# MARKETING SUPPLY CHAIN USING B2B BUY-SIDE E-COMMERCE SYSTEMS: DOES ADOPTION IMPACT FINANCIAL PERFORMANCE?

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## ABSTRACT

*Research suggests that new information technologies can improve the functionality of business processes, leading to improved firm profitability. However, new technologies are not equal in their contributions to a company's bottom line. Further, there is some debate as to whether early adopters of new technology benefit over later adopters. This study examines the financial performance of firms that modify their marketing supply chain by adopting business-to-business (B2B) buy-side e-commerce systems. Analyses show that early adopters outperform their non-adopting industry peers in the post-adoption period. Superior performance in adopters' return on assets (ROA) is driven by increases in profit margins rather than by improved asset turnover. The results are consistent with the claim that B2B buy-side improves company performance through lower purchasing and administrative costs. Early adopters of B2B buy-side systems received a competitive advantage over industry counterparts due to greater market transparency and better transactional efficiency.*

## INTRODUCTION

Advances in information technologies can improve the operating efficiency and effectiveness of management information processes, thereby leading to improved firm profitability. Business-to-business (B2B) e-commerce has grown rapidly since 1997 and is believed to have fundamentally altered the economy by increasing transactional efficiency and creating more transparent markets (Chen & Siems, 2001). Currently, total B2B e-commerce has been estimated as high as $8 trillion (Roseindia, 2009). The US accounts for almost half of all e-commerce transactions worldwide, with e-commerce predicted to grow about 14% annually and at an even faster rate in Europe and developing countries (Schulman, 2008).

With mounting corporate investment in B2B e-commerce, assessment of its impact on the marketing supply chain is important. This study empirically investigates effects of adoption of B2B buy-side for operating input on early adopters' financial performance.[1] Adoption of B2B technology is expected to improve company performance through improved transparency and

transactional efficiency. Prior studies investigating technology investments and financial performance report mixed results, so this study will add to the research addressing this relationship.

In this study, a sample of B2B buy-side adopters is identified from B2B buy-side system vendors' news announcements and from Newswire announcements for the period January 1997 to June 2000. This period was selected because it corresponds to the initial use of B2B buy-side systems, as determined by news announcements. Our research methodology follows Kinney and Wempe (2002) that examines the impact of JIT adoption on firm financial performance. Using these B2B buy-side early adopters and industry- and size-matched control firms, we examine changes in return on assets (ROA) from pre- to post-adoption, and find the between-sample difference in ROA changes is highly significant. Similar analyses of profit margin and asset turnover components of ROA suggest that relative ROA improvement derives primarily from profit margin improvement. Further refined analysis indicates that performance improvement is driven by improvement in SG&A. The results are consistent with the hypothesis that B2B adoption improves market transparency and transactional efficiency, which leads to, improved company financial performance.

We find smaller B2B buy-side adopters obtain relatively greater profit gains than larger adopters. We hypothesize this result derives from a relatively greater financial benefit for smaller adopters from improved market transparency. This result is consistent with our supposition that vendors are more likely to compete to gain the attention of large customers due to their substantial revenue and profit opportunities. In contrast, the revenue and profit opportunities offered by smaller customers do not attract the same quantity of competition, nor result in prices as competitive as those obtained by larger firms.

Finally, we find that B2B buy-side adopters experience deterioration in selling and general administrative (SG&A) expense in years prior to adoption, and that B2B buy-side adoption may be viewed as a tactical move (i.e., a quick fix) to address deteriorating SG&A expense efficiency. Since implementation is relatively simple, its benefits are realized relatively quickly

This study is important for a couple of reasons. First, the effects of B2B buy-side adoption on financial performance have not been empirically demonstrated in the literature. There is a general debate whether early adopters of any new technology receive financial benefits over industry counterparts who wait to adopt the new technology (Pacheco-de-Almeida & Zemsky, 2008; Rahman & Hussain, 2008). On the other hand, some studies show that information technology expenditures are positively associated with subsequent firm performance and shareholder returns (Kobelsky et al., 2008). Our study documents adoption of a specific type of e-commerce technology adoption—B2B buy-side for operating inputs— has a positive impact on firms' profitability.

Second, the empirical results from this study may be of interest to purchasing managers, especially those in developing countries where e-commerce is lagging behind the developed

world. We hope these purchasing managers would seriously consider adopting, investing in, and embracing e-commerce technology that can improve their procurement process and improve their firms' financial performance.

The remainder of the paper is organized as follows. Section 2 provides an overview of B2B e-commerce and a literature review of related research. The next section reviews the methodology and develops hypotheses regarding the profitability impact of B2B buy-side adoption. Section 4 presents the results. Finally, Section 5 provides conclusions and limitations of this study.

## OVERVIEW OF THE TYPES OF B2B E-COMMERCE

Table 1 shows that B2B e-commerce can be categorized by the nature of products purchased and the host the platform. With regards to the nature of products, Kaplan and Sawhney (2000) classify business purchases into manufacturing inputs and operating inputs. Manufacturing inputs are the raw materials and components that go directly into a product or production process, e.g., chemicals, computer chips, and airplane turbines. These goods are usually purchased from industry-specific suppliers, and are generally delivered using special logistics and fulfillment mechanisms. On the other hand, operating inputs such as office supplies, computers, airline tickets, and services are generic products and are not generally parts of finished products. They are often called maintenance, repair, and operating (MRO) goods. Suppliers of operating inputs such as Staples, Gateway, and American Express serve a wide range of industries and their products are more likely to be shipped by generalists such as United Parcel Service.

**Table 1: Classification of B2B E-Commerce**

| | Buy-Side | Sell-Side | Market Exchange |
|---|---|---|---|
| **Manufacturing (Vertical Inputs)** In this grid, B2B e-commerce is classified based on products. | | | |
| **Operating (Horizontal Inputs)** In this grid, B2B e-commerce is classified based on who hosts the platform. Buy-side platforms are hosted by buyers, sell-side platforms are hosted by sellers, and market exchange platforms are generally hosted by independent parties who earn commissions on the trades. | **B2B Buy-Side for Operating Input** | | |

B2B can also be categorized based on whether buyer (as in this study) or seller is hosting the platform. Typically the host of a platform is a larger entity relative to the counterparties and would benefit most from the implementation of the system. A platform hosted by an

independent party who earns commission on the trades is called a marketplace. Examples of a marketplace are Elemica and SupplyOn.

