The Impact of Enterprise Resource Planning (ERP) Systems on the Audit Report Lag

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ABSTRACT: Prior research has shown that the implementation of ERP systems can significantly affect a firm’s business operations and processes. However, scant research has been conducted on the relationship between ERP implementation and the timeliness of external audits, such as audit report lags. While some of the alleged benefits of ERP are closely related to removing impediments contributing to audit report lags, others argue that the complex mechanisms of ERP systems create greater complexity for control and audit. In this paper, we examine the relationship between ERP implementations and audit report lags. The test results indicate that overall, a firm’s ERP implementation is negatively associated with audit report lag. However, this negative association is significant only at the fourth and fifth years after initial ERP implementation. These results imply that the use of ERP systems by client firms may help decrease the audit report lag, but it takes time for the full impact of the firms’ accounting systems to be realized.

Keywords: enterprise resource planning systems; accounting systems; audit report lag.

INTRODUCTION

The primary purpose of this study is to examine the relationship between the implementation of enterprise resource planning (ERP) systems and the timeliness of audited financial statements. Specifically, this study investigates whether the implementation of ERP systems affects the audit report lag, the time period between a company’s fiscal year-end and the date of the audit report.

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It is argued that an ERP system is the most important development in the corporate use of information technology in the 1990s (Davenport 1998). An ERP system is a packaged business software system that enables a company to manage resources (material, human, financial, etc.) more efficiently and effectively by providing an integrated solution for the organization’s information-processing needs (Nah, Lau, and Kuang 2001). Kumar and Hillegersberg (2000) define ERP systems as information system packages that integrate information and information-based processes within and across functional areas in an organization. As a result, ERP systems collect and distribute information more timely and, thus, help managers improve their ability to process and analyze information (Hitt, Wu, and Zhou 2002). Therefore, ERP systems can radically change the way in which accounting information is processed, prepared, audited, and disseminated (Brazel and Dang 2008).

The alleged benefits and widespread usage of ERP systems have motivated many empirical research inquiries over a variety of issues, such as success factors of ERP, post-implementation firm performance, and market reaction. However, a relatively small amount of research has been conducted on how ERP systems affect the external audit. Because an ERP system is typically the most important investment in information technology of corporations, this study can provide useful insight on how information technology (ERP) of a client firm affects the efficiency of external audit, at least to the extent that audit report lag is a good proxy for audit efficiency.

Our research is motivated by several factors concerning the recent audit and IT environment of corporations. First, the usage of ERP systems is now widespread. ERP software packages have become popular, especially for both large and medium-sized organizations, to overcome the limitations of fragmented and incompatible legacy systems (Robey, Ross, and Boudreau 2002). Thus, it is important to thoroughly examine the impacts of ERP systems. However, scant research has been conducted on the relationship between ERP implementation and the timeliness of external audits, such as audit report lags. An interesting aspect of ERP is that even though managers decide to implement ERP systems for their own operational purposes, ERP implementation has also changed the audit environment, affecting the efficiency of audit work. According to Behn, Searcy, and Woodroof (2006), auditors regard inefficient client closing process and consolidation process as important impediments to reduce the audit report lag. Also, they point out that poor integration of different systems within the same company is the biggest system impediment to eliminate the audit lag. However, some prior studies that investigate the characteristics or benefits of ERP imply that those problems can be improved by implementing ERP systems (O’Leary 2004). Thus, it will be interesting to examine the relationship between ERP implementation and the audit report lag.

Second, there are contradicting implications over how advancements in technology or ERP systems affect audit report lag. Issuing new corporate filing requirements in 2002 that reduce the number of days allowed for filings of Forms 10-K and 10-Q, the Securities and Exchange Commission (SEC 2002) argued that advancements in information technology have improved the ability of companies to capture, process, and disseminate their financial information. On the other hand, some studies suggest that ERP systems can deteriorate the internal control mechanism of corporations. For example, Lightle and Vallario (2003) point out that integrated ERP systems provide a single point of control segmentation for segregation of duties, but also provide opportunities for inappropriately configured access privileges that violate internal control guidelines. As poorer internal controls might be positively associated with audit delay (Ashton, Willingham, and Elliott 1987), this control risk can be a factor that leads to longer audit delay. Thus, whether ERP systems implementation affects audit delay positively or negatively is a matter of empirical investigation.

Third, there has been a growing interest in continuous auditing (CA) over the past 20 years, and CA is increasingly under consideration as a tool to enhance the external audit (Kuhn and Sutton 2010). However, theoretically, CA can be realized by reducing time to audit by taking advantage of...
more advanced IT systems, and it is expected that the movement to a CA model will be evolutionary rather than revolutionary (Behn et al. 2006). Even though this paper neither directly relates ERP systems to CA nor argues that ERP systems will realize CA, we think that ERP systems are critical investments of firms in their IT systems and, thus, the development and pervasive use of ERP systems can provide the significant infrastructure necessary for the evolution of the assurance function from the traditional audit to CA (Kuhn and Sutton 2010). In this regard, examining the relationship between ERP implementation and the audit report lag can add empirical evidence on whether ERP systems or advances in information technology of client firms can actually help reduce the time spent by external auditors to complete audit works and, furthermore, whether they can make a contribution to the movement toward CA.

The results of this study suggest that ERP implementation is negatively associated with audit report lag. The test results of the first model indicate that an increase in audit report lags of post-ERP implementation periods for ERP firms is significantly smaller than that of matched firms. On the other hand, it is not likely that ERP systems are associated with audit report lags immediately after those systems are implemented. According to the results of the second model, only the fourth and fifth years after ERP implementation show significant negative coefficients. This result may suggest that it takes time for ERP systems to be fully utilized and to make a significant impact on the firm’s accounting systems.

This study contributes to the research in both the accounting information systems and auditing literatures that examine the effects of ERP systems implementation on a firm’s information environment. What is interesting in our findings is that implementing ERP systems can have unintended effects. Managers decide to implement ERP systems in order to improve operational performances of their firms. However, this paper indicates that implementing ERP systems can affect not only various measures of firms’ performances, but also the external audit, which is generally regarded as something independent of client firms’ decisions. This is the first paper to show empirical evidence that investments in information technology of client firms can make an impact on the efficiency of external audit even though the investment is motivated by the management’s operational purposes. This finding also contributes to auditing literature in that it identifies an additional determinant of the audit report lag, which is the quality of IT systems of client firms. Identifying the determinants of audit delay is meaningful because understanding the determinants of audit delay helps us to better explain the auditing processes or behaviors of auditors. For example, given the results of this study, we may conjecture that external auditors rely, at least partially, on the clients’ IT systems when they collect and process data necessary to carry out their audit tasks. Although Brazel and Dang (2008) report a negative association between ERP implementation and earnings announcement lags, the earnings announcement lag cannot properly reflect the audit delay because it is influenced by management’s incentives (E. Bamber, L. Bamber, and Schoderbek 1993). Thus, our study more directly examines the association between ERP implementation and audit delay. In addition, our study indirectly supports the argument that implementation of ERP systems is positively associated with the effectiveness of internal controls. From the result that ERP implementation is associated with shorter audit report lags, we may conjecture that as ERP systems get effectively utilized, external auditors are likely to regard ERP firms as having stronger internal controls than non-ERP firms. That is because weak internal control indicates high control risk, which may force auditors to conduct more strict audits in order to decrease detection risk, ultimately leading to an increased audit work.

The remainder of this paper is organized as follows: The second section discusses prior research and develops our research question; the third section describes the data-collection process and research methodology; the fourth section presents empirical results; the fifth section discusses the analyses with the 2000s ERP data; and the sixth section concludes by discussing implications, limitations, and further research.
LITERATURE REVIEW AND RESEARCH QUESTION

Audit Report Lag

Relevance, along with reliability, is a primary attribute that makes accounting information useful for decision making (Financial Accounting Standards Board [FASB] 1980), and one of the critical ingredients of relevance is timeliness. Being delayed in releasing financial statements affects the timeliness of information provided (Ashton, Graul, and Newton 1989). Audit delay, which can be measured by audit report lag, is likely to increase the level of uncertainty associated with decisions for which the financial statements provide information and, thus, can ultimately impair the usefulness of these reports (Givoly and Palmon 1982). In general, the concept of timeliness in financial reporting can be defined by two dimensions: the frequency of reporting, which is the length of reporting period, and the reporting lag (Davies and Whittred 1980). This study uses the latter one to examine whether ERP implementations affect the timeliness of financial reports. Thus, the audit report lag in this study is defined as the time period between a firm’s fiscal year-end and the audit report date. For the audit report dates, we have used the dates when auditors sign on the independent auditors’ reports of 10-Ks.

