The impact of enterprise systems on corporate performance

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This research studied the effect of investments in enterprise resource planning (ERP), supply chain management (SCM) systems on a firm’s long-term stock price performance and profitability measures such as return on assets and return on sales. The results are based on a sample of 558 announcements of ERP implementations, 420 SCM implementations. Our analysis of the financial benefits of these implementations gives mixed results. In the case of ERP systems, we observed some evidence of improvements in profitability but not in stock returns. The results for improvements in profitability are stronger in the case of ERP systems. On average, adopters of SCM system have positive stock returns, as well as improvements in profitability. Although our results are not uniformly positive across the different enterprise systems (ES), they are encouraging, despite the high implementation costs. This should make less help to concerns that some have expressed about the viability of ES, given the highly publicized implementation problems at some firms.

Key words: Enterprise resource planning (ERP) and supply chain management (SCM).

INTRODUCTION

For the purposes of this paper, enterprise systems (ES) include the enterprise resource Planning (ERP), supply chain management (SCM) systems. This paper studies the effect of investments in ERP, SCM systems on long-run stock price and profitability performance. The results are based on an analysis of a sample of 558 announcements of ERP implementations, 420 SCM implementations at publicly traded firms. Performance effects are examined over a 3-year time period for ERP implementations and a 2-year time period for SCM. Performance effects are also examined for the implementation and post-implementation periods. There is relatively little empirical research that links investments in ES to financial performance using objective financial performance data. While some researchers have examined the effect of investments in ERP systems on financial performance, research on the effect of SCM systems on financial performance is very limited or nonexistent. Furthermore, existing research on the effect of ES systems on financial performance is not as comprehensive and detailed as it could be in terms of the metrics used, the methodology used to estimate the performance effects, and the time periods covered. Our analysis provides complete evidence on the effect of ES system on performance. The evidence in this paper also contributes to the literature on the effect of information technology (IT) investments on financial performance (Dehning and Richardson, 2002). Very few studies have attempted to examine the effects of specific type of IT investments on performance (Chatterjee et al., 2002). Therefore, our knowledge about how specific IT investments affect performance is limited. Such knowledge can be useful in capital budgeting and allocating decisions, and targeting investments to those applications that give the highest returns. Investments in ES systems require major commitments of capital and managerial resources, and it makes sense to carefully estimate the returns from these investments. In documenting the effect of ES, researchers have used objective performance data on stock returns and methods to analyze the short-term stock market reaction and accounting metrics as well as performance data collected through surveys and experiments. Hayes et al. (2001), Ranganathan and Samarah (2003), and Chatterjee et al. (2002) examined the stock market reaction to IT investment announcements about technologies. These studies find statistically significant abnormal stock market returns ranging anywhere from 0.9 to 0.78%, indicating
that the market reacts positively to IT investment announcements. However, abnormal returns over short windows may not provide a complete assessment of the value of investment. Recent research has shown that the stock market partially anticipates many corporate announcements, and in other cases abnormal stock price performance is also observed subsequent to the announcement (Fama, 1998). Therefore, to suggest that to get a better idea of the value of ERP investments, we estimate abnormal performance over a longer time period. Mabert et al. (2003) found that few firms had reduced direct operational costs. Stratman’s (2001) survey found that manufacturing firms saw little change in operational metrics. Hunton et al. (2002) suggest that survey-based and experimental research could be further supported by triangulation with findings based on objective performance data. Hitt et al. (2002) found evidence of improved financial performance during implementation, but are unable to estimate the longrun impact of ERP systems due to a lack of post-implementation data at the time they conducted their study. Barber and Lyon (1996) in their studies show that in use of accounting metrics matching on prior performance is critical to get a powerful test statistics. Matching on prior performance adjusts for mean reversion in accounting metrics that reflects a transitory component of performance that may have nothing to do with the event under consideration. Without matching on prior performance, results can be confounding as it is unclear whether the observed abnormal performance is due to mean reversion or due to the event under consideration. Dehning et al. (2004) investigated the financial benefits of SCM systems and found that these systems generally are associated with improved financial performance. Unlike Poston and Grabski’s (2001) analyses of ERP adoptions, Denting et al. (2004) control for industry and economy-wide effects by using the median industry performance as benchmark. While this is certainly better than not using any controls, they do not control for prior performance as advocated by Barber and Lyon (1996). The earlier critique of the existing study identifies some significant gaps in our understanding of the effect of ES system on financial performance which shows major differences between our studies. We examine the effect of ES on both the long-term stock returns and profitability, to examine the consistency between different categories of performance measures. In the long run, both the stock price changes and profitability changes should point to the same conclusion about the effect of ES on performance. We examine performance effects for the implementation and the post-implementation periods. Finally, to separate the effect of ES on performance, we use methodologies that address some of the estimation and statistical concerns and drawbacks of previous studies. In particular, we control for prior performance, which has been shown to result in well-specified statistical tests (Lyon et al., 1999; Kothari and Warner, 1997).