B2B buy-side, a system hosted by buyers, offers three potential benefits to adopters: market transparency, purchasing control, and lower administrative (transaction) costs. Market transparency allows buyers to discover new sources of supply, gauge product availability and obtain more accurate and lower market prices. The Internet feature allows buyers to find vendors not only from the same city, but to find vendors from other states, regions, or countries. Buyers can compare offers from different vendors who participate in the B2B buy-side system. With more suppliers, buyers can obtain better purchase terms and compare suppliers' performances.

B2B buy-side improves purchasing control by allowing inclusion of corporate purchasing policies (approval procedures and purchasing limits), lists of preferred suppliers, and volume purchasing agreements to be incorporated within the platform. Most companies have poor control over spending; they allocate total budget amounts but in fact have limited control over exactly what and when employees buy. The National Association of Purchasing Managers estimates that one-third of all corporate purchases are out of compliance with volume purchase agreements, and those mavericks that circumvent these contracts on average pay 18 % – 27 % above the volume purchase agreement price (Phillips & Meeker, 2000). To enhance purchasing control, the B2B buy-side software also offers tracking of suppliers' performance, frequent purchasers, high volume products, and other supporting reports.

Finally, B2B buy-side is expected to decrease administrative costs. The cost of manually processing a purchase order ranges from $125 to $175, but online procurement can decrease the cost to $10 to $15 per order. The reduction of administrative costs derived mainly from a transfer of activities from corporate central procurement to the requisitioner as corporate policies can be incorporated into the system. As a consequence, companies save costs in central purchasing that helps to reduce processing cost for each requisition / purchase order. Reduction in administrative costs can also result from faster approvals and easier, asynchronous communication with suppliers. Finally, better coordination eliminates mistakes in purchase orders and minimizes the time spent on reconciliation. The purchasing process becomes more efficient because it is automated, paperless, and online.

This study examines adopters of B2B buy-side for operating inputs, a specific type of e-commerce system, for three reasons. First, the B2B buy-side for operating inputs is relatively easy to implement. Examination of adoption announcements reveals that the implementation time for the system ranges from three to six months. Second, B2B buy-side for operating inputs is not integrated with production systems; therefore, it allows refined predictions as to where associated benefits will occur (e.g., administration and purchasing costs). Finally, the expected amount of savings is still significant because the amount of operating purchases is substantial. For example, Eastman Chemical Company's annual procurement amounted to more than $3 billion and, on average, operating inputs account for about 20% of the total procurement costs. In term of number of transaction, British Telecom handles 1.3 million purchasing transactions of

indirect goods annually (Commerce One, 1999). Thus B2B buy-side for operating inputs has the potential to offer significant improvement in purchase price and transactional costs.

## LITERATURE REVIEW OF RELATED RESEARCH

There are currently two streams of e-commerce research. The first stream includes studies that evaluate the impact of e-commerce initiatives. These studies include Kaufman et al. (2009), Kotabe et al. (2008), Amblee and Bui (2008), Gregory et al. (2007), Subtramani and Walden (2001), Shankar (2000), Chen and Siems (2001), and Bakos (1997, 1991).

Kauffman et al. (2009) examine e-commerce under channel migration. They propose two pricing strategy models to evaluate how consumer channel migration affects pricing strategy. Findings contribute to better understanding of traditional and Internet-based selling. Findings indicate that in settings of high-level channel migration, a company should manage the two channels as one. On the other hand, in settings of low channel migration, a company should optimize and manage each channel separately. Modeling results were validated by empirical analysis of 10 large South Korean e-commerce companies.

Kotabe et al. (2008) examine the relationship between outsourcing levels and e-commerce. Findings indicate that e-commerce is a factor in determining the optimal point of outsourcing for a firm. The study offers implications for the practice and study of outsourcing and e-commerce. Gregory et al. (2007) develop and test a theoretical model to evaluate how e-commerce drivers affect export marketing strategy. Their findings support including e-commerce constructs into existing theory on export marketing strategy.

Amblee and Bui (2008) evaluate the impact of product reviews in e-commerce. They conducted a longitudinal study involving 395 e-books sold on Amazon's website. One finding was that firms can improve their sales performance by managing their brand portfolio in ways that improve the likelihood of more reviews of their products. Wang and Benbasat (2007) consider trust in and adoption of online agents. Au and Kauffman (2001) examine e-commerce factors such as network externalities, compatibility issues, and e-billing adoption.

Other recent research regarding e-commerce, focusing specifically on B2B, includes a multi-case approach to identify where and how organizations evaluate their B2B e-commerce initiative (Standing & Lin, 2007). Son and Benbasat (2007) examine use of B2B marketplaces. Ordanini (2006) examines what motivates doing business in B2B exchanges. Aklouf et al. (2006) consider ontologies and web services technologies in a B2B products exchange model. Castro-Lacouture and Skibniewski (2006) propose a B2B e-Work system to improve a contract approval process. Dai and Kauffman 2006 consider managerial choices for e-procurement channels. Claycomb et al. (2005) develop models to predict level of B2B e-commerce, using predictor variables such as innovation characteristics, channel factors, and organizational structure. Yoo et al. (2002-3) examine a model for B2B intermediaries.

The second stream of e-commerce research includes studies that identify special characteristics of e-commerce firms to evaluate firm valuation or stock returns (Hand, 2000; Rajgopal et al., 2002; Trueman et al., 2000). The current study considers the financial impact of management's adoption of B2B e-commerce technology for its marketing supply chain. The current study generally adds to the broad stream of research that uses operational information to analyze the financial impact of changes in business techniques or processes, e.g., IT adoption and investment (Au & Kauffman, 2003), activity-based costing (Datar & Gupta, 1994; Ittner et al., 2002), product quality (Nagar & Rajan, 2001), capital budgeting at Caterpillar, Inc. (Miller & O'Leary, 1997), human resource management (Blackwell et al., 1994), and participative budgeting (Kanodia, 1993).

## SAMPLE SELECTION FOR STUDY

The main goal of the sample selection process was to identify a set of observations that represented a homogeneous type of B2B adoption. The time period selected analysis was 1997-June 2000, as this is the period in which B2B buy-side system adoptions were first taking place. The search proceeded in four stages. In the first stage, a prospective list of 174 B2B vendors was obtained from the Morgan Stanley Dean Witter B2B Report entitled '*The B2B Internet Report*.'[2] From this list, we identified eight firms targeting the "procurement" systems market as reported in the "B2B Company Profile Master List" (Phillip & Meeker, 2000, pages 117-120).[3] Second, web sites of the eight firms were searched for announcements of sales and implementations of B2B procurement systems. Three firms (Ariba, Commerce One, and Rightworks) were found to provide announcements regarding adoptions of their B2B buy-side for operating input systems.