There are numerous studies that investigate the determinants of the audit report lag. One stream of the research on the determinants of the audit report lag is related to auditors. Using Australian data, Whittred (1980) examines the effect of qualified audit reports on the timeliness of annual reports. The results show that qualifications are positively associated with delay in releasing preliminary profits and final annual reports. They also indicate that the more serious the qualification is, the greater the audit report lag is. He argues that this result is due to the increase in time spent for the year-end audit and auditor-client negotiations. Newton and Ashton (1989) examine the relationship between audit structure and audit delay for Canadian Big 8 firms, and find that auditors using structured audit approaches tend to have greater audit report lag than auditors using unstructured approaches. Knechel and Payne (2001) relate audit report lag to incremental audit hours, resource allocation of audit team effort, and provision of nonaudit services. Their results indicate that the presence of controversial tax issues and the use of less experienced audit staff are positively correlated with audit report lag.

Another research stream on the determinants of the audit report lag is related to the characteristics of client firms. Using the U.S. firm data, Givoly and Palmon (1982) show that the reporting lag of individual firms seems to be more closely related to industry patterns and tradition, rather than to firm attributes such as size and complexity of operations. Using data from an international accounting firm, Ashton et al. (1987) investigate the relationship between the audit report lag and 14 different firm attributes. Among these attributes, five variables show significant relationship with the report lag: total revenue representing firm size, quality of internal control, public company, operation complexity, and relative amount of interim work. On the other hand, Ashton et al. (1989) examine cross-sectional variability in audit delay with a sample of Canadian firms. They test eight variables and the results indicate that firm size (total asset), industry (financial service), negative net income, and the existence of extraordinary items are significantly related to audit delay. Bamber et al. (1993) try to propose a more comprehensive model of audit report lag, and emphasize the importance of the amount of audit work required, the level of resources expended to complete the audit, and the audit firm technology. The results show that the explanatory power of their model is almost three times greater than that of previous models.

Besides these studies, Krishnan and Yang (2009) explore the trends in audit report lags and earning announcement lags, and examine the quality of reporting for the period from 2001 to 2006. The results show that although the filing lags decreased after 2003, when the new corporate filing requirements became effective, audit lags increased substantially following the new rules,
particularly in 2004 and 2005 with the introduction of Sarbanes-Oxley (SOX) Section 404. On the other hand, the long audit report lags do not seem to be associated with lower quality of reporting, measured by absolute value of discretionary accruals and quality of accruals. Table 1 exhibits the determinants of the audit report lag that have been identified as significant in some of the prior studies.

**Enterprise Resource Planning (ERP) Systems**

Empirical research related to ERP systems can be broadly divided into four streams. First, several studies explore the impacts of ERP systems on corporations. Deloitte Consulting’s (1998) study suggests the rationale and specific benefits of implementing ERP, and O’Leary (2004) identifies tangible and intangible benefits. Table 2 presents parts of benefits reported on Deloitte Consulting (1998) and O’Leary (2004). However, Granlund and Malmi (2002) argue that ERP systems have led to relatively small changes in management accounting and control procedures.

Second, a significant amount of ERP research has identified the factors necessary for a successful ERP implementation and an effective ongoing usage. Through an extensive literature review, Nah et al. (2001) identify 11 critical factors for the success of ERP projects; among those are the teamwork and composition of the ERP project team, top management support, business process reengineering, and effective communication. Bradley (2008) examines success factors using the classical management theory. The author suggests that a proper project manager, personnel training, and the presence of a champion are important to implement ERP systems successfully. In addition, the organizational culture and top management leadership, including

<table>
<thead>
<tr>
<th>TABLE 1</th>
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<tbody>
<tr>
<td><strong>Determinants of Audit Report Lag</strong></td>
</tr>
<tr>
<td><strong>Audit Client Related</strong></td>
</tr>
<tr>
<td>- Client size</td>
</tr>
<tr>
<td>- Net loss</td>
</tr>
<tr>
<td>- Poor financial condition</td>
</tr>
<tr>
<td>- Extraordinary Item</td>
</tr>
<tr>
<td>- Operational complexity</td>
</tr>
<tr>
<td>- Public company</td>
</tr>
<tr>
<td>- Mgmt. incentive to provide timely reports</td>
</tr>
<tr>
<td>- Quality of internal control</td>
</tr>
<tr>
<td>- Industry (financial)</td>
</tr>
<tr>
<td><strong>Auditor Related</strong></td>
</tr>
<tr>
<td>- Opinion qualification</td>
</tr>
<tr>
<td>- Audit technology</td>
</tr>
<tr>
<td>- Audit team allocation (partner or manager)</td>
</tr>
<tr>
<td>- Year-end (Dec. or Dec. and Jan.)</td>
</tr>
<tr>
<td>- Interim work</td>
</tr>
<tr>
<td><em>(1)</em>: Ashton et al. (1987), data of international accounting firm.</td>
</tr>
<tr>
<td><em>(2)</em>: Ashton et al. (1989), data of Canadian firms.</td>
</tr>
<tr>
<td><em>(4)</em>: Bamber et al. (1993), data of U.S. firms.</td>
</tr>
<tr>
<td><em>(5)</em>: Knechel and Payne (2001), data of international accounting firm.</td>
</tr>
<tr>
<td><em>(6)</em>: Krishnan and Yang (2009), data of U.S. firms.</td>
</tr>
</tbody>
</table>
strategic and tactical conducts, appear to be significantly associated with successful ERP implementation (Ke and Wei 2008).

Third, a stream of research investigates the relationship between ERP implementation and post-implementation firm performance. Research findings show mixed results on this association. For example, Poston and Grabski (2001) find no positive relation between ERP implementation and overall post-implementation financial performance, but Hunton, Lippincott, and Reck (2003) find that although the financial performance of ERP adopters does not change much, performances of non-ERP adopters tend to decrease compared to those of ERP adopters. Nicolaou (2004) indicates that ERP implementation has a positive association with a long-term financial performance, and this relation is stronger when implementation characteristics are controlled. Nicolaou and Bhattacharya (2006, 2008) also show that both the timing of ERP customizations and carrying of such modifications in conformity with the adopting organizations’ strategic objectives increase post-implementation operational performance.

Finally, prior studies have found that, in general, the market reacts positively to announcements of ERP implementation. Hayes, Hunton, and Reck (2001) have found the overall positive reaction to initial ERP announcements measured by standard cumulative abnormal returns. This positive reaction seems to be more significant when firms are small and healthy and when the ERP vendors are large. Hunton, McEwen, and Wier (2002) show that analysts react to ERP implementation plans by revising their earnings forecasts positively. Consistent with Hayes et al. (2001), this tendency is stronger when firms are financially healthy.

**Research Question**

Key characteristics of ERP systems are integration, standardization, routinization, and centralization. These attributes allow managers to access more comprehensive information on a near real-time basis so that they can make better decisions. However, implementation of ERP systems affects not only internal information processes, but also external audit environment. Using ERP systems, firms can integrate data from different departments or business segments, standardize data, improve financial control, and reduce financial closing cycles and data-entry mistakes (O’Leary 2004). These benefits have potential to remove the main impediments recognized by auditors for the audit delay, such as poor integration of different systems, poor standardization of data, poor financial control, and inefficient financial closing (Behn et al. 2006). Thus, the alleged benefits of ERP systems can imply that the audit report lags are likely to decrease by implementing ERP.

