) and propensity score matching. For the Heckman two-stage model, we regress the choice of implementing ES on a bulk of variables that were previously shown to be determinants of firms implementing ES in the first stage (Masli, Richardson, Sanchez, and Smith 2009), and calculated the Inverse Mills Ratio (*IMR*).[23] In the second stage, we add the *IMR* from the first stage to our forecast and earnings management models. The untabulated results show that all our results remain unchanged.

As an alternative to the Heckman procedures we also utilize propensity score matching techniques as proposed by Rosenbaum and Rubin 1983. We create a matched sample based on the predicted likelihood of implementing ES from the first stage probit regression model as we discussed above. This method creates a non-ES control sample with the closest predicted likelihood of implementing ES. We then reestimate our forecast quality models. The results remain qualitatively the same under that the propensity score matching procedures. Thus, our inferences are unaffected by the additional tests that specifically control for self-selection bias of implementing ES.

## 5. Conclusion

Enterprise systems (ES) require a substantial investment of time, money, and internal resources, and they are fraught with technical as well as business risks (Hitt et al. 2002). However, the large and increasing investment worldwide in ES indicates there are many potential benefits to the firm's internal information environment. The access to information throughout the organization in centralized data sets is purported to give great benefit to the organization by arguably improving the information environment and management decision making. One of the important decisions a company must make is whether to issue management forecasts, especially given the potential litigation associated with management forecasts (Kasznik 1999). If the organization has solid, wide-ranging, and integrated internal information, we argue that management will be more likely to issue forecasts and the forecasts issued will be of higher quality. We find results supportive of that claim.

Our study has the following limitations. First, our ES sample is from press releases; not all firms implementing ES will make such announcements. Although we conduct both telephone surveys and Lexis-Nexis and annual reports searches to mitigate the concern that firms in our matched sample also have ES implementations before or during the sample period, we cannot completely rule out that concern. Second, firms' ES implementation and disclosure policies are endogenously determined, and some firm innate characteristics could affect both ES implementation decisions and management forecast or earnings quality. In response to these concerns, we use various test designs including a matched design and compare the ES and non-ES firms in both pre-ES implementation and post-ES implementation periods, compare ES firms with themselves three years prior and three years

23. We compare firms with ES implementation to all non-ES firms in the same SIC 2-digit industry. Our probit model is: $ES = b_1 LNAT_{t-1} + b_2 LEVERAGE_{t-1} + b_3 CAPITALINTENSITY_{t-1} + b_4 MB_{t-1} + b_5 LOSS_{t-1} + b_6 DIVIDENDS_{t-1} + b_7 FOREIGN_{t-1} + b_8 M\&A_{t-1} + b_9 R\&D_{t-1} + b_{10} ADVERTISE_{t-1} + b_{11} ANALYSTS_{t-1} + YEARDUMMIES$. All variables as previously defined with the additions of *CAPITAL INTENSITY* = revenue divided by total assets; *DIVIDENDS* = 1 if firm made cash dividend payment, 0 otherwise; *FOREIGN* = 1 if firm had foreign transaction activity, 0 otherwise; *M&A* = 1 if firm had a merger acquisition activity, 0 otherwise; *R&D* = R&D expenses divided by total assets (0 if COMPUSTAT data #46 is blank); *ADVERTISE* = Advertising expenses divided by total assets (0 if COMPUSTAT data #45 is blank). All variables are measured as the year prior to the ES implementation. The model has a pseudo $R^2$ of 15 percent, comparable to Masli et al. 2009.

after the ES implementation, and explicitly control for self-selection bias of implementing ES. However, we cannot completely rule out that alternative explanations, such as selection bias and innate volatility, are driving our results.

Subject to those caveats, our study contributes to the impact of accounting technology literature by providing first-time archival evidence on the influence of enterprise-wide technology (enterprise systems) on management decision making. Specifically, we document the benefit of implementing ES on a distinct information-oriented outcome, namely management forecast quality. While a limited amount of prior research has considered aggregate measures of ES benefits, such studies tend to be limited by constrained sample settings, broad indirect firm performance measures, or mixed results (e.g., Poston and Grabski 2001; Hunton et al. 2003; Wier et al. 2007; Kallunki et al. 2010; Hayes et al. 2001; Hunton et al. 2002). We extend these studies by utilizing a broad sample of ES implementations and a more distinct and direct information-oriented outcome of the firm's ES.