In the third stage, an effort was made to add additional sample firms. Lexis-Nexis was searched for B2B buy-side for operating input adoption announcements using keywords "B2B" and "procure" or "buy". Fourth, the announcements of adoptions were read to verify that the systems adopted were for operating input. These four steps identified a total of seven providers (adoptions of systems sold by Oracle, Claris, FreeMarkets, and Intelysis were identified from the Lexis-Nexis search) and 96 adoption announcements for the period 1997- June 2000, with the first announcement appearing in May 1997.[4] Financial information was obtained from the 2002 Compustat file or from 10-K filings. Thirty-four adopters were deleted because they lacked data from publicly-available sources (10-K or Compustat). Our final sample consists of 62 adopters, as shown in Table 2.[5]

Following the studies of firm performance after JIT (Just in Time) adoption (e.g., Balakrishnan et al., 1996; Kinney & Wempe, 2002), this study uses a matched sample to evaluate the profitability impact of B2B buy-side adoption thereby providing controls for general economic, industry, and size effects. Control firms were selected by matching each adopter based on size and industry in the year of adoption ($t_0$). Matched firms with net sales within 70 % to 130 % of each adopter and within the same 4-digit (Standard Industry Code) SIC code were

identified. If no match was found using these criteria, the search proceeded with the same net sales criterion within the 3-digit SIC, and if that search failed, the search was resumed at the 2-digit SIC level. If more than one match was found, then the firm with the lowest absolute difference in net sales was selected as the matched firm for an adopter. Control firm financial statements were reviewed for mention of adoption of B2B buy-side in the sample period. Table 3 lists the adopters and their matched firms.

| **Table 2: Sample Selection** | |
|---|---|
| Number of B2B buy-side system adopters identified by year: | |
| 1997 | 6 |
| 1998 | 33 |
| 1999 | 37 |
| Up to June 2000 | 20 |
| Total adopters identified | 96 |
| Adopters with data missing from publicly-available sources: | -34 |
| Final sample available for testing: | 62 |
| **Notes:** A sample of adopters is identified from announcements found in B2B buy-side providers' news section websites. A list of firms providing B2B procurement platforms is identified from Morgan Stanley's report titled *The B2B Internet Report* dated April 1, 2000. In addition, we searched the Lexis-Nexis Newswire and Business Wire database to identify additional B2B buy-side adoptions. | |

## RESEARCH METHODOLOGY AND HYPOTHESES

The first measure of profitability examined is return on assets (ROA). Paired differences (adopter minus matched firm) in changes in ROA from pre-to post-adoption periods are used to measure the impact of B2B buy-side adoption:

$$DIF\Delta ROA = \Delta ROA_i - \Delta ROA_j \quad (1)$$

in which

i indicates B2B buy-side adopters,

j indicates matched control firms,

ΔROA is post-adoption ROA minus pre-adoption ROA, where ROA is income before extraordinary and special items divided by average total assets.

If adoption improves ROA, then DIFΔROA should be positive. This leads to our first hypothesis.

*H1: Pre- to post-adoption changes in ROA for B2B buy-side adopters exceed those for matched firms.*

Because ROA is an aggregate measure, we decompose ROA into its profit margin and asset turnover components, and conduct tests analogous to those conducted for ROA.

$$DIF\Delta PM = \Delta PM_i - \Delta PM_j \quad (2)$$

$$DIF\Delta AT = \Delta AT_i - \Delta AT_j \quad (3)$$

in which

$\Delta PM$ is post-adoption profit margin minus pre-adoption profit margin where profit margin is income before extraordinary and special items divided by net sales, and

$\Delta AT$ is post-adoption asset turnover minus pre-adoption asset turnover where asset turnover is net sales divided by average total assets.

**Table 3: B2B Buy-Side Adopters and Matched Control Firms**

| No. | Adopters | Matched Firms |
|---|---|---|
| 1 | ADVANCED MICRO DEVICES | NATIONAL SEMICONDUCTOR CORP |
| 2 | ALCOA INC | CORUS GROUP |
| 3 | ALLTEL CORP | VODAFONE GROUP |
| 4 | APPLIED MATERIALS INC | DOVER CORP |
| 5 | AUTODESK INC | SYNOPSYS INC |
| 6 | BAKER-HUGHES INC | BLACK & DECKER CORP |
| 7 | BELL CANADA | ROYAL KPN NV |
| 8 | BOEING CO | HONDA MOTOR LTD |
| 9 | BRISTOL MYERS SQUIBB | ROCHE HOLDINGS LTD |
| 10 | CANADIAN NATIONAL RAILWAY CO | NORFOLK SOUTHERN RAILWAY VA |
| 11 | CATERPILLAR INC | SANYO ELECTRIC CO LTD |
| 12 | CHEVRONTEXACO CORP | USX CORP |
| 13 | CISCO SYSTEMS INC | SUN MICROSYSTEMS INC |
| 14 | CITIGROUP INC | GENERAL ELECTRIC CAPITAL SVC |
| 15 | COMPAQ COMPUTER CORP | NEC CORP |
| 16 | COMTECH TELECOMMUN | BLONDER TONGUE LABS INC |
| 17 | CREDIT SUISSE FIRST BOS USA | BEAR STEARNS COMPANIES INC |
| 18 | CYPRESS SEMICONDUCTOR CORP | LINEAR TECHNOLOGY CORP |
| 19 | DIAGEO PLC | COCA-COLA CO |
| 20 | DU PONT | DOW CHEMICAL |
| 21 | DYNEGY INC | SHELL OIL CO |
| 22 | EARTHGRAINS CO | COORS (ADOLPH) |
| 23 | EASTMAN CHEMICAL CO | ROHM & HAAS CO |
| 24 | EDWARDS J D & CO | SYBASE INC |
| 25 | FEDERAL EXPRESS CORP | DELTA AIR LINES INC |
| 26 | FORD MOTOR CO | TOYOTA MOTOR CORP |
| 27 | FRESH DEL MONTE PRODUCE INC | CHIQUITA BRANDS INTL |
| 28 | FULLER (H. B.) CO | CYTEC INDUSTRIES INC |
| 29 | GENERAL ELECTRIC CO | SIEMENS A G |
| 30 | GENERAL MILLS INC | KELLOGG CO |
| 31 | GENERAL MOTORS CORP | DAIMLERCHRYSLER AG |
| 32 | HARLEY-DAVIDSON INC | BORG WARNER INC |
| 33 | HD VEST INC | FRIEDMN BILLINGS RMSY |
| 34 | HEWLETT-PACKARD CO | TOSHIBA CORP |
| 35 | HORMEL FOODS CORP | INTERSTATE BAKERIES CP |
| 36 | INVESTMENT TECHNOLOGY GP INC | NATIONAL DISC BROKERS INC |
| 37 | LANDS END INC | SYSTEMAX INC |
| 38 | LEXMARK INTL INC | MAXTOR CORP |
| 39 | LILLY (ELI) & CO | SCHERING-PLOUGH |
| 40 | MERCK & CO | JOHNSON & JOHNSON |
| 41 | MORGAN STANLEY | MERRILL LYNCH & CO |
| 42 | MOTOROLA INC | ERICSSON |
| 43 | NOVELL INC | INTERGRAPH CORP |
| 44 | OFFICE DEPOT INC | STAPLES INC |