Enterprise resource planning (ERP) systems

ERP systems replace complex and manual interfaces between different systems with standardized, cross-functional transaction automation. Order cycle times can be reduced, customer response times, and delivery speeds (Cotteeleer and Bendoly, 2006; McAfee, 2002). Automated financial transactions can reduce cash-to-cash cycle times and the time needed to settle financial data at the end of the year (Mabert et al., 2000, 2003; Stratman, 2001). Another benefit of ERP systems is that all enterprise data are collected once during the initial transaction, stored, and updated in real time. This ensures that all levels of planning are based on the same data and that the result reflects the prevailing operating conditions of the firm. The standardized firm-wide transactions and stored enterprise data facilitate the governance of the firm (Scott and Vessey, 2000; McAfee and Upton, 1996). ERP reports provide managers with a clear view of the relative performance of the various parts of the enterprise, which can be used to identify and take advantage of market opportunities (Kearney, 2000; Boston Consulting Group, 2000).

Supply chain management (SCM) systems

The benefit of SCM systems is better operational, and business planning. SCM systems use finite capacity planning algorithms that do not require iteration adjustments to the schedule (Raman and Singh, 1998), and real-time planning capabilities allow firms to react quickly to supply and demand changes. There is a rich literature in OM on the benefits of better supply chain planning and coordination (Cheung and Lee, 2002; Milner and Kouvelis, 2002). Recent empirical research has demonstrated that reducing forecasting and planning errors that result in supply chain disruptions avoid value destruction (Hendricks and Singhal, 2003). Increased revenue, increased productivity, operational cost savings, and lower inventory, are some of the benefits from SCM system implementations (Nucleus Research, 2003a).

Sample selection procedure and data description

Sarmayeh Gozari Bahman, Lizing Iran, Lizing Kgodrove Saipa and the Lizing Saneet Maeeden, Journals are our primary sources for collecting the sample of firms that have invested in ES. We started with the set of all announcements during 2003 to 2009 that mentioned ES providers by name. Although more than 75 providers were used in our search for SCM systems. These announcements mentioned firms that have invested in...
ES. To be included in the final sample, a firm must have stock price information on the center for research on security prices (CRSP) database. Our sample consists of 978 firms with the following breakdown: 558 announcements of investments in ERP systems, 420 in SCM systems. Furthermore, the size of firms that invest in SCM applications is larger than those that invest in ERP applications. This may be because SCM applications are relatively new compared to ERP applications. Our sample has two distinct sets of announcements.

One set indicates that the firm has started or plans to start the implementation of an ES application. The other set indicates that the firm has completed the implementation of an ES application. Of the 556 ERP announcements, 105 are on completed implementations; of the 420 SCM announcements, 36 are on completed implementations.

**METHODOLOGY**

Our methodology includes the period over which the performance effects are measured and the approach used to estimate the long-term stock price and profitability effects of investments in ES. In this study, we focus on longer periods to the performance effects of ES. We examine the performance during the implementation period as well as the post-implementation period. Therefore, we use a 2-year implementation period for ERP systems (O’Leary, 2000; Stratman, 2001; Mabert et al., 2000; Raman and Singh, 1998). Our discussion with an SCM expert at Lizing Kgodrove Saipa, suggests that a 12-month implementation period seems reasonable. We choose a 3-year post-implementation period for ERP, SCM, applications. Overall, we examine the changes in financial performance over a 3-year period for ERP systems (a 1-year implementation period and a 2-year post-implementation period), and a 2-year period for SCM systems (a 1-year implementation period and a 1-year post-implementation period). Methodology for estimating the long-term stock price effects, we estimate the longrun buy-and-hold abnormal returns using daily returns. An abnormal return is the difference between the return on a stock and the return on an appropriate benchmark (Lyon et al., 1999; Fama, 1998; Kothari and Warner, 1997). This discussion has focused on 2 issues. The first issue is the appropriate factors that should be controlled in computing long-run abnormal returns. The second issue is the interpretation of the statistical significance of long-run abnormal returns (Kothari and Warner, 1997; Lyon et al., 1999). We implemented this approach as follows:

1) We identify the portfolio that a sample firm is assigned to in the first month of the start of the sample firm’s measurement period. Since all other firms in this portfolio are similar to the sample firm on size, market-to-book ratio, and prior performance, all these firms can be considered as benchmarks for the sample firm.