We encourage future research to evaluate other empirical questions concerning the extent to which accounting technologies, such as ES, impact other types of managerial decisions, information disclosures, or indicators of information quality. While our findings support the assertion that ES improves the internal information environment for management decision making, it is not clear how the presence of ES changes the procedural logic of managerial decisions such as those related to production scheduling (Jacobs and Weston 2007). Related to implications for disclosures, to the extent that ES increase management's confidence in its own information endowment, the wide-ranging nature of information available in ES may also give management the incentive to disclose voluntarily other types of information (Diamond 1985). Future work could look at other voluntary disclosure settings (e.g., conference calls, press releases, enhanced annual reports, etc.) to assess a link between ES and voluntary disclosure. Future studies could also examine whether and how the implementation of an ES facilitates successful reengineering of business processes or corporate wide restructurings.

## Appendix 1

### Factor analyses

| Factors | Component Loading |
|---|---|
| **VOLATILITY** | |
| *CASH FLOW VOLATILITY* | 0.769 |
| *EARNINGS VOLATILITY* | 0.745 |
| *SALES VOLATILITY* | 0.468 |
| **ORGANIZATIONAL CHANGE** | |
| *ASSET GROWTH* | 0.670 |
| *SALES GROWTH* | 0.429 |
| *LEVERAGE* | 0.502 |
| *M&A* | 0.308 |
| **COMPLEXITY** | |
| *SEGMENTS* | 0.478 |
| *FOREIGN TRANSACTIONS* | 0.422 |
| *RESTRUCTURING* | 0.346 |
| **FINANCIAL CHALLENGES** | |
| *ROA* | −0.700 |
| *LOSSES* | 0.501 |
| *R&D* | 0.467 |
| *SI* | 0.422 |

We follow Feng et al. 2009 in the design and construction of these four factors using principal components factor analysis with varimax rotation. We use the resulting factor scores directly in estimation models 1–3. *VOLATILITY* is composed of *CASH FLOW VOLATILITY*, *EARNINGS VOLATILITY*, and *SALES VOLATILITY*. *ORGANIZATIONAL CHANGE* is composed of *ASSET GROWTH*, *SALES GROWTH*, *LEVERAGE*, and *M&A*. *COMPLEXITY* is composed of *SEGMENTS*, *FOREIGN TRANSACTIONS*, and *RESTRUCTURING*. *FINANCIAL CHALLENGES* is composed of *ROA, LOSSES*, *R&D*, and *SPECIAL ITEMS*. We note that both the factor loading of *M&A* and *RESTRUCTURING* are below the conventional component level 0.4 level suggested by Hinkin 1998. We see the cross loadings on other factors are low (the highest being 0.10) with all of loadings more than twice as strong on the appropriate factor than on any other factor, which is a common heuristic for factor loadings (Hinkin 1998). We interpret them on the basis of theory and prior work in this area (Feng et al. 2009). We also run the factor analysis and subsequent factor scores without the *M&A* and *RESTRUCTURING* components and find our factor score and subsequent regression analysis results to be robust.

There are statistical issues associated with the use of binary variables (*M&A* and *LOSSES*) in factor analysis (Drasgow 1988). To address this issue, we computed the tetrachoric correlations between each of the components included in the factor analysis. The tetrachoric correlations estimate what the correlation between the binary variables and between the binary and non-binary variables would be if the binary variables were measured on a continuous scale. We then use the resulting tetrachoric correlation matrix to compute the resulting factor scores and find them to be very similar to our initial reported factor analysis. We then run the subsequent regression analysis with the newly formulated factor scores and find the results to be very similar and the inferences unchanged. For example, in the pre-ES period, the coefficients on both forecast occurrence and forecast error are not significant ($p$-values = 0.682 and 0.405, respectively), but in the post-ES period, ES firms are significantly more likely to issue forecasts ($p$-value = 0.019) and the forecasts are more accurate ($p$-value = 0.010) than non-ES firms. For ease of comprehension for the reader, we report the factor scores and subsequent analysis without the tetrachoric correlation adjustment.