| Table 3: B2B Buy-Side Adopters and Matched Control Firms | | |
|---|---|---|
| No. | Adopters | Matched Firms |
| 45 | PACIFIC GAS & ELECTRIC CO | AQUILA INC |
| 46 | PEOPLESOFT INC | ELECTRONIC ARTS INC |
| 47 | PEROT SYSTEMS CORP | DST SYSTEMS INC |
| 48 | PITNEY BOWES INC | SKF AB |
| 49 | PRICE (T. ROWE) GROUP | UNITED ASSET MGMT CORP |
| 50 | RAYTHEON CO | EASTMAN KODAK CO |
| 51 | SEAGATE TECHNOLOGY | EMC CORP/MA |
| 52 | SHAW INDUSTRIES INC | MOHAWK INDUSTRIES INC |
| 53 | SONOCO PRODUCTS CO | SEALED AIR CORP |
| 54 | SPX CORP | AVX CORP |
| 55 | ST PAUL COS | CHUBB CORP |
| 56 | TEXAS INSTRUMENTS INC | SOLECTRON CORP |
| 57 | UNILEVER | NESTLE S A |
| 58 | UNITED TECHNOLOGIES CORP | LOCKHEED MARTIN CORP |
| 59 | WELLPOINT HLTH NETWRK | HEALTH NET INC |
| 60 | WELLS FARGO & CO | WACHOVIA CORP |
| 61 | WORLDCOM INC | BCE INC |
| 62 | XEROX CORP | CANON INC |

**Notes:** Matched firms are selected based on net sales and SIC code in the year of adoption. First, we try to identify firms with net sales within 30% of each adopter's net sales in the same 4-digit SIC code. If no firms are found then we proceed to find firms within the same 3-digit SIC code and finally firms within the same 2-digit SIC code. If multiple firms are identified as a potential match, then the firm with the smallest absolute difference in net sales is selected.

Atkinson et al. (2001, page 543) describe asset turnover as a measure of productivity – the ability to generate sales with a given level of investment, and profit margin as a measure of efficiency – the ability to control costs at a given level of sales activity. Adoption of B2B buy-side is expected to decrease purchasing and administrative costs. Therefore, we expect that adopters improve profit margin. By making the purchasing process more efficient, a given level of investment should support a higher level of sales. It this conjecture is true then we may find an increase in asset turnover ratio. This leads to our second and third hypotheses:

*H2: The pre- to post-adoption profit margin changes of adopters significantly exceed those of matched firms.*

*H3: The pre- to post-adoption asset turnover ratio changes of adopters significantly exceed those of matched firms.*

Finding significant improvement in profit margin alone is insufficient evidence to conclude that the improvement is attributable to B2B buy-side adoption. For example, improvement in profit margin due to higher net sales, as the result of lower returns, or to lower bad debt provisions is not consistent with the benefits of B2B buy-side adoption. Because evaluation of actual performance using a longer window is subject to the possibility that other factors produce observed results, identifying specific financial measures in which the expected benefits should occur is a means of providing additional assurance that the results are consistent. Therefore, we test whether adopters achieve greater improvement in operating income before depreciation (OIBD).[6] Subsequently we examine relative changes in CGS and SG&A.

$$DIF\Delta OIBD = \Delta OIBD_i - \Delta OIBD_j \quad (4)$$
$$DIF\Delta CGS = \Delta CGS_i - \Delta CGS_j \quad (5)$$
$$DIF\Delta SG\&A = \Delta SG\&A_i - \Delta SG\&A_j \quad (6)$$

in which

ΔOIBD is post-adoption minus pre-adoption operating income before depreciation,

ΔCGS is post-adoption minus pre-adoption cost of goods sold,

ΔSG&A is post-adoption SG&A expense minus pre-adoption SG&A expense. SG&A expense is calculated as net sales minus operating income minus cost of goods sold.[7]

Higher profit margins from lower purchasing and administrative costs should be reflected in a higher proportion of operating income before depreciation to net sales. This leads to our fourth hypothesis.

*H4: The pre- to post-adoption changes in proportion of operating income to sales of adopters exceed those of matched firms.*

If adoption of B2B buy-side reduces purchasing costs and administrative expenses, then we expect to see lower SG&A expense.[8] Therefore, from this we derive our fifth hypothesis.

*H5: The pre- to post-adoption changes in proportion of SG&A expense to sales for adopters are significantly more negative than those for matched firms.*

If some B2B buy-side purchases represent items belonging to manufacturing overhead, adoption of B2B could result in lower CGS as well as lower SG&A. If so, we expect CGS as a proportion of sales to decline after B2B adoption. This leads to our sixth hypothesis.

*H6: The pre- to post-adoption changes in proportion of cost of goods sold to sales for adopters are significantly more negative than those for matched firms.*

B2B buy-side adoption may benefit smaller firms to a greater extent than larger firms. The financial gains from B2B buy-side adoption are likely to derive primarily from improved market transparency and secondarily from reduced transactions costs and improved internal process transparency. The aggregate benefits captured by smaller adopters should exceed those of larger adopters because the potential to improve market transparency is greater for smaller firms. Large firms can exploit scale economy advantages to reduce transaction costs and can

wield the promise of volume purchasing to elicit competitive pricing from vendors. Thus, we anticipate that the relative profit gains of smaller adopters will exceed those of larger adopters. We partition the sample firms into two groups by size (net sales). Those with net sales above (below) the median net sales are classified as larger (smaller) firms. This leads to our seventh hypothesis.