2) In each month, all eligible firms are sorted according to their market value of equity and size portfolio. The smallest size portfolio is further divided into quintiles, resulting in 42 size portfolios. Each portfolio is further divided into quintiles according to their market-to-book ratio of equity, resulting in 210 portfolios. Each portfolio is further divided into 3 portfolios based on the stock price performance of firms in that portfolio over the previous year, resulting in 630 portfolios for each month where firms in each portfolio are similar in terms of size, market-to-book ratio, and prior performance.

3) A sample firm’s abnormal return is the difference between its buy-and-hold return and the average of the buy-and-hold returns of all other firms that belong to the sample firm’s portfolio (Hendricks and Singhal, 2005).

4) Statistical judgment is based on an imitation approach (Lyon et al., 1999). The idea is to compute an empirical distribution of abnormal returns for a portfolio and compare where the abnormal return of the sample portfolio falls on this distribution. To achieve this we create a fake-sample where for each sample firm, we randomly select. This randomly selected firm is assigned the same announcement date as that of the sample firm. Once this is done for all sample firms, the mean abnormal performance for this pseudo-sample is computed using the portfolio approach discussed in Step 3. This results in one observation of the mean abnormal performance from a fake-sample.

5) The distribution of the mean abnormal returns from 500 fake-portfolios is used to test whether the mean abnormal return for the sample portfolio is significantly different from zero. We compute the p-value as the bit of the 500 fake – samples with mean abnormal returns less than the mean abnormal return of the sample portfolio (Lyon et al., 1999).

To estimate the profitability effects of investments in ES, we analyze changes in operating return on sale (ROS) and operating return on assets (ROA) which is the ratio of operating income to book value of total assets (sales). We focus on operating income over other income measures because it is a tool measure of performance, as it is not hidden by specific items. To control for various factors unrelated to investments in ES that could affect the performance, we compare the performance of each sample firm against an appropriately chosen comparison group. We estimate abnormal performance as the change in the sample firm’s performance minus the change in the median performance of the comparison group. More formally, let Pt1 and Pt2 be the performance level in year t1 and t2 (Where t2 > t1), respectively, for the sample firm I. Let PCt1 and PCt2 be the median performance level in year t1 and t2, respectively, for the comparison group for sample firm I. Then Lizing Kgodrove Saipa, the abnormal performance of sample firm I is:

\[ API = (Pt2 - Pt1) - (PCt2 - PCt1) \]

Barber and Lyon (1996) develop guidelines on selecting comparison groups that give well-specified test statistics. They emphasize the importance of selecting comparison groups that have similar prior performance as that of the sample firms, as well as using a portfolio of firms as the comparison group. We implement the findings of Barber and Lyon (1996) using a 3-step procedure:

1) For each sample firm, we identify all firms that have the same three-digit SIC code as that of the sample firms and whose ROA (ROS) in the starting year of the measurement period is within 85 to 100% of the sample firm (Hendricks et al., 2007).
2) If we do not find any firms in Step 1, then we attempt to match performance within the 85 to 100% filter, using all firms in the same one-digit SIC code.
3) If we do not find any firms in Step 2, then we attempt to match performance within the 85 to 100%, without regard to SIC code.

The mean (median) number of firms in the comparison groups is 60 (42) for the ERP sample, 51 (36) for the SCM sample. Our results show that by the use of the second comparison group, whose total assets are within a factor of 30 of the total assets of the sample firm. Abnormal performance can be reported as the change in the level of performance or as the percent change in the level of performance. The difference between these two methods in the level of ROA is 3%, whereas the percent change in ROA is 71.34%. If the ROA is negative, then percent change calculations are
nonsensical. Therefore, results on percent change require that we exclude firms (sample or comparison group firms) that have negative ROA. This can lead to biases in test statistics. Because of these issues with the percent change method, we report abnormal performance based on the change in the level of performance. To pool observations across time, for each firm in our sample, we translate calendar year to event years as follows. The year of the announcement date is year 0 in event year, the next year is year 1, and year after that is year 2, and so on. For ERP systems (SCM systems) the implementation period spans years 0 to 1 and the postimplementation period spans years 2 to 3.