**TABLE 2**

<table>
<thead>
<tr>
<th>Tangible Benefits</th>
<th>Intangible Benefits</th>
</tr>
</thead>
<tbody>
<tr>
<td>Inventory Reduction</td>
<td>Information Access/Visibility</td>
</tr>
<tr>
<td>Personnel Reduction</td>
<td>New Improved Processes</td>
</tr>
<tr>
<td>Productive Improvements</td>
<td>Customer Responsiveness</td>
</tr>
<tr>
<td>Order Management Improvements</td>
<td>Integration</td>
</tr>
<tr>
<td>Financial Close Cycle Reduction</td>
<td>Standardization</td>
</tr>
<tr>
<td>IT Cost Reduction</td>
<td>New Reports/Reporting Capability</td>
</tr>
<tr>
<td>Cash Management Improvement</td>
<td>Sales Automation</td>
</tr>
<tr>
<td>Revenue/Profit Increases</td>
<td>Financial Control</td>
</tr>
<tr>
<td>Maintenance Reductions</td>
<td>No Redundant Data Entry</td>
</tr>
</tbody>
</table>

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In addition, Morris (2011) finds that ERP firms are less likely to report internal control weaknesses under SOX Section 404. This may imply that external auditors are more likely to regard ERP firms as having stronger internal controls compared to non-ERP firms. According to the audit risk model suggested by the AU Section 312 (American Institute of Certified Public Accountants [AICPA] 2007), audit risk consists of inherent risk, control risk, and detection risk. Thus, if control risk is low, auditors can increase detection risk, maintaining the same level of overall audit risk. Then, *ceteris paribus*, auditors can carry out audit tasks less strictly and, thus, the amount of year-end audit work will decrease. As a result, the audit report lag is likely to decrease. Therefore, we might conjecture that ERP implementation can lead to shorter audit report lag. In fact, Ettredge, Li, and Sun (2006) report an association between material weakness in internal control and audit delay. With the introduction of SOX Section 404, attestation of corporate internal control by auditors and managers became mandatory. Using data on internal control assessments over financial reporting, Ettredge et al. (2006) find that the presence of material internal control weakness is associated with longer audit delay. Also, Pae and Yoo (2001) present a model that shows that when the auditor’s legal liability is large, the client firm underinvests in the internal control system and, thus, the auditor overinvests effort, leading to a decrease in audit efficiency.

However, some others are against this argument. Grabski, Leech, and Schmidt (2011) say that the hidden and complex mechanisms of ERP systems create greater complexity for control and audit. Lightle and Vallario (2003) point out that integrated ERP systems provide a single point of control segmentation for segregation of duties, but also provide opportunities for inappropriately configured access privileges to violated internal control guidelines. These studies imply that ERP implementation can rather increase the overall control risk. In fact, we have witnessed that several firms had experienced serious problems in the process of implementing advanced information systems. For example, building and implementing a new system known as “Pulse,” Oxford Health Plans experienced critical problems that led to being nearly out of control on its various business processes (Hammonds and Jackson 1997). Thus, if we apply the same logic of the audit risk model mentioned earlier, it might be expected that ERP implementation is associated with longer audit report lag.

It is, therefore, an empirical question whether ERP implementation affects audit report lag positively or negatively. This paper seeks to provide empirical evidence on this issue. Thus, the research question examined in this study is:

**RQ:** Is there an association between ERP implementation and audit report lag?

**RESEARCH DESIGN**

**Sample Selection**

We used the original Nicolaou (2004) data set of ERP and non-ERP firms in order to examine our research question. For collecting ERP data, a two-phase process was employed to identify the sample of ERP firms. First, ERP firms were identified by extracting ERP implementation announcements from the Lexis-Nexis Academic Universe (News) Wire Service Reports for the period of January 1, 1990 through December 31, 1998. Following Hayes et al. (2001), we employed a keyword search method using a combination of the search terms “implement,” “convert,” and “contract” with the name of each of the following ERP vendors: Adage, BAAN, Epicor, GEAC SmartStream, Great Plains, Hyperion, Intentia International, JBA International, JD Edwards, Lawson, Oracle Financials, PeopleSoft, QAD, SAP, SSA, or SCT. This keyword search method yielded an initial sample of 1,825 announcements. After eliminating announcements that are not related to ERP implementation, a total of 332 announcements remained. Second, the Global
Disclosure database was searched for any mention of ERP system implementation in annual reports and SEC filings. The search term of “enterprise resource planning” was applied to the full text of 10-Ks and 10-Qs for the time period from January 1, 1990 to February 28, 1999. The initial search identified 1,453 documents. Subsequently, each of these documents was examined individually. Finally, this process resulted in 131 valid ERP implementation-related disclosures. These 131 disclosures are all from firms that are not included in the original Lexis-Nexis Newswires search. Thus, a total of 463 firms were identified to have implemented ERP systems in the sample period through our two-phase process. It is also important to notice that all of these announcements or SEC filings are related to initial implementations of ERP systems, thus providing important information on ERP adopters.

A subsequent cross-match with the “Global Vantage Key” (GVKEY) file from the Research Insight database resulted in the elimination of 142 firms. Furthermore, 67 firms were eliminated because financial data for these firms were not available in the Compustat database. In addition, five foreign firms were excluded, along with two other firms that reported discontinued ERP projects. After these elimination processes, we had the final sample of 247 firms. The paired t-test results indicate that the two groups from different data sources are not significantly different in terms of size, measured by total assets and net sales. Panel A of Table 3 presents the distribution of the final sample of 247 firms by year and source, while Panel B presents the distribution of ERP firms by industry.

Identification of ERP Adoption and ERP Completion Year

ERP project completion time is defined as the system go-live date, the time point at which the system gets ready to use. Of the 247 firms included in the final sample, only 105 firms disclosed both the start and completion years of the ERP implementation. For the 142 sample firms that did not disclose a completion year, it was assumed that their expected completion time was equal to the mean expected completion time of 9.92 months, which is based on reporting by 72 firms from the original Lexis-Nexis Newswires sample and 89 firms from the original Global Disclosure database sample that reported expected completion times. The year of completion was coded as the time period “t0” to indicate that this is the starting year of ERP use.

Matching Procedure

Following Barber and Lyon (1996), each ERP firm was matched with a control group company on both industry and size at the year preceding the ERP adoption year (time \( t-1 \)). Firms were first matched by the four-digit Standard Industrial Classification (SIC) code, and then matched by total assets. There were some instances where it was necessary to go beyond the four-digit SIC code. For such cases, firms were matched using a three-digit code. Also, an inability to find proper U.S. matches for certain unique firms resulted in five lost firms; an example of one such firm is Boeing. As a result, the sample that has been actually used for subsequent analyses consisted of only 242 firms.

In order to validate the soundness of the matching procedure, we performed a search of the Lexis-Nexis Newswires and the websites of the major ERP vendors. Through this procedure, we could find that 12 firms that were originally included in the non-ERP matched group had actually implemented ERP systems. These 12 firms were substituted with other non-ERP firms. Furthermore, a graduate assistant called the IT director or other person in charge of system implementation to make sure that the firms selected as non-ERP matched firms are actually not ERP adopters. This procedure eliminated 38 firms that either did not respond or responded that they had implemented an ERP system in the recent past. These firms were also substituted with others.
Audit Report Lag Data

The data for audit report lags were manually collected with all available 10-Ks of ERP firms and matched firms for the time period from January 1, 1994 to December 31, 2006. Because 10-Ks before 1994 were not available and the time period of our ERP sample data is up to 1998, the time period of 1994 to 2006 was used. Initially, 4,330 firm-years were collected: 1,927 firm-years for

Table 3
Sample Selection and Identification of ERP firms

Panel A: Distribution of ERP Implementations by Year in Sample Period

<table>
<thead>
<tr>
<th>Implementation Year</th>
<th>Number of Valid ERP Announcements</th>
<th>Number of ERP Firms with GVKEY Identification</th>
<th>Number of ERP Firms with Available Data in Compustat</th>
</tr>
</thead>
<tbody>
<tr>
<td>Source: Lexis-Nexis Newswires</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>98</td>
<td>141</td>
<td>69</td>
<td>52</td>
</tr>
<tr>
<td>97</td>
<td>83</td>
<td>55</td>
<td>44</td>
</tr>
<tr>
<td>96</td>
<td>43</td>
<td>30</td>
<td>21</td>
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<tr>
<td>95</td>
<td>19</td>
<td>15</td>
<td>11</td>
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<tr>
<td>94</td>
<td>32</td>
<td>19</td>
<td>17</td>
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<tr>
<td>93</td>
<td>3</td>
<td>4</td>
<td>2</td>
</tr>
<tr>
<td>92</td>
<td>4</td>
<td>4</td>
<td>4</td>
</tr>
<tr>
<td>91</td>
<td>3</td>
<td>2</td>
<td>2</td>
</tr>
<tr>
<td>90</td>
<td>4</td>
<td>2</td>
<td>2</td>
</tr>
<tr>
<td>Sum</td>
<td>332</td>
<td>200</td>
<td>155</td>
</tr>
<tr>
<td>Source: Global Disclosure</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>98</td>
<td>49</td>
<td>46</td>
<td>39</td>
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<tr>
<td>97</td>
<td>66</td>
<td>62</td>
<td>41</td>
</tr>
<tr>
<td>96</td>
<td>12</td>
<td>10</td>
<td>8</td>
</tr>
<tr>
<td>90–95</td>
<td>4</td>
<td>3</td>
<td>4</td>
</tr>
<tr>
<td>Sum</td>
<td>131</td>
<td>121</td>
<td>92</td>
</tr>
<tr>
<td>Grand Sum</td>
<td>463</td>
<td>321</td>
<td>247</td>
</tr>
</tbody>
</table>