*H7: The relative pre- to post-adoption profit gains of smaller B2B adopters will exceed those of larger adopters.*

We define the B2B buy-side pre-adoption period as the adoption year and the two preceding years, and the post-adoption period as the year following adoption. We use one-year post-adoption period for two reasons. First, B2B buy-side for operating inputs is relatively simple to implement and to use. Because the system can be typically implemented in only 3 to 6 months, we expect the benefits of this system to materialize quickly but they would disappear relatively quickly because it is easy to mimic. Indeed our robustness test (unreported) show that adopters benefits are significant in the first two years after adoption but disappeared afterward. Second, using a longer observation period may allow other subsequent events to confound the validity of the analysis.

## MAIN RESULTS ON FIRM PERFORMANCE

Data reported in Table 4 indicate that B2B buy-side adopters represent many industries, but that industrial machinery and computer equipment is the most prevalent industry with 12.9 % of the total observations (Table 3 Panel A). Table 4, Panel B, indicates that more adoptions occurred in 1998 and 1999 than in 1997 or 2000; however, our sample includes only partial-year data for 2000. In Panel A, Table 5, are descriptive statistics for the three-year, pre-adoption period (t-2 to t0) for adopters and matched firms, and in Panel B are statistics for the adoption year (t0) only.

Statistics in Table 5 show that distributions of financial attributes are positively skewed; therefore, both means and medians are displayed. In Panel A, profitability and efficiency measures in the pre-adoption period including ROA, profit margin, and asset turnover do not significantly differ between adopters and matched firms.[9] Our proxies for leverage (Debt to Asset ratio) and fixed costs (Depreciation/CGS) do not significantly differ between the samples.

Although a size criterion is used in the matching process, as shown in Panel B, adopters are larger than matched firms. Mean (median) total assets of adopters is $53,818 million ($9,016 million) and for matched firms mean (median) total assets is $34,826 million ($5,796 million). The mean (median) paired difference in total assets is $18,986 million ($989 million) and is significant at $p = 0.062$ ($p = 0.009$). Mean (median) net sales of adopters is $19,782 million ($8,533 million) and for matched firms mean (median) net sales is $17,596 million ($7,815

million).[10] The mean (median) paired difference in net sales is $2,187 million ($12 million) and is significant (insignificant) at p = 0.068 (p = 0.270). However, there is no statistically significant difference between the samples in the size of inventory.

H1 through H3, respectively, express our expectations regarding differences between adopters and matched firms in pre- to post-adoption changes for ROA, profit margin and asset turnover. Table 6, Panel A, indicates the mean ROA of adopters insignificantly increases from 6.83 % in the pre-adoption period to 6.90 % in the post-adoption period (p = 0.92). The median ROA (Panel B) decreases from 5.61 % to 5.39 %, which is statistically insignificant (p = 0.95).

**Table 4: Descriptive Statistics of B2B Buy-Side Adopters and Matched Firms**

**Panel A: Distribution of 2-digit industry classification**

| SIC Code | Industry Description | No. of firms | Percent |
|---|---|---|---|
| 01 | Agriculture Production - Crops | 1 | 1.6 |
| 13 | Oil and Gas Extraction | 2 | 3.2 |
| 20 | Food and Kindred Products | 5 | 8.1 |
| 22 | Textile Mill Products | 1 | 1.6 |
| 26 | Paper and Allied Products | 1 | 1.6 |
| 28 | Chemical and Allied Products | 6 | 9.7 |
| 29 | Petroleum Refining and Related Industries | 1 | 1.6 |
| 33 | Primary Metal Industries | 1 | 1.6 |
| 35 | Industrial Machinery & Computer Equipment | 8 | 12.9 |
| 36 | Electronic and Other Electrical Equipment | 6 | 9.7 |
| 37 | Transportation Equipment | 5 | 8.1 |
| 38 | Measurement Instrument and Photographic Goods | 1 | 1.6 |
| 40 | Railroad Transportation | 1 | 1.6 |
| 42 | Motor Freight Transportation and Warehouse | 1 | 1.6 |
| 45 | Transportation by Air | 1 | 1.6 |
| 48 | Communications | 3 | 4.8 |
| 49 | Electric, Gas, and Sanitary Services | 1 | 1.6 |
| 59 | Miscellaneous Retail | 2 | 3.2 |
| 60 | Depository Institution | 1 | 1.6 |
| 61 | Nondepository Credit Institution | 1 | 1.6 |
| 62 | Security and Commodity Brokers | 5 | 8.1 |
| 63 | Insurance Carriers | 2 | 3.2 |
| 73 | Business Services | 5 | 8.1 |
| 99 | Nonclassifiable Establishment | 1 | 1.6 |
| | Total | 62 | 100.0 |

**Panel B: Distribution of B2B Buy-side sample firms by years**

| Adoption Year | No. of firms | Percent |
|---|---|---|
| 1997 | 4 | 6.5 |
| 1998 | 22 | 35.5 |
| 1999 | 22 | 35.5 |
| To June 2000 | 14 | 14.5 |
| Total | 62 | 100.0 |

The mean ROA for matched firms decreases significantly from 6.48 % in the pre-adoption period to 3.61 % in the post-adoption period (p = 0.01). The decrease in median ROA for matched firms is similar in magnitude and significance to the decrease in mean ROA. Consistent with H1, the between-sample mean (median) paired difference in ROA change is 2.94 % (0.63 %). A one-tailed t-test (Wilcoxon sign-rank test) is significant at p = 0.01 (p = 0.03).

**Table 5: Financial Attributes of Adopters and Matched Firms**

**Panel A: Financial attributes; (t-2,t-1, and t0)**

| | | B2B adopters | | Matched firms | | Paired differences | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Firm attribute[a] | | Mean | Median | Mean | Median | Mean | Median | S. Dev | p-value Mean[b] | p-value Median[c] |
| ROA (%) | | 6.83 | 5.61 | 6.48 | 5.56 | 0.35 | 0.12 | 7.88 | 0.7259 | 0.8598 |
| Profit Margin (%) | | 6.54 | 5.54 | 6.68 | 5.63 | -0.14 | -0.06 | 8.33 | 0.8925 | 0.5532 |
| Asset Turnover | | 1.16 | 1.02 | 1.12 | 1.03 | 0.04 | -0.08 | 0.77 | 0.7100 | 0.2918 |
| Debt to Asset Ratio | | 0.61 | 0.62 | 0.60 | 0.60 | 0.02 | 0.01 | 0.19 | 0.5014 | 0.4844 |
| Fixed Cost Ratio | | 0.12 | 0.07 | 0.10 | 0.08 | 0.02 | 0.00 | 0.10 | 0.1129 | 0.6989 |

**Panel B: Financial attributes (at t0)**

| | | B2B adopters | | Matched firms | | Paired differences | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Firm attribute[a] | | Mean | Median | Mean | Median | Mean | Median | S. Dev | p-value Mean[b] | p-value Median[c] |
| Inventory ($MM) | | 6,707 | 439 | 4,153 | 451 | 2,664 | -7 | 16,912 | 0.2234 | 0.7802 |
| Total Assets ($MM) | | 53,813 | 9,016 | 34,826 | 5,796 | 18,986 | 989 | 78,629 | **0.0620** | **0.0093** |
| Net Sales ($MM) | | 19,782 | 8,533 | 17,596 | 7,815 | 2,187 | 12 | 9,256 | **0.0677** | 0.2699 |

**Notes:**

[a] ROA = income before extraordinary and special items / average total assets. Profit margin = income before extraordinary and special items / sales. Asset turnover = sales / average total assets. Debt to asset ratio = total liabilities / total assets. Fixed cost ratio = depreciation / cost of goods sold.