RESULTS

Table 1 presents results for the sample of firms that invested in ERP systems. During the 1-year implementation period, the stock price performance of the sample firms was relatively poor to the benchmark portfolios. The mean (median) abnormal return during this time period is -8.82% (-19.89%). A p-value of 0.058 indicates that the mean abnormal return is lower than the mean abnormal returns of 436 out of the 500 fake-portfolio abnormal returns. Of the 558 sample firms, only 45% of the sample firms do better than the median return of the firms which is significantly lower than 50% (p-value ≤ 0.01). The abnormal stock price performance during the implementation period is negative and statistically significant. The results for the one-year post-implementation period are mixed. The mean abnormal return of 7.97% is statistically significant (p-value = 0.031).

However, the median abnormal return is −0.98%. Only 48.05% of the firms do better than the median return of the firms which is insignificantly different from 50%. Overall, only one of the three statistics suggests positive abnormal performance. When the performance is examined over the full three-year period (the combined implementation and post-implementation periods), there is no evidence of abnormal performance. The mean abnormal return is −4.06%, insignificantly different from zero (p-value = 0.37). The median abnormal return is −8.39%. Nearly 51% of the sample firms do better than the median return of the firms which is insignificantly different from 50%. The result shows that over the three-year period, the stock price performance of firms that invest in ERP systems is no different from that of their benchmark portfolios. The results of Panel B Table 1 shows that the mean and median changes in ROA are positive for the implementation, post-implementation, and the combined implementation and postimplementation periods. The positive changes in ROA during the implementation period are statistically significant at the 5% level. Although the changes in ROA during the post-implementation period are positive, none of the changes are statistically significant. However, during the combined implementation and postimplementation periods the median change of 1.01% in ROA is significantly different from zero (p-value ≤ 0.01), and nearly 54% of the sample firms positive abnormal change in ROA, significantly different from 50% (p-value ≤ 0.025). The results show that ERP adopters show an improvement in ROA. When ROS is used as the performance metrics, eight of the nine performance metrics (three for each time period) are positive but only three changes are statistically significant at the 5% level. These are the median change during the post-implementation period, the percent of sample firms that positive abnormal change during the post implementation period, and the percent of sample firms that positive abnormal change during the combined implementation and post-implementation periods. Although results show some positive abnormal changes in ROS, and are not as strong as that of the changes in ROA. Overall results show that firms that invests in ERP systems is not statistically significant increase in stock returns, there is some evidence to suggest that profitability improves over the combined implementation and post-implementation periods. To examine the ERP results in more detail, we segment the sample into four different subsamples. To estimate the effect of ERP systems during the post-implementation period we examine the results only for those announcements that indicated that the firm has completed the implementation of an ERP system. We also examine the results for those announcements that indicated that the firm has started or planned to start the implementation of an ERP system. By examining the performance of these firms over the three-year period we look on the payback from ERP systems over a three year period. We also divide our sample into manufacturing and service firms to see if the benefits from investments in ERP systems are more or less for manufacturing or service firms. We did not find any differences between them for manufacturing or service firms. Table 2 shows results for the sample of firms that invested in SCM systems. During the one-year implementation period, the mean abnormal return is −1.12%, insignificantly different from zero (p-value = 0.421). The median abnormal return is −5.65%. Of the 420 sample firms, about 40% of the sample firms did better than the median return of the firms which is insignificantly different from 50%. Basically, the abnormal stock price performance during the implementation period is not statistically significant. During the post-implementation period the mean abnormal return of 14.06% is statistically significant (p-value = 0.012). However, the median abnormal return is −2.85%. Nearly 47% of the firms do better than the median return of the firms which is insignificantly different from 50%. Over the full two-year period, the mean abnormal return of 14.32% is statistically significant at the 5% level. The median is −6.82%. Overall, there is some evidence of positive abnormal stock price performance during the two-year period. The results for the accounting metrics (Panel B of Table 2) provide strong support that firms that invest in SCM systems show improvements in ROA and ROS which is positive and statistically significant at the 1.5% level or better. The results for the combined implementation and post-implementation periods indicate that the median
### Table 1. Performance results for the sample of firms investing in ERP systems.