Panel B: Distribution of ERP Firms by Industry

ERP Firms Represented by the Following SIC Codes | Number of Firms |
<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>0700—Agricultural Services</td>
<td>3</td>
</tr>
<tr>
<td>1000—Mining, Construction</td>
<td>5</td>
</tr>
<tr>
<td>2000—Manufacturing</td>
<td>56</td>
</tr>
<tr>
<td>3000—Manufacturing</td>
<td>127</td>
</tr>
<tr>
<td>4000—Transportation, Communications, Utilities</td>
<td>12</td>
</tr>
<tr>
<td>5000—Wholesale and Retail Trade</td>
<td>18</td>
</tr>
<tr>
<td>6000—Finance, Insurance, Real Estate</td>
<td>10</td>
</tr>
<tr>
<td>7000—Services</td>
<td>14</td>
</tr>
<tr>
<td>8000—Health Services</td>
<td>2</td>
</tr>
<tr>
<td>9000—Public Institutions</td>
<td>0</td>
</tr>
<tr>
<td>Total</td>
<td>247</td>
</tr>
</tbody>
</table>

Audit Report Lag Data

The data for audit report lags were manually collected with all available 10-Ks of ERP firms and matched firms for the time period from January 1, 1994 to December 31, 2006. Because 10-Ks before 1994 were not available and the time period of our ERP sample data is up to 1998, the time period of 1994 to 2006 was used. Initially, 4,330 firm-years were collected: 1,927 firm-years for
ERP firms and 2,403 firm-years for matched firms. Eliminating the firm-years whose control variables used in our models were missing resulted in the decrease of our sample size to 3,710 firm-years. In addition, we deleted firm-years that are more than five years earlier or more than five years later than the ERP completion year. This elimination gave us a final sample of 3,225 firm-years. The final numbers of firm-years for ERP firms and for non-ERP firms are 1,616 and 1,609, respectively. In the case of ERP firms, the number of firm-years for the pre-ERP period is 863 and that of the post-ERP period is 753. As to non-ERP firms, the number of firm-years for the pre-ERP period is 673 and that of the post-ERP period is 936. Panels A and B of Table 4 describe the distribution of firm-years for audit report lag data.

Model Specification

We have tested the association between ERP implementation and audit report lag by estimating log-normal duration models. The standard log-normal model is based on the assumption that the durations follow a log-normal distribution with density function:

$$f(t) = \frac{1}{bt} \phi\left(\frac{\log(t) - a}{b}\right), \quad b > 0,$$

where $\phi$ and $\Phi$ denote the standard normal density and distribution functions, respectively:

$$\phi(t) = \frac{1}{\sqrt{2\pi}} \exp\left(-\frac{t^2}{2}\right) \quad \text{and} \quad \Phi(t) = \int_0^t \phi(\tau)d\tau.$$

The survivor function and transition rate functions are:

$$G(t) = 1 - \phi\left(\frac{\log(t) - a}{b}\right),$$

$$r(t) = \frac{1}{bt} \frac{\phi(z_t)}{1 - \Phi(z_t)} \quad \text{with} \quad z_t = \frac{\log(t) - a}{b},$$

where $a = Ax$ and $b = \exp(B\beta)$. $A$ and $B$ denote covariate vectors introduced into the model. It is assumed that the first component of each of the covariate (row) vectors $A$ and $B$ is a constant equal to 1. The associated coefficient vectors $x$ and $\beta$ are the model parameters to be estimated (Blossfeld, Golsch, and Rohwer 2007).

There are several reasons why we chose a log-normal model. First, a simple OLS model is not appropriate for this study since the audit report lag is positively skewed (Krishnan and Yang 2009), which is a violation of one of the OLS assumptions for hypothesis testing. Second, transformation of data can be avoided if we use a log-normal model. Some prior studies, such as Krishnan and Yang (2009) and Ashton et al. (1987, 1989), use the logarithmic transformation to address the normality issue. However, we try to avoid this transformation since transformation of data can be a distortion of data. Third, a log-normal model is a member of the class of accelerated failure time models that can be interpreted in terms of time duration. Audit report lag is time duration measured by number of days. Thus, it appears to be appropriate for this type of study. Last, the hazard ratio graph of our data has the property that the transition rate initially increases with time to the maximum and then decreases, which is consistent with the shape of log-normal transition rate graphs. A log-normal model is widely used when the transition rate at first increases and then, after reaching a maximum, decreases (Blossfeld et al. 2007). For example, Levinthal and Fichman (1988) examine auditor-client relationships to explore the dynamics of interorganizational relations.
by estimating a log-normal model. They find that interorganizational attachments have positive duration dependence in the initial years of attachment and negative duration dependence for longer durations. In particular, the results show that the hazard rate of dissolution in the early stages of attachments increases with time, and after this honeymoon period, the rate declines as the tenure of

* Denotes ERP project completion year.
the attachment increases. Bucklin and Sismeiro (2003) have also used the log-normal model to explore the browsing behavior of visitors to a website. This study focuses on two basic elements of browsing behavior: a user’s decision to continue browsing or to exit the site, and the length of time spent for each page. They specify a log-normal model for examining page-view durations, and the results indicate that the browsing patterns of the website users are consistent with learning effects, site stickiness, time constraints, and cost-benefit tradeoffs.¹

We have two models to provide empirical evidence on our research question. In the first model, the independent variable of our interest is AfterERP, which is an interaction term of two indicator variables, ERP and After. The variable ERP is an indicator variable that takes 1 if a firm-year is for an ERP firm, and 0 otherwise. The variable After is also an indicator variable that takes 1 if a firm-year belongs to post-ERP period, and 0 otherwise. Thus, the variable AfterERP takes 1 only if a firm-year is one of the post-ERP firm-years for ERP firms. Consequently, by using an interaction term, we can examine the difference of differences, and the coefficient of AfterERP shows how much audit report lags of ERP firms change compared to the change in audit report lags of non-ERP firms.

However, it is not likely that ERP systems make a significant impact on the firms right away, as soon as they become implemented. The results of Nicolaou (2004) suggest that it takes time for ERP systems to significantly affect the accounting systems of companies. Thus, in the second model, we divide the variable AfterERP into five post-ERP years (from AfterERP1 to AfterERP5) so that we can examine how long it takes for ERP systems to get associated with the audit report lag.

In addition, both models include various control variables that seem to have a significant impact on audit report lag in prior research. Givoly and Palmon (1982) report that report lag appears to be associated with industry patterns and tradition, and other studies indicate that different industries are a significant factor that affects audit report lag (Ashton et al. 1989; Newton and Ashton 1989; Bamber et al. 1993; Krishnan and Yang 2009). Thus, following Krishnan and Yang (2009), we included four indicator variables to control different practices and accounting rules across industries: HighLit, which represents high-litigation industries, HighGrowth, which represents high-growth industries, Financial, which represents financial services industries, and HighTech, which represents high-tech industries. Prior studies found accounting or firm complexity to be a significant determinant for audit report lag (Ashton et al. 1987, 1989; Newton and Ashton 1989; Bamber et al. 1993; Krishnan and Yang 2009). Thus, to control the different degrees of complexity in the firms’ accounting and operations, we included variables that represent the number of business segments (NumSegment), the existence of extraordinary items (ExtraItem), and the existence of foreign operations (ForeignOper). We also included Size and Auditor to control different firm size and audit firm effects. In addition, we controlled different fiscal year-ends by including BusyEnd, which is an indicator variable that distinguishes firms whose fiscal year-end is December or January from firms whose fiscal year-end is the other months. Furthermore, financial distress seems to affect the audit report lag (Ashton et al. 1989; Bamber et al. 1993; Krishnan and Yang 2009). Financial distress is proxied by variables representing negative earnings (Loss) and debt to total asset ratio (Leverage). Audit opinion is also found to be a significant determinant in several prior studies (Bamber et al. 1993; Krishnan and Yang 2009). We have captured audit opinion with the variable of AuditOpi.² Finally, we controlled the time

¹ Log-normal models have been also employed for studies in other disciplines such as medicine, food science, and zoology (Strum, May, and Vargas 2000; McCready et al. 2000; Gamel and McLean 1994; Hough, Langoir, Gomez, and Curia 2003; Aragao, Corradini, Normand, and Peleg 2007; Tokeshi 1990; Tolkamp and Kyriazakis 1999).
² The indicator variable AuditOpi takes 1 if the firm receives an other-than-clean opinion, 0 otherwise. We used “AUOP” (Auditor Opinion) item in Compustat for this variable. When constructing this variable, we coded only “unqualified opinion” as clean opinion, and “unqualified opinion with additional language” was not coded as clean opinion because the additional language can affect the time that auditors need to spend to complete the audit.
trend of audit report lags by including year dummies. Table 5 summarizes the definitions of variables used in this study.