**Variable definitions:**

*CASH FLOW VOLATILITY* = The standard deviation of quarterly operating cash flows over the prior seven years (requiring at least three non-missing observations).

*EARNINGS VOLATILITY* = The standard deviation of quarterly ROA over the prior seven years (requiring at least non-missing observations).

*SALES VOLATILITY* = The standard deviation of quarterly sales over the prior seven years (requiring at least three non-missing observations).

*ASSET GROWTH* = Asset growth from year $t - 1$ to year $t$.

*SALES GROWTH* = Sales growth from year $t - 1$ to year $t$.

*LEVERAGE* = Total liabilities /lagged total assets.

*M&A* = 1 if the firm undertook a large merger or acquisition in year $t$, and 0 otherwise.

*SEGMENTS* = The natural logarithm of the total number of geographic and operating segments.

*FOREIGN TRANSACTIONS* = 1 if the firm has foreign transactions in year $t$, and zero otherwise.

*RESTRUCTURING* = 1 if the firm recognized restructuring charges in year $t$, and zero otherwise.

*ROA* = Earnings before extraordinary items / lagged total assets.

*LOSSES* = 1 if earnings before extraordinary items in year $t$ and $t-1$ sum to less than zero, and 0 otherwise.
*R&D* = Research and development expense / lagged total assets.
*SI* = The absolute value of special items / lagged total assets.

## Appendix 2

### The Calculation of Abnormal Accruals

We use absolute value of discretionary accruals generated by the modified Jones 1991 approach (Dechow, Sloan, and Sweeney 1995). Following Francis, Nanda, and Olsson 2008, we estimate the cross-sectional regression model below for each of the Fama-French 1997 48 industry groups with at least 20 firms in year $t$:

$$\frac{TA_{j,t}}{Asset_{j,t-1}} = \kappa_1 \frac{1}{Asset_{j,t-1}} + \kappa_2 \frac{\Delta Rev_{j,t}}{Asset_{j,t-1}} + \kappa_3 \frac{PPE_{j,t}}{Asset_{j,t-1}} + \varepsilon_{j,t} \quad (8),$$

where:
$TA_{j,t}$ = firm $j$'s total accruals in year $t$, measured as $(\Delta CA_{j,t} - \Delta CL_{j,t} - \Delta Cash_{j,t} + \Delta STDEBT_{j,t} - DEPN_{j,t})$.
$\Delta CA_{j,t}$ = firm $j$'s change in current assets between year $t-1$ and year $t$;
$\Delta CL_{j,t}$ = firm $j$'s change in current liabilities between year $t-1$ and year $t$;
$\Delta Cash_{j,t}$ = firm $j$'s change in cash between year $t-1$ and year $t$;
$\Delta STDEBT_{j,t}$ = firm $j$'s change in debt in current liabilities between year $t-1$ and year $t$;
$DEPN_{j,t}$ = firm $j$'s depreciation and amortization expense in year $t$.
$Asset_{j,t-1}$ = firm $j$'s total assets at the beginning of year $t$.
$\Delta Rev_{j,t}$ = firm $j$'s change in revenues between year $t-1$ and year $t$.
$PPE_{j,t}$ = firm $j$'s gross value of property, plant, and equipment in year $t$.

We use the industry- and year-specific parameter estimates obtained from (8) to estimate firm-specific normal accruals ($NA$) as a percentage of lagged total assets:

$$NA_{j,t} = \hat{\kappa}_1 \frac{1}{Asset_{j,t-1}} + \hat{\kappa}_2 \frac{\Delta Rev_{j,t} - \Delta AR_{j,t}}{Asset_{j,t-1}} + \hat{\kappa}_3 \frac{PPE_{j,t}}{Asset_{j,t-1}} \quad (9),$$

where:
$\Delta AR_{j,t}$ = firm $j$'s change in accounts receivable between year $t-1$ and year $t$.

Abnormal discretionary accruals ($AA_{jt}$) in year $t$ is then calculated as $AA_{j,t} = TA_{j,t} / Asset_{j,t-1} - NA_{j,t}$. Finally, following Kothari, Leone, and Wasley 2005, we performance match the absolute value of $AA_{j,t}$ based on firms' $ROA$. The resulting absolute value of performance matched abnormal accruals, $|AA_{j,t}|$, becomes our second proxy for earnings quality.

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