#### Panel A

<table>
<thead>
<tr>
<th>Performance measures</th>
<th>Implementation period</th>
<th>Post-implementation period</th>
<th>Implementation and post implementation period</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>(Day 0 to 250)</td>
<td>(Day 251 to 500)</td>
<td>(Day 0 to 500)</td>
</tr>
<tr>
<td>Number of observations</td>
<td>558</td>
<td>558</td>
<td>558</td>
</tr>
<tr>
<td>Mean abnormal return (%)</td>
<td>-8.82(0.056)</td>
<td>7.97(0.031)</td>
<td>-4.06(0.37)</td>
</tr>
<tr>
<td>Median abnormal return (%)</td>
<td>-19.89</td>
<td>-0.98</td>
<td>-11.39</td>
</tr>
<tr>
<td>Percent of sample firms with returns greater than its portfolio median</td>
<td>39.78(-2.79)*</td>
<td>48.05(0.29)</td>
<td>51.21(0.44)</td>
</tr>
</tbody>
</table>

Panel A: Results on the mean abnormal stock return (p-value from the empirical distribution created from 500 replications of pseudo-portfolios in parentheses). The median abnormal stock return and percent of sample firm with returns greater than the median return of the firms that belong to their assigned benchmark portfolios (the binomial sign test Z-static in parentheses).

change in the level of ROA is 1.12%. The median change in the level of ROS is 1.08%. Both these changes are statistically significant (p-value ≤ 0.01). More than 50% of the sample firms experience positive abnormal changes in ROA and ROS during the combined implementation and post-implementation periods. All the results show that are statistically significant at the 1% level or better.

However, the overall results indicate that investments in SCM systems improved profitability. We also divide the SCM announcements sample into those made by manufacturing firms (about 70% of the sample). The results for this subsample are consistent with the results for the full sample. Moreover, we need to address an important issue, it is plausible that the some of the insignificant results that we find with respect to ES systems are because the controls have adopted ES systems. Therefore, we cannot claim that all firms in our control set have not implemented ES systems. We believe that the chances are low that our results that a subset of control firms may have implemented ES. First, our sample has 978 ERP, SCM announcements. Anyhow more than 3000 firms are publicly traded, our control firms will come from a sample of more than 3000 firms. If most of these firms have adopted ES, then one would be very much concerned about our results. While most of the controls which have ES are quite low. Furthermore, given that our last announcement is in 2009, the adoption rate among controls in 2009 is likely to be much lower than today. Second, even if some of the 3000 control firms have adopted ES, it should not have much of an impact on our stock price performance results because of the method used to create the 500 fake-samples. In each fake sample we use size, prior performance, to select 978 firms from the sample of more than 3000 firms. We then compare the results of the sample firms against the results of these 500 fake-samples. If each of
Table 2. Performance results for the sample of firms investing in SCM systems.

<table>
<thead>
<tr>
<th>Performance measures</th>
<th>Implementation period (Day 0 to 125)</th>
<th>Post-implementation period (Day 126 to 500)</th>
<th>Implementation and post implementation period (Day 0 to 500)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number of observations</td>
<td>420</td>
<td>420</td>
<td>420</td>
</tr>
<tr>
<td>Mean abnormal return (%)</td>
<td>-1.12 (0.421)</td>
<td>14.06 (0.012)</td>
<td>14.32 (0.068)</td>
</tr>
<tr>
<td>Median abnormal return (%)</td>
<td>-5.65</td>
<td>-2.85</td>
<td>-6.82</td>
</tr>
<tr>
<td>Percent of sample firms with returns greater than its</td>
<td>40.25 (-1.01)</td>
<td>47.30 (0.34)</td>
<td>50.00 (0.00)</td>
</tr>
<tr>
<td>portfolio median</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Panel B