RESULTS

Descriptive Statistics

Table 6 reports the descriptive statistics, where Panels A, B, and C display the distributional properties of the variables used in this study. Panel A shows the descriptive statistics of all samples, including both ERP firms and non-ERP firms. The mean of audit report lags is 46.2 days. This figure is similar to means of lags of year 2001 or year 2002 of Krishnan and Yang (2009) data, and about 22 days shorter than one reported in Knechel and Payne (2001), who use data of year 1991. Also, the descriptive statistics indicate that about 60 percent of firm-years have fiscal year-end months of December or January, and more than 90 percent of firm-years were audited by one of the Big 6 auditors. Also, less than 30 percent of firm-years received other than clean opinions from auditors. Panel B exhibits the descriptive statistics of ERP firms versus non-ERP firms. The descriptive statistics indicate that ERP firms are bigger than non-ERP firms, more likely to have foreign operations and have fewer business segments. The audit report lags of the two samples do not seem to be different, on average. Panel C presents descriptive statistics of pre- and post-ERP implementation periods. Numerous variables of the post-ERP implementation period are

<p>| TABLE 5 |</p>
<table>
<thead>
<tr>
<th>Variable Definitions</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Audit Report Lag</strong> = number of days from the fiscal year-end to the audit report date;</td>
</tr>
<tr>
<td><strong>ERP</strong> = 1 if the firm is in the ERP firm data, 0 otherwise;</td>
</tr>
<tr>
<td><strong>After</strong> = 1 if the firm-year is a post-ERP implementation year, 0 otherwise;</td>
</tr>
<tr>
<td><strong>AfterERP</strong> = interaction term of ERP and After;</td>
</tr>
<tr>
<td><strong>After1 to After5</strong> = indicator variables representing the first, second, third, fourth, and fifth year after the ERP project completion year, respectively;</td>
</tr>
<tr>
<td><strong>AfterERP1 to AfterERP5</strong> = interaction terms between ERP and After1 to After5, respectively;</td>
</tr>
<tr>
<td><strong>HighLit</strong> = 1 if the firm belongs to industries 28, 35, 36, 38, 60, 67, and 73 (two-digit SIC code), 0 otherwise;</td>
</tr>
<tr>
<td><strong>HighGrowth</strong> = 1 if the firm belongs to industries 35, 45, 48, 49, 52, 57, 73, 78, and 80 (two-digit SIC code), 0 otherwise;</td>
</tr>
<tr>
<td><strong>Financial</strong> = 1 if the firm belongs to industries 60–67 (two-digit SIC code), 0 otherwise;</td>
</tr>
<tr>
<td><strong>HighTech</strong> = 1 if the firm belongs to industries 283, 284, 357, 366, 367, 371, 382, 384, and 737 (three-digit SIC code), 0 otherwise;</td>
</tr>
<tr>
<td><strong>NumSegment</strong> = the number of business segments (Compustat historical segments file);</td>
</tr>
<tr>
<td><strong>ExtraItem</strong> = 1 if the firm reports extraordinary items, 0 otherwise;</td>
</tr>
<tr>
<td><strong>Size</strong> = natural log of total assets;</td>
</tr>
<tr>
<td><strong>BusyEnd</strong> = 1 if the firm’s fiscal year ends in December or January, 0 otherwise;</td>
</tr>
<tr>
<td><strong>Loss</strong> = 1 if the firm reports a loss before extraordinary items, 0 otherwise;</td>
</tr>
<tr>
<td><strong>Leverage</strong> = debt to total assets ratio;</td>
</tr>
<tr>
<td><strong>Auditor</strong> = 1 if the firm is audited by a Big 6 auditor, 0 otherwise;</td>
</tr>
<tr>
<td><strong>AuditOpi</strong> = 1 if the firm receives an other than clean opinion, 0 otherwise (Compustat item “AUOP”);</td>
</tr>
<tr>
<td><strong>ForeignOper</strong> = 1 if the firm has foreign operations, 0 otherwise; and</td>
</tr>
<tr>
<td><strong>GC</strong> = 1 if the firm receives a going concern opinion, 0 otherwise (Audit Analytics).</td>
</tr>
</tbody>
</table>
### TABLE 6
Descriptive Statistics

#### Panel A: Distributional Properties of Variables (All Sample), n = 3,225

<table>
<thead>
<tr>
<th>Variable</th>
<th>Mean</th>
<th>Median</th>
<th>Std. Dev.</th>
<th>1Q</th>
<th>3Q</th>
</tr>
</thead>
<tbody>
<tr>
<td>Audit Report Lag</td>
<td>46.244</td>
<td>41</td>
<td>33.002</td>
<td>29</td>
<td>54</td>
</tr>
<tr>
<td>ERP</td>
<td>0.501</td>
<td>1</td>
<td>0.5</td>
<td>0</td>
<td>1</td>
</tr>
<tr>
<td>After</td>
<td>0.523</td>
<td>1</td>
<td>0.499</td>
<td>0</td>
<td>1</td>
</tr>
<tr>
<td>AfterERP</td>
<td>0.233</td>
<td>0</td>
<td>0.423</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>After1</td>
<td>0.116</td>
<td>0</td>
<td>0.32</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>After2</td>
<td>0.108</td>
<td>0</td>
<td>0.311</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>After3</td>
<td>0.105</td>
<td>0</td>
<td>0.307</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>After4</td>
<td>0.1</td>
<td>0</td>
<td>0.3</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>After5</td>
<td>0.092</td>
<td>0</td>
<td>0.289</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>HighLit</td>
<td>0.465</td>
<td>0</td>
<td>0.498</td>
<td>0</td>
<td>1</td>
</tr>
<tr>
<td>HighGrowth</td>
<td>0.222</td>
<td>0</td>
<td>0.415</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Financial</td>
<td>0.026</td>
<td>0</td>
<td>0.16</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>HighTech</td>
<td>0.34</td>
<td>0</td>
<td>0.473</td>
<td>0</td>
<td>1</td>
</tr>
<tr>
<td>NumSegment</td>
<td>2.47</td>
<td>2</td>
<td>1.904</td>
<td>1</td>
<td>4</td>
</tr>
<tr>
<td>ExtrItem</td>
<td>0.143</td>
<td>0</td>
<td>0.35</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Size</td>
<td>6.453</td>
<td>6.386</td>
<td>1.948</td>
<td>4.977</td>
<td>7.829</td>
</tr>
<tr>
<td>BusyEnd</td>
<td>0.622</td>
<td>1</td>
<td>0.484</td>
<td>0</td>
<td>1</td>
</tr>
<tr>
<td>Loss</td>
<td>0.267</td>
<td>0</td>
<td>0.442</td>
<td>0</td>
<td>1</td>
</tr>
<tr>
<td>Leverage</td>
<td>0.964</td>
<td>0.557</td>
<td>19.225</td>
<td>0.386</td>
<td>0.715</td>
</tr>
<tr>
<td>Auditor</td>
<td>0.908</td>
<td>1</td>
<td>0.287</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>AudOpi</td>
<td>0.294</td>
<td>0</td>
<td>0.455</td>
<td>0</td>
<td>1</td>
</tr>
<tr>
<td>Foreign</td>
<td>0.584</td>
<td>1</td>
<td>0.492</td>
<td>0</td>
<td>1</td>
</tr>
</tbody>
</table>