[b] p-values are the significance levels from two-tailed t-tests.

[c] p-values are the significance levels from two-tailed Wilcoxon signed rank tests.

Mean (median) profit margin of adopters increased from the pre-adoption level of 6.54 % (5.54 %) to 7.52 % (6.53 %) post adoption. The mean (median) change is insignificant at p = 0.27 (p = 0.22). The mean (median) profit margin of matched firms decreased from 6.68 % (5.63 %) pre-adoption to 4.98 % (4.60 %) post adoption. The one-tailed t-test (Wilcoxon test) of change in mean (median) is insignificant; p = 0.16 (p = 0.23). It is interesting to note that the profit margin changes for adopters and matched firms move in opposite directions. The between-sample change in mean (median) profit margin is 2.68 (0.51) and is significant at p = 0.01 (p = 0.06). We interpret this evidence as support for H2.

Asset turnover decreases for both adopters and matched firms from pre-adoption to post-adoption. The decrease in mean (median) asset turnover of 0.09 (0.05) for adopters is significant at p < 0.01 (p< 0.01) and the mean (median) decrease of 0.09 (0.29) for matched firms is significant at p = 0.02 (p < 0.01). A one-tailed mean (median) test of between-sample differences in asset turnover is statistically insignificant; p = 0.47 (p = 0.34). These results

are contrary to our expectation expressed in H3; the ROA benefit of B2B adoption appears to derive solely from improved profit margin.

**Table 6: Test of Changes in ROA, Profit Margin, and Asset Turnover**

**Panel A: Mean analysis**

| | B2B Adopter | Matched Firms | Paired Difference | | |
|---|---|---|---|---|---|
| Variables[a] | Mean | Mean | Mean | Std Dev | t-test[b] |
| ROA (%) | | | | | |
| Pre-adoption (t-2, t-1 and t0) | 6.83 | 6.48 | 0.35 | 7.88 | 0.7259 |
| Post-adoption (t1) | 6.90 | 3.61 | 3.29 | 10.85 | **0.0200** |
| Change | 0.07 | -2.87 | 2.94 | 9.11 | **0.0068** |
| p-value, intra-sample change[b] | 0.9187 | **0.0102** | | | |
| Profit Margin (%) | | | | | |
| Pre-adoption (t-2, t-1 and t0) | 6.54 | 6.68 | -0.14 | 8.33 | 0.8925 |
| Post-adoption (t1) | 7.52 | 4.98 | 2.54 | 11.75 | **0.0945** |
| Change | 0.98 | -1.70 | 2.68 | 9.34 | **0.0138** |
| p-value, intra-sample change[b] | 0.2719 | 0.1629 | | | |
| Asset Turnover | | | | | |
| Pre-adoption (t-2, t-1 and t0) | 1.16 | 1.12 | 0.04 | 0.77 | 0.7102 |
| Post-adoption (t1) | 1.08 | 1.04 | 0.04 | 0.72 | 0.6675 |
| Change | -0.09 | -0.09 | 0.00 | 0.34 | 0.4743 |
| p-value, intra-sample change[b] | **0.0018** | **0.0192** | | | |

**Panel B: Median analysis**

| | B2B Adopter | Matched Firms | Paired Difference | | |
|---|---|---|---|---|---|
| Variables[a] | Median | Median | Median | Std Dev | median test[c] |
| ROA (%) | | | | | |
| Pre-adoption (t-2, t-1 and t0) | 5.61 | 5.56 | 0.12 | 7.88 | 0.8598 |
| Post-adoption (t1) | 5.39 | 3.54 | 1.63 | 10.85 | **0.0057** |
| Change | 0.13 | -0.63 | 0.63 | 9.11 | **0.0306** |
| p-value, intra-sample change[c] | 0.9475 | **0.0212** | | | |
| Profit Margin (%) | | | | | |
| Pre-adoption (t-2, t-1 and t0) | 5.54 | 5.63 | -0.06 | 8.33 | 0.5532 |
| Post-adoption (t1) | 6.53 | 4.60 | 2.75 | 11.75 | **0.0452** |
| Change | 0.47 | -0.12 | 0.51 | 9.34 | **0.0624** |
| p-value, intra-sample change[c] | 0.2160 | 0.2322 | | | |
| Asset Turnover | | | | | |
| Pre-adoption (t-2, t-1 and t0) | 1.02 | 1.03 | -0.08 | 0.77 | 0.2918 |
| Post-adoption (t1) | 0.94 | 0.94 | -0.02 | 0.72 | 0.8980 |
| Change | -0.05 | 0.29 | 0.00 | 0.34 | 0.3426 |
| p-value, intra-sample change[c] | **<0.0001** | **0.0013** | | | |

**Notes:**

[a] ROA = income before extraordinary and special items/average total assets. Profit margin = income before extraordinary items/sales. Asset turnover = sales/average total assets. Pre-adoption ROA = $(ROA_{t-2} + ROA_{t-1} + ROA_{t0})/3$. Pre-adoption Profit Margin = $(\text{Profit Margin}_{t-2} + \text{Profit Margin}_{t-1} + \text{Profit Margin}_{t0})/3$. Pre-adoption Asset Turnover = $(\text{Asset Turnover}_{t-2} + \text{Asset Turnover}_{t-1} + \text{Asset Turnover}_{t0})/3$.

[b] For intra-sample tests, p-values are from two-tailed t tests. For paired differences of pre-adoption and post-adoption tests, p-values are also from two-tailed t-tests. P-values for tests of paired differences of change in ROA, profit margin, and asset turnover are from one-tailed t-tests.