<table>
<thead>
<tr>
<th>Performance measures</th>
<th>From year 0 to 2</th>
<th>From year 2 to 5</th>
<th>From year 0 to 5</th>
</tr>
</thead>
<tbody>
<tr>
<td>Abnormal change in the 558 level of return on assets</td>
<td>Observation</td>
<td>Mean</td>
<td>Median</td>
</tr>
<tr>
<td></td>
<td>423</td>
<td>0.95</td>
<td>0.76</td>
</tr>
<tr>
<td></td>
<td>(2.18)^b</td>
<td>(2.61)^a</td>
<td>(2.61)^a</td>
</tr>
<tr>
<td>Abnormal change in the 558 level of return on assets</td>
<td>423</td>
<td>0.65</td>
<td>0.58</td>
</tr>
<tr>
<td></td>
<td>(1.80)^c</td>
<td>(1.50)^a</td>
<td>(2.27)^b</td>
</tr>
</tbody>
</table>

Panel A: Results on the mean abnormal stock return (t-value from the empirical distribution created from 500 replications of pseudo-portfolios in parenthesis). The median abnormal stock return and percent of sample firm with returns greater than the median return of the firms that belong to their assigned benchmark portfolios (the binomial sign test Z-static in parentheses).

Panel B: Results on abnormal return on assets and return on sales. T-statistic for the mean, Wilcoxon signed-rank test Z-statistic for the percent positive are reported in parentheses. * Significantly different from zero (50% in the case of percent positive) at the 1% level for one-tailed test. ** Significantly different from zero (50% in the case of percent positive) at the 2.5% level for one-tailed test. *** Significantly different from zero (50% in the case of percent positive) at the 5% level for one-tailed test.

These 500 fake-samples are influenced by control firms that have implemented ES then our results would be a source of concern. While this could happen in a few of the fake-samples, the chances of the most fake sample are very low as process of creating the fake samples is quite randomized. Third, in analyzing the performance effect of ES on ROA and ROS, we match each sample firm to a comparison group that consists of firms from the same industry, and which have similar performance characteristics. On average each comparison group consists of 60 firms. Furthermore, we estimate abnormal performance relative to the change in the median performance of the comparison group. The median of the comparison group is less likely to be impacted by nonidentified ES adopters. Finally, we note that our sample is based on firms that have started their implementation between 2003 and 2009. At least in the case of SCM system our sample is likely to have firms that are early adopters, which minimizes the chances that the control firms may have also implemented SCM system. The earlier discussion provides some rationale of why the chances are low that our results are impacted by controls that have also implemented ES. Table 3 indicates that abnormal stock price performance results of early adopters are not that different from the overall sample. The abnormal return during the implementation period is negative, and it is positive during the post-implementation period. However, the mean abnormal returns over the implementation and post-implementation periods are
Table 3. Performance results for the early adopters (1997 and before) ERP systems.

<table>
<thead>
<tr>
<th>Panel A</th>
<th>Performance measures</th>
<th>Implementation period (days 0-250)</th>
<th>Post-implementation period (days 251-500)</th>
<th>Implementation and Post implementation period (days 0-500)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Number of observations</td>
<td>312</td>
<td>312</td>
<td>312</td>
</tr>
<tr>
<td></td>
<td>Mean abnormal return (%)</td>
<td>-6.48 (0.167)</td>
<td>14.99 (0.075)</td>
<td>-1.82 (0.36)</td>
</tr>
<tr>
<td></td>
<td>Median abnormal return (%)</td>
<td>-16.46</td>
<td>0.23</td>
<td>-13.43</td>
</tr>
<tr>
<td></td>
<td>Percent of sample firms with returns greater than its portfolio median</td>
<td>40.8 (-2.04)</td>
<td>52.88 (0.58)</td>
<td>52.88 (0.87)</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Panel B</th>
<th>Performance measures</th>
<th>Implementation period From years 0 to 2</th>
<th>Post-implementation From years 2 to 5</th>
<th>Implementation and Post-implementation from years 0 to 5</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Abnormal change in the 558 level of return on assets</td>
<td>Observation</td>
<td>Mean</td>
<td>Median</td>
</tr>
<tr>
<td></td>
<td>330</td>
<td>1.16 (1.60)</td>
<td>0.45 (1.51)</td>
<td>54.54 (0.95)</td>
</tr>
<tr>
<td></td>
<td>Abnormal change in the 558 level of return on assets</td>
<td>330</td>
<td>1.43 (1.78)</td>
<td>0.66 (1.78)</td>
</tr>
</tbody>
</table>