#### Panel B: Distributional Properties of Variables (ERP Firm Sample versus Matched Firm Sample)a

<table>
<thead>
<tr>
<th>Variable</th>
<th>ERP Firm Sample, n = 1,616</th>
<th>Matched Firm Sample, n = 1,609</th>
</tr>
</thead>
<tbody>
<tr>
<td>Audit Report Lag</td>
<td>44.939 41 29.096 29 54.553 41 36.47 30 55</td>
<td></td>
</tr>
<tr>
<td>After</td>
<td>0.465 0 0.498 0 1 0.581 1 0.493 0 1</td>
<td></td>
</tr>
<tr>
<td>After1</td>
<td>0.112 0 0.316 0 0 0.12 0 0.325 0 0</td>
<td></td>
</tr>
<tr>
<td>After2</td>
<td>0.096 0 0.295 0 0 0.12 0 0.325 0 0</td>
<td></td>
</tr>
<tr>
<td>After3</td>
<td>0.093 0 0.291 0 0 0.118 0 0.322 0 0</td>
<td></td>
</tr>
<tr>
<td>After4</td>
<td>0.086 0 0.28 0 0 0.114 0 0.319 0 0</td>
<td></td>
</tr>
<tr>
<td>After5</td>
<td>0.077 0 0.267 0 0 0.107 0 0.309 0 0</td>
<td></td>
</tr>
<tr>
<td>HighLit</td>
<td>0.454 0 0.498 0 1 0.476 0 0.499 0 1</td>
<td></td>
</tr>
<tr>
<td>HighGrowth</td>
<td>0.219 0 0.414 0 0 0.224 0 0.417 0 0</td>
<td></td>
</tr>
<tr>
<td>Financial</td>
<td>0.038 0 0.192 0 0 0.014 0 0.118 0 0</td>
<td></td>
</tr>
<tr>
<td>HighTech</td>
<td>0.334 0 0.471 0 1 0.346 0 0.475 0 1</td>
<td></td>
</tr>
<tr>
<td>NumSegment</td>
<td>2.401 1 1.897 1 3 2.54 2 1.9089 1 4</td>
<td></td>
</tr>
<tr>
<td>ExtrItem</td>
<td>0.136 0 0.343 0 0 0.149 0 0.356 0 0</td>
<td></td>
</tr>
<tr>
<td>BusyEnd</td>
<td>0.624 1 0.484 0 1 0.621 1 0.485 0 1</td>
<td></td>
</tr>
<tr>
<td>Loss</td>
<td>0.255 0 0.436 0 1 0.28 0 0.449 0 1</td>
<td></td>
</tr>
<tr>
<td>Leverage</td>
<td>0.562 0.562 0.265 0.379 0.718 1.368 0.55 27.215 0.39 0.714</td>
<td></td>
</tr>
<tr>
<td>Auditor</td>
<td>0.916 1 0.276 1 1 0.901 1 0.298 1 1</td>
<td></td>
</tr>
<tr>
<td>AudOpi</td>
<td>0.3 0 0.458 0 1 0.288 0 0.453 0 1</td>
<td></td>
</tr>
<tr>
<td>Foreign</td>
<td>0.621 1 0.485 0 1 0.546 1 0.497 0 1</td>
<td></td>
</tr>
</tbody>
</table>

(continued on next page)
TABLE 6 (continued)

Panel C: Distributional Properties of Variables (Pre-ERP versus Post-ERP)\(^a\)

<table>
<thead>
<tr>
<th>Variable</th>
<th>Pre-ERP Implementation, n = 1,536</th>
<th>Post-ERP Implementation, n = 1,689</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Mean</td>
<td>Median</td>
</tr>
<tr>
<td>Audit Report Lag</td>
<td>44.033</td>
<td>40</td>
</tr>
<tr>
<td>ERP</td>
<td>0.561</td>
<td>1</td>
</tr>
<tr>
<td>HighLit</td>
<td>0.439</td>
<td>0</td>
</tr>
<tr>
<td>HighGrowth</td>
<td>0.209</td>
<td>0</td>
</tr>
<tr>
<td>Financial</td>
<td>0.033</td>
<td>0</td>
</tr>
<tr>
<td>HighTech</td>
<td>0.317</td>
<td>0</td>
</tr>
<tr>
<td>NumSegment</td>
<td>2.008</td>
<td>1</td>
</tr>
<tr>
<td>ExtraItem</td>
<td>0.107</td>
<td>0</td>
</tr>
<tr>
<td>BusyEnd</td>
<td>0.608</td>
<td>0</td>
</tr>
<tr>
<td>Loss</td>
<td>0.203</td>
<td>0</td>
</tr>
<tr>
<td>Leverage</td>
<td>0.6</td>
<td>0.555</td>
</tr>
<tr>
<td>Auditor</td>
<td>0.878</td>
<td>1</td>
</tr>
<tr>
<td>AudOpi</td>
<td>0.234</td>
<td>0</td>
</tr>
<tr>
<td>Foreign</td>
<td>0.55</td>
<td>0</td>
</tr>
</tbody>
</table>

Panel D: Pearson Correlations (Top) and Spearman Correlation (Bottom),\(^b\) n = 3,225

<table>
<thead>
<tr>
<th></th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
<th>7</th>
<th>8</th>
<th>9</th>
<th>10</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Audit Report Lag</td>
<td>-0.04</td>
<td>0.06</td>
<td>-0.02</td>
<td>-0.01</td>
<td>0.00</td>
<td>0.02</td>
<td>0.12</td>
<td>-0.07</td>
<td>0.02</td>
<td></td>
</tr>
<tr>
<td>2. ERP</td>
<td>-0.03</td>
<td>-0.12</td>
<td>-0.01</td>
<td>-0.04</td>
<td>-0.04</td>
<td>-0.05</td>
<td>-0.05</td>
<td>-0.02</td>
<td>-0.01</td>
<td></td>
</tr>
<tr>
<td>3. After</td>
<td>0.05</td>
<td>-0.12</td>
<td>0.35</td>
<td>0.33</td>
<td>0.33</td>
<td>0.33</td>
<td>0.30</td>
<td>0.05</td>
<td>0.03</td>
<td></td>
</tr>
<tr>
<td>4. After1</td>
<td>-0.02</td>
<td>-0.01</td>
<td>0.35</td>
<td>-0.13</td>
<td>-0.12</td>
<td>-0.12</td>
<td>-0.12</td>
<td>-0.11</td>
<td>0.01</td>
<td>0.01</td>
</tr>
<tr>
<td>5. After2</td>
<td>0.00</td>
<td>-0.04</td>
<td>0.33</td>
<td>-0.13</td>
<td>-0.12</td>
<td>-0.12</td>
<td>-0.12</td>
<td>-0.11</td>
<td>0.01</td>
<td>0.11</td>
</tr>
<tr>
<td>6. After3</td>
<td>-0.02</td>
<td>-0.04</td>
<td>0.33</td>
<td>-0.12</td>
<td>-0.12</td>
<td>-0.12</td>
<td>-0.12</td>
<td>-0.11</td>
<td>0.02</td>
<td>0.02</td>
</tr>
<tr>
<td>7. After4</td>
<td>0.02</td>
<td>-0.05</td>
<td>0.32</td>
<td>-0.12</td>
<td>-0.12</td>
<td>-0.12</td>
<td>-0.12</td>
<td>-0.11</td>
<td>0.02</td>
<td>0.02</td>
</tr>
<tr>
<td>8. After5</td>
<td>0.11</td>
<td>-0.05</td>
<td>0.30</td>
<td>-0.12</td>
<td>-0.11</td>
<td>-0.11</td>
<td>-0.11</td>
<td>0.03</td>
<td>0.02</td>
<td></td>
</tr>
<tr>
<td>9. HighLit</td>
<td>-0.15</td>
<td>-0.02</td>
<td>0.05</td>
<td>0.02</td>
<td>0.01</td>
<td>0.02</td>
<td>0.02</td>
<td>0.32</td>
<td></td>
<td></td>
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TABLE 6 (continued)

Panel E: Continued from Panel D

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* Bold text indicates significant differences between two subsamples at the 0.05 level or better, one-tailed. Differences in means (medians) are assessed using a t-test (Wilcoxon rank sum test).

** Bold text indicates significance at the 0.05 level or better, two-tailed.

significantly bigger than those of the pre-ERP implementation period: number of segments, incidence of extraordinary items, size, incidence of negative earnings, firms audited by Big 6 auditors, firms receiving other than a clean opinion, and firms operating abroad. Also, the mean of audit report lags of the post-ERP implementation period is significantly longer than that of the pre-ERP implementation period. Panel D reports the pair-wise Pearson correlations and Spearman correlations. The table indicates that audit report lag is negatively correlated with high-litigation industry, high-tech industry, size, Big 6 auditors, and foreign operations, and positively correlated with net loss and modified opinions.