[c] For intra-sample tests and paired differences of pre-adoption and post-adoption tests, p-values are from two-tailed signed rank tests. P-values for tests of paired differences of change in ROA, profit margin and asset turnover are from one-tailed signed rank tests.

We conduct a test to assess effects of relative changes in profit margin and asset turnover on relative change in ROA. In this test we examine the ROA effect of relative changes in profit margins by holding the asset turnover at the adopter's pre-adoption level. A like analysis was conducted on asset turnover. Results suggest profit margin dominates asset turnover in explaining the change in relative ROA.[11]

H4 expresses our expectations regarding differences between adopters and matched firms in pre- to post-adoption changes in operating income scaled by sales. H5 and H6 express our expectations regarding differences between adopters and matched firms in pre- to post-adoption changes in SG&A and CGS. To test H5 and H6 requires that we disaggregate operating expenses into two ratios: SG&A expenses scaled by sales, and CGS scaled by sales. Table 7, Panel A, shows that the mean proportion of operating income before depreciation to sales insignificantly increased for adopters ($p = 0.58$) but significantly decreased for matched firms ($p = 0.05$). The paired difference in mean change of the proportion in operating income to net sales is 1.73 % and is significant at $p = 0.02$. Median values show similar changes. The mean 1.73 % improvement in operating income before depreciation to sales is within the 1 % to 6 % projection of Boston Consulting Group (Brewton & Kingseed, 2001). We interpret these results as supporting H4.

The primary, expected benefit of B2B buy-side adoption is lower administrative expenses. The mean SG&A expense expressed as a percentage of sales declines from 18.04 to 17.67 and is statistically insignificant; $p = 0.34$. The median SG&A expense expressed as a percentage of sales increases from 16.97 to 17.17 and is also statistically insignificant; $p = 0.88$. The mean SG&A expense as a percentage of sales increases insignificantly for matched firms; $p = 0.22$. The median SG&A expense as a percentage of sales decreases insignificantly for matched firms; $p = 0.94$. The mean (median) between-sample difference in change of the proportion of SG&A expense to sales is –0.91 (-0.00) and is significant at $p = 0.05$ ($p = 0.30$). We interpret these results as providing modest support for H5.

To provide an economic interpretation of the change in SG&A expense, we observe from Table 7 that mean pre-adoption SG&A for adopters is 18.04 % of sales, and the mean, relative, pre-to-post SG&A cost savings of adopters is 0.91 % of sales. Multiplying 0.91% by mean pre-adoption sales of adopters ($18,384 million from Table 5) yields a mean SG&A cost savings of $167 million.

A secondary, expected benefit of B2B buy-side adoption is lower CGS. Table 7 shows the mean (median) CGS expressed as a percentage of sales changed from 61.06 (64.35) to 61.05 (65.87) for adopters which is insignificant; $p = 0.99$ ($p = 0.39$). For matched firms, the mean (median) measure changed from 62.14 (65.68) to 62.96 (66.88) which is insignificant; $p = 0.19$ ($p = 0.26$). The mean (median) paired difference in change of the proportion of cost of goods sold to sales is –0.82 (-0.66) and is marginally significant at $p = 0.12$ ($p = 0.11$). We interpret these data as providing limited support for H6.

| Table 7: Test of Changes in Operating Income before Depreciation, SG&A, and CGS | | | | | |
|---|---|---|---|---|---|
| **Panel A: Mean analysis** | | | | | |
| | B2B Adopter | Matched Firms | Paired Difference | | |
| Variables[a] | Mean | Mean | Mean | Std Dev | t-test[b] |
| Operating Income Before Dep. (OIBD) | | | | | |
| Pre-adoption (t-2, t-1 and t0) | 20.90 | 18.81 | 2.09 | 10.05 | 0.1156 |
| Post-adoption (t1) | 21.27 | 17.45 | 3.82 | 11.36 | **0.0124** |
| Change | 0.37 | -1.36 | 1.73 | 6.02 | **0.0156** |
| p-value, intra-sample change[b] | 0.5842 | **0.0540** | | | |
| SG&A | | | | | |
| Pre-adoption (t-2, t-1 and t0) | 18.04 | 19.05 | -1.01 | 13.44 | 0.5652 |
| Post-adoption (t1) | 17.67 | 19.59 | -1.92 | 13.20 | 0.2692 |
| Change | -0.36 | 0.54 | -0.91 | 4.18 | **0.0507** |
| p-value, intra-sample change[b] | 0.3446 | 0.2172 | | | |
| CGS | | | | | |
| Pre-adoption (t-2, t-1 and t0) | 61.06 | 62.14 | -1.08 | 16.71 | 0.6221 |
| Post-adoption (t1) | 61.05 | 62.96 | -1.90 | 17.96 | 0.4194 |
| Change | -0.01 | 0.81 | -0.82 | 5.40 | 0.1232 |
| p-value, intra-sample change[b] | 0.9880 | 0.1910 | | | |
| **Panel B: Median analysis** | | | | | |
| | B2B Adopter | Matched Firms | Paired Difference | | |
| Variables[a] | Median | Median | Median | Std Dev | median test(c) |
| Operating Income Before Dep. (OIBD) | | | | | |
| Pre-adoption (t-2, t-1 and t0) | 17.10 | 14.98 | 1.70 | 10.05 | **0.0853** |
| Post-adoption (t1) | 17.09 | 13.44 | 3.50 | 11.36 | **0.0031** |
| Change | 0.36 | -0.04 | 1.12 | 6.02 | **0.0154** |
| p-value, intra-sample change[c] | 0.1889 | 0.2708 | | | |
| | | | | | |
| SG&A | | | | | |
| Pre-adoption (t-2, t-1 and t0) | 16.97 | 18.45 | 0.00 | 13.44 | 0.6405 |
| Post-adoption (t1) | 17.17 | 16.40 | 0.00 | 13.20 | 0.2578 |
| Change | 0.00 | 0.00 | 0.00 | 4.18 | 0.3009 |
| p-value, intra-sample change[c] | 0.8817 | 0.9425 | | | |
| CGS | | | | | |
| Pre-adoption (t-2, t-1 and t0) | 64.35 | 65.68 | -1.21 | 16.71 | 0.4780 |
| Post-adoption (t1) | 65.87 | 66.88 | -3.42 | 17.96 | 0.3123 |
| Change | -0.73 | 0.19 | -0.66 | 5.40 | 0.1137 |
| p-value, intra-sample change[c] | 0.3941 | 0.2643 | | | |

**Notes:**

[a] OIBD = (sales – cost of goods sold – selling, general and administrative expenses) / sales. Relative to income before extraordinary and special items, this measure excludes depreciation, interest (income) expense, minority interest, and income taxes. SG&A = selling, general and administrative expenses / sales. CGS = cost of goods sold / sales. Pre-adoption OIBD = $(OIBD_{t-2} + OIBD_{t-1} + OIBD_{t0})/3$. Pre-adoption SG&A = $(SG\&A_{t-2} + SG\&A_{t-1} + SG\&A_{t0})/3$. Pre-adoption CGS = $(CGS_{t-2} + CGS_{t-1} + CGS_{t0})/3$.