Panel A: Results on the mean abnormal stock return (p-value from the empirical distribution created from 500 replications of pseudo-portfolios in parentheses). The median abnormal stock return and percent of sample firm with returns greater than the median return of the firms that belong to their assigned benchmark portfolios (the binomial sign test Z-static in parentheses). Panel B: Results on abnormal return on assets and return on sales. T-statistic for the mean. Wilcoxon signed-rank test Z-statistic for the percent positive are reported in parentheses. a Significantly different from zero (50% in the case of percent positive) at the 1% level for one-tailed test. b Significantly different from zero (50% in the case of percent positive) at the 2.5% level for one-tailed test. c Significantly different from zero (50% in the case of percent positive) at the 5% level for one-tailed test.

insignificantly different from zero. Panel B of Table 3 appears to be stronger than the results for the full ERP sample (Panel B of Table 1). Over the combined implementation and post implementation periods, the improvements in ROA and ROS are positive and statistically significant, which is stronger than what was observed for the full ERP sample. Consistent with the results for the full sample, there is poor evidence of improvements in profitability during the implementation period. The evidence of Table 3 suggests that early adopters may have benefited more from ERP implementation when compared to later adopters.

DISCUSSION AND FUTURE RESEARCH
Our analysis show a mixed results that examining
the financial impact of IT investments led some to propose a "productivity paradox". Brynjolfsson and Hitt (1996) and Kohli and Devaraj (2003) suggest that often the financial value of large systems was hidden is not sufficient. Some of the research issues are not clear such as:

1. The choice of the performance metrics (Bharadwaj et al., 1999),
2. The time period studied (Devaraj and Kohli, 2000),
3. The method of analysis (Robey and Boudreau, 1999).

In the case of adopters of ERP systems, we find some evidence of improvements in profitability but not in stock returns. The results for improvements in profitability are stronger in the case of early adopters of ERP systems. Although our results are not uniformly positive across the different ES systems, we do not find evidence of negative performance associated with ES adoption. Our results also add to the emerging literature on information technology and productivity. The use of both accounting data and stock returns we analyze data over a two-year or three-year period to get the long-term impact of ES adoption, and our estimation procedures show that abnormal performance is strongly measured, and that the associated statistical tests are well specified. However, in using stock price and accounting data, we are not able to examine internal firm mediating factors that may influence the financial value from ES. The linkage between internal capability factors and financial performance is not always clear. The resource-based view (RBV) provides a theoretical framework for evaluating the types of internal capabilities that provide a competitive advantage that can in turn lead to improvements in financial performance (Peteraf, 1993; Wernerfelt, 1984, 1995). The decisions made during the adoption process are likely to differ across firms (Adner and Helfat, 2003), which implies that the outcomes may also differ. Several studies suggest that internal organizational capabilities could influence the direction and extent of financial benefits from ES adoption (Boudreau and Robey, 2005; Brynjolfsson et al., 2002; Melville et al., 2004; Powell and Dent-Micallef, 1997). The analysis suggests that future research should explore the relationship between internal organizational capabilities and financial performance. The abnormal stock price performance results presented in Table 1 have mean values that are generally higher than the median values. This suggests that some firms are achieving high returns from their ES investments. Additional support for this explanation is provided by Figure 1, which shows the distribution of abnormal stock returns during the 1-year post-implementation period for our three ES samples. In the case of the ERP adopters, nearly 60 out of 558 sample firms have abnormal returns greater than 100%. The conclusions based on a small sample, shows that these 60 firms may represent firms that are best able to develop the requisite internal capabilities during ES adoption. The performance improvements reported by such firms that they can achieve similar results by purchasing ES, even though they lack the internal capabilities needed to fully leverage the potential of these systems. Existing OM research in the area of ES has primarily focused on key factors for successful implementation (Mabert et al., 2003) and the operational benefits, such as faster transaction processing and customer response, obtained from the use of these systems (McAfee, 2002). Stratman (2001) found that ERP users with high ERP competence are more likely to experience a performance improvement from ERP adoption. Somers and Nelson (2003) also look beyond implementation issues to assess the fit between ERP capabilities and organizational strategies and integration mechanisms. We report the financial impact by the average firm adopting ES. Although, we do not capture details of individual firm implementation success or
failure, it is likely that our sample includes some firms which had implementation difficulties or failed implementations. Our approach allows us to assess the overall benefits and risks faced by a typical firm planning to adopt ES. This study combines secondary and primary data might provide a clearer picture of how ES influence operational and in turn financial performance. Primary data sources could be used to determine precise implementation timelines, as well as to collect information on specific operational practices that leverage the capabilities of ES.

REFERENCES


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