Multivariate Results

We examine how ERP implementation affects the audit report lag by estimating two log-normal duration models. The test results of the first model are presented in Table 7. The results show a negative and significant coefficient for the interaction term *AfterERP*, which indicates that ERP implementation is negatively associated with the length of audit report lag. The coefficients of other control variables are consistent with prior studies in general. High-litigation industry, high-tech industry, and client size seem to be negatively associated with the audit report lag. It seems that the negative association between the audit report lag and high-litigation and high-tech industries is due to the concern of the market on firms that belong to risky industries. It is expected that, being aware of this concern of the market, those firms try to relieve the market’s anxiety by releasing
annual reports more timely. On the other hand, presence of extraordinary items, negative earnings, and modified audit opinion are positively associated with the audit report lag. The dummy variable for year 2004 is positive and strongly significant. This can be attributed to the SOX Section 404 reporting requirements that became effective in 2004. The SOX Section 404 requires managers and auditors to assess the soundness of corporate internal control, an attestation that was not mandatory before the regulation. The introduction of this new regulation probably leads to increased audit hours to be spent in order to complete the audit. The result for the year 2004 dummy is also consistent with Ettredge et al. (2006) and Krishnan and Yang (2009), who report dramatic increases in audit report lags in 2004, 19.8 days (from 50.3 to 70.1) and 23.3 days (from 49.3 to 72.6), on average, respectively.

### TABLE 7
Multivariate Test Results (Model 1)

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<th>Variable</th>
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Number of Obs. 3,225
LR Chi-square (27) 852.84
Prob. > Chi-square 0.000

***, *** Denote significance at the 0.05 and 0.01 levels, respectively.
Table 8 reports the test results for the second model. The coefficients of the post-ERP fourth- and fifth-year interaction terms are negative and significant. Even though the coefficients of the other three post-ERP period terms are not significant, they are all negative. This result implies that ERP systems may help decrease the audit report lag, but it takes time for the significant impact on the firms’ accounting systems to be realized. The results for other control variables are mainly the same as those of the first model.

Table 8
Multivariate Test Results (Model 2)

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<td>4.09</td>
<td>0.000</td>
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<td>8.73</td>
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<td>0.000</td>
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<td>d_1995</td>
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<td>d_2002</td>
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<td>0.088</td>
<td>1.71</td>
<td>0.086</td>
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<tr>
<td>d_2004***</td>
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<td>0.093</td>
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<td>0.000</td>
</tr>
<tr>
<td>d_2005</td>
<td>0.421</td>
<td>0.303</td>
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<td>0.165</td>
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<tr>
<td>d_2006</td>
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<td>0.786</td>
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Number of Obs. 3,225
LR Chi-square (31) 857.03
Prob. > Chi-square 0.000

*, **, *** Denote significant at the 0.10, 0.05, and 0.01 levels, respectively.
Additional Tests

There exists a possibility that the auditors in the late 1990s might have more knowledge or better understanding of ERP systems than in the early 1990s because ERP systems began to be introduced in the early 1990s, and as time passes, the auditors may get accustomed to those systems. Thus, we checked whether there is knowledge effect (or education effect) of auditors by examining whether there is any difference in impacts of ERP on audit report lags (ARLs) between early ERP adopters and late ERP adopters. However, we could not find any significant differences between the two groups (untabulated).³

In addition to two log-normal models, we ran OLS regressions using the natural logarithm of audit report lag, rather than the audit report lag itself, as a dependent variable. The results for both models are qualitatively the same as those of log-normal models (untabulated). The coefficient of the interaction term in the first model is negative and significant at the 5 percent level. The coefficients of the post-ERP fourth- and fifth-year interaction terms in the second model are also negative and significant. The results for control variables are very similar to those of log-normal models.

Furthermore, we examined the variance inflation factor (VIF) values of the independent variables to check whether there is a serious multicollinearity problem. However, we could not find an indication of multicollinearity. The VIF values for all variables do not exceed 5.

ANALYSES WITH ERP DATA OF THE 2000s

ERP Data of the 2000s

We tried to collect additional information on the firms that have implemented ERP systems in the 2000s, from year 2000 to year 2008, in order to check whether our results hold with more recent data. The data-collection method is similar to that employed for collecting our main ERP data. We used Lexis-Nexis Newswires to search for any announcements relevant to ERP implementation and searched for any mentions of ERP implementation in SEC filings. This search process yielded 786 unique firms that had ERP-related announcements or mentions related to ERP implementation in SEC filings during the search period. However, 151 firms were eliminated because those firms are not available in Compustat. In order to collect information on ARLs, we employed the Audit Analytics database instead of collecting manually. An additional 43 firms were eliminated that are not available in Audit Analytics or whose data for ARLs are not available in Audit Analytics. Consequently, we had the final sample of 592 firms. Finally, the ERP firms were matched by the four-digit SIC code and total assets to form a non-ERP control group. The firm-years were selected as they had been for our main ERP data. These processes gave us a final sample of 8,622 firm-years.

Multivariate Results

The models estimated with the recent ERP data are the same as those used for the main ERP data, and the test results are presented in Tables 9 and 10. We could find results that are consistent with those from our main ERP data, which makes the reliability of the results even stronger. Table 9 reports the results of the first model. The results show that the coefficient of the interaction term AfterERP is negative and significant at the 1 percent level. The results for other control variables are similar to those from the main data. In general, the signs of coefficients are the same, but they tend

³ We divided ERP firms into two groups, early adopters and late adopters. However, because the dividing point is not clear, we examined three pairs of groups: pre- and post-1994, 1995, and 1996 pairs. Nevertheless, we couldn’t find significant results for all three pairs.
to be more significant than those of the previous corresponding model. For example, the coefficients of \textit{NumSegment} and \textit{BusyEnd}, which were positive and insignificant, are now positive and significant. The coefficients for year dummies are all significant, but the sign turns to positive from negative in year 2004, which has a similar implication to that of previous results, the effect of SOX Section 404. One possible reason for the increase in statistical significance is probably due to the increase in the number of observations estimated.

Table 10 reports the results for the second model using the recent ERP data. The coefficients of all five interaction terms are negative, but in contrast to the results of the previous corresponding model, they are all statistically significant. We can find one possible reason for this result from the difference in (IT) audit environments between the 1990s and 2000s. In the 1990s, when ERP systems were first introduced and both implementing firms and auditors were not familiar with
those systems, it might take much more time for firms and auditors to learn about how they work and to assess their reliability. However, in the 2000s, ERP systems are not new anymore to auditors and probably even to implementing firms. In other words, their knowledge level on ERP systems in the 2000s may be much higher than that in the 1990s. Thus, we can conjecture that it might not take much time for auditors to understand and effectively utilize ERP systems for their audit. Another possible reason can arise from the possibility that those ERP announcements in the 2000s are not indications of initial ERP implementations, rather just additions of some more systems to or

<table>
<thead>
<tr>
<th>Variable</th>
<th>Coefficient</th>
<th>Standard Error</th>
<th>z-value</th>
<th>p-value</th>
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<td>AfterERP1***</td>
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<td>0.019</td>
<td>-3.49</td>
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<td>AfterERP2**</td>
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<td>0.026</td>
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<tr>
<td>AfterERP3***</td>
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<td>0.020</td>
<td>-2.72</td>
<td>0.007</td>
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<tr>
<td>AfterERP4***</td>
<td>-0.046</td>
<td>0.023</td>
<td>-2.01</td>
<td>0.045</td>
</tr>
<tr>
<td>AfterERP5*</td>
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<td>HighLi***</td>
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<td>0.014</td>
<td>-2.88</td>
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<td>HighGrowth</td>
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<td>0.957</td>
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<tr>
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<td>0.033</td>
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<tr>
<td>HighTech</td>
<td>-0.015</td>
<td>0.013</td>
<td>-1.14</td>
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<tr>
<td>NumSegment***</td>
<td>0.016</td>
<td>0.002</td>
<td>7.09</td>
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<tr>
<td>ExtraItem***</td>
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<td>0.000</td>
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<td>0.003</td>
<td>-14.58</td>
<td>0.000</td>
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<tr>
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<td>0.009</td>
<td>3.47</td>
<td>0.001</td>
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<td>Loss***</td>
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<td>9.48</td>
<td>0.000</td>
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<td>0.003</td>
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<td>0.036</td>
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<td>0.000</td>
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<tr>
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<td>4.79</td>
<td>0.000</td>
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<td>d_2012*</td>
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Number of Obs. 8,610
LR Chi-square (31) 2012.65
Prob. > Chi-square 0.000

* *, **, *** Denote significant at the 0.10, 0.05, and 0.01 levels, respectively.
upgrades of existing ERP systems. This is more likely, especially for the 2000s data than 1990s data. The period of the 1990s is the booming period of implementing ERP systems. The popularity of ERP did soar in the early 1990s and firms began to invest billions in ERP systems (Chen 2001). Thus, it is likely that most major companies were already using ERP systems in the early 2000s. Therefore, we cannot deny the possibility that a significant portion of ERP-related announcements in the 2000s can be related to additions of some more systems to existing ERP systems or upgrades of them. If this is the case, auditors would not need to spend time in order to understand those modifications to the systems as much as when the client firms are first implementing ERP systems. Thus, it would also take less time for those modifications to make a significant impact on the firms’ accounting systems.

Limitations of Data

However, in spite of our efforts to collect more recent ERP data, we should confess that this recent ERP data can be noisy. As mentioned above, because it is highly likely that most major firms had already implemented ERP systems until the early 2000s, it is more difficult to find proper matched non-ERP firms in the 2000s than in the 1990s. Also, when collecting ERP data, it is very difficult to distinguish between initial ERP implementations and different sorts of system modifications, such as upgrades, additions of more systems, or system integrations of foreign branches. This problem is more pronounced in the 2000s data because the 1990s data are related only to initial implementations, and it is more likely that ERP-related announcements in the 2000s are just additions of some more systems to existing ERP systems or upgrades of them because of the aforementioned reason.

Despite these potential disadvantages of the 2000s ERP data, we, however, think that the data still provide interesting information for a different time period. Also, the results of these data make our main conclusion of negative association between ERP implementations and ARLs even stronger in that, overall, they are quite consistent with those of the 1990s data. Nevertheless, we need to be careful in interpreting the results from the 2000s data, especially for the second model because, as mentioned above, the data can be noisy and there is a discrepancy between the results of the second model and prior ERP studies. Prior studies, in general, report that it takes time for ERP systems to make an impact on implementing firms.

CONCLUSION

Implications

We investigated whether ERP implementation is associated with the audit report lag. The audit report lag is affected by numerous factors, as shown in prior research. Recent advances in technology have radically changed business operation and processes. Meanwhile, it has also changed audit environment and can affect the determinants of the audit report lag. This paper is the first study to show empirical evidence that investment in IT of client firms can make an impact on the external audit even though the investment is motivated by managers’ operational purposes. The test results of this study indicate that the ERP implementation has negative association with the audit report lag. Given that an ERP system is typically the most important investment in information technology for a company, this result has an implication that advanced technology of client firms can have a positive influence on the efficiency of the external audit, at least to the extent that audit report lag is a good proxy for audit efficiency. Also, the test result of our second model suggests that it takes time for ERP systems to be fully utilized and to make a significant impact on the accounting systems. Our findings are interesting in that implementing ERP systems can have unintended effects on the external audit. Companies decide to implement ERP systems to improve
their own operational performances. However, our results indicate that a decision to implement ERP systems can affect not only various measures of firms’ performances, but also the external audit, which is generally regarded as something independent of client firms’ decisions.

We might be able to find possible reasons for these results from the characteristics of ERP systems. In the accounting aspect, ERP systems can be characterized as integrated and comprehensive enterprise-wide recordkeeping systems that embrace most activities and processes of an organization. Thus, the firms with ERP systems can be equipped with more efficient accounting closing and consolidation processes. Under the ERP environment, auditors first need to examine the reliability of systems, which means the adequacy of system design and compliance. Once the results of this examination are acceptable, auditors can save time spent on collecting data from different departments or business segments and on confirming management assertions, because they can be provided with comprehensive, integrated, and reliable information much more quickly. Our test results might indicate that auditors are realizing these benefits of ERP systems.

The SEC mandated accelerated filing requirements for corporate 10-K and 10-Q filings in 2003 (SEC 2002). The requirements reduced the 10-K filing period for accelerated filers from 90 days to 75 days, and for large accelerated filers, the filing period was further reduced to 60 days. Concerning this filing environment, some might argue that auditors might not have as much incentive as before to complete audit work sooner than required periods and, thus, people might not be interested in audit delay as much as before. Those arguments might be true. However, the main finding of this paper is that auditors are more efficient for ERP firms, and this may imply that even if firms file at the same date, the audit quality can be higher for ERP firms. Also, the audit efficiency is closely related to auditors’ costs. Thus, the audits can be more profitable for ERP firms as the audit costs may be lower because of the increased efficiency. Therefore, the finding of this paper still provides implications on different aspects of audits under the current filing rule. Research questions related to audit fee or audit quality may be worth examining.

Prior studies focus only on effects of ERP systems on firm performances, such as operational performances or market performances, which are managers’ intended (expected) effects. However, this paper implies the possibility that implementing advanced IT systems can have unexpected impacts on different aspects, including outsiders, of the implementing firms. Therefore, this study provides an implication that as more advanced and sophisticated IT systems get introduced, related parties should endeavor to understand all potential effects of the systems more comprehensively so that they can maximize the benefits of the systems.

Limitations

However, this study has some limitations. Because ERP-related announcements, which are our source of data for this study, are not detailed enough, we could not take into consideration different degrees of integration of a firm’s IT systems. If the ERP systems are implemented only in financials and not integrated with logistics, MRP, or CRM, or if the subsidiaries are not included in the implementation, the benefits of ERP for the external audit will be limited. However, we could not distinguish different degrees of integration due to the lack of information. Future research with more complete and thorough information on the integration of ERP systems might be more convincing.

Additionally, more comprehensive and in-depth research is needed about how advances in technology of client firms affect the behaviors of external auditors or what the true factors are that improve audit efficiency. There is a concern on the change in audit environment caused by the advance in technology. It is argued that auditors do not properly recognize the heightened degree of risk in ERP systems regarding internal control, such as network security, database security, and application security (Hunton, A. Wright, and S. Wright 2004). Hunton et al. (2004) say that auditors...
do not have enough knowledge on systems, and ERP audits should be performed by a cross-functional team of auditors and IS experts. If this argument is true, it could be conjectured that auditors trust IT systems of client firms without proper evaluation on them and reduce their audit work. Then, this is not the realization of benefits of ERP, but rather they are increasing the efficiency of the audit at the expense of effectiveness of the audit. Thus, future research that deals with this issue will be interesting and meaningful.

Further Research

Morris and Laksmana (2010) indicate that ERP implementation is negatively associated with earnings management activities. Earnings management by client firms increases the detection risk of auditors and, thus, ultimately increases the audit risk. Pratt and Stice (1994) and Simunic and Stein (1990) suggest that one of the responses of auditors to risk (litigation risk) is audit fee adjustment. Also, it is obvious that the time that auditors spend to carry out audit tasks is a critical factor that affects the level of audit fees. Thus, jointly, given the results of Morris and Laksmana (2010) and of this study, we may conjecture that ERP implementation is negatively associated with audit fees. By examining this additional hypothesis, we may be able to understand more comprehensively how advances in technology of client firms affect the environment of external audit.

REFERENCES

The Impact of Enterprise Resource Planning (ERP) Systems on the Audit Report Lag


Journal of Emerging Technologies in Accounting
Volume 10, 2013


Queries for jeta-10-00-02

1. Author: As a result of a change made to our standard format by the AAA Publications Committee, the first within-text citation of a work done by three to five authors now includes all of the author names, e.g., Scholes, Wolfson, Erickson, Maydew, and Shevlin (2008). Subsequent citations of that same work use the abridged format, e.g., Scholes et al. (2008). Review carefully. Copyeditor

2. Author: The first initials for same-last-name authors in a citation have been inserted at the first mention of that citation due to a change in AAA standard style. Review carefully. Copyeditor

3. Author: Table 1 has been modestly reformatted to conform to AAA standard style. Review carefully. Copyeditor

4. Author: re Table 4, Panel B has been modestly reformatted to conform to AAA standard style. Review carefully. Copyeditor

5. Author: re: Table 6: Panel D has been split into Panels D and E to conform to AAA guidelines for table width. Please review and provide a preferred description for Panel E. Copyeditor

6. Author: In the sentence beginning "That is because weak internal control," should "leading to an increased audit work" be revised to "leading to an increase in audit work," or perhaps "leading to increased audit work"? Please mark to revise as may be appropriate. Copyeditor