[b] For intra-sample tests, paired differences of pre-adoption and post-adoption tests, p-values are from two-tailed t tests. P-values for tests of paired differences of changes in Operating income before depreciation, SG&A, and CGS are from one-tailed t-tests.

[c] For intra-sample tests, paired differences of pre-adoption and post-adoption tests, p-values are from two-tailed signed rank tests. P-values for tests of paired differences of changes in Operating income before depreciation, SG&A, and CGS are from one-tailed signed rank tests.

From the pre- to post-adoption period, B2B firms, relative to matched firms, reduced mean SG&A approximately 5 % (0.91 ÷ 18.04) while adopters' mean CGS decreased relative to matched firms by 1% (0.82 ÷ 61.06). These findings are consistent with the primary benefit of B2B buy-side adoption being reduced SG&A expense. Differences in median statistics are less

supportive of this expectation and suggest the improvement in SG&A and CGS may vary substantially across adopters.

## LARGE FIRMS VERSUS SMALL FIRMS

We state in H7 that we expect a greater profit improvement effect for small adopters than for large adopters. To test H7 we partition the sample based on sales magnitude in the pre-adoption period. Firms with sales above (below) the median are classified as large (small) firms. In Table 8 we report data for the small (top panel) and large (bottom panel) subsamples similar to those data provided in Table 7 for the original sample. All variables are scaled by sales.

Table 8 data suggest smaller adopters drive the overall improvement in profit margin of adopters. Although pre- to post-adoption pair-wise change in operating income for small adopters is 3.16 % and is significant ($p < 0.01$), the pair-wise increase of 0.25 % for large adopters is insignificant ($p = 0.42$).

It appears that large firms, sans B2B technology, more easily obtain market transparency and competitive pricing. Because large firms represent a substantial revenue and profit opportunity for vendors, vendors are more likely to seek out and to spend marketing budgets to gain the attention of such customers. Furthermore, because vendors are aware that large customers attract similar attention from competitors, vendors are more likely to offer competitive bids to capture the business.

Alternatively, the revenue and profit opportunities offered by smaller customers do not attract the same quantity of competition, nor result in prices as competitive as those obtained by larger firms. The cost of a competitive marketing effort to attract business of smaller firms is more difficult to justify for vendors. With the implementation of B2B, large customers can only marginally enhance the competition among their vendors, because even before implementing B2B, significant competition existed among vendors. However, smaller B2B adopters can potentially improve the competition in their procurement markets dramatically because the costs vendors incur to enter into the competition are minimal relative to conventional marketing efforts. Hence, smaller B2B adopters enjoy substantially more incremental improvement in market transparency relative to large B2B adopters.

Table 8 also suggests that the relative improvement in profit margin of small adopters derives largely from relative improvement in SG&A. Small adopters reduced SG&A, relative to matched firms, by 2.04% which is significant at $p = 0.02$. In contrast large adopters' SG&A, relative to matched firms, insignificantly increased from pre-to post-adoption. Also noteworthy in Table 8 are the marginally significant results indicating large adopters' SG&A is lower than matched firms in both the pre-adoption ($p = 0.09$) and post-adoption ($p = 0.11$) periods. Conversely, even though small adopters enjoy a significant pre- to post-adoption reduction in SG&A, relative to matched firms, there is no significant difference in post-adoption SG&A levels between small adopters and matched firms.

| Table 8: Differences in OIBD, SG&A, and CGS between Small and Large Firms | | | | | |
|---|---|---|---|---|---|
| **Panel A: Small firms (N=31)[a]** | | | | | |
| | Adopter | Matched | Paired Differences | | |
| Variables[b] | Mean | Mean | Mean | Std. Dev. | t-test[c] |
| Operating Income Before Depr. (OIBD) | | | | | |
| Pre-adoption | 19.44 | 18.42 | 1.02 | 10.94 | 0.6126 |
| Post-Adoption | 20.47 | 16.29 | 4.18 | 12.81 | 0.0604 |
| Change | 1.03 | (2.13) | 3.16 | 10.60 | **0.0021** |
| p-value, intra-sample change[c] | 0.1864 | **0.0316** | | | |
| SG&A | | | | | |
| Pre-adoption | 22.38 | 19.98 | 2.40 | 12.15 | 0.2890 |
| Post-Adoption | 21.55 | 21.20 | 0.35 | 12.07 | 0.8743 |
| Change | (0.82) | 1.22 | (2.04) | 4.97 | **0.0161** |
| p-value, intra-sample change[c] | 0.2381 | 0.1143 | | | |
| CGS | | | | | |
| Pre-adoption | 58.18 | 61.60 | (3.42) | 14.59 | 0.2096 |
| Post-Adoption | 57.97 | 62.51 | (4.54) | 14.91 | 0.1064 |
| Change | (0.21) | 0.91 | (1.12) | 5.08 | 0.1222 |
| p-value, intra-sample change[c] | 0.7417 | 0.2585 | | | |
| **Panel B: Large firms (N=31)[a]** | | | | | |
| | Adopter | Matched | Paired Differences | | |
| Variables[b] | Mean | Mean | Mean | Std. Dev. | t-test[c] |
| Operating Income Before Depr. (OIBD) | | | | | |
| Pre-adoption | 22.41 | 19.21 | 3.19 | 9.10 | 0.0691 |
| Post-Adoption | 22.10 | 18.66 | 3.44 | 12.07 | 0.1358 |
| Change | (0.31) | (0.55) | 0.25 | 6.19 | 0.4157 |
| p-value, intra-sample change[c] | 0.5088 | 0.6075 | | | |
| SG&A | | | | | |
| Pre-adoption | 13.54 | 18.08 | (4.54) | 13.99 | 0.0918 |
| Post-Adoption | 13.66 | 17.92 | (4.27) | 14.11 | 0.1147 |
| Change | 0.11 | (0.16) | 0.27 | 2.78 | 0.3013 |
| p-value, intra-sample change[c] | 0.9937 | 0.6910 | | | |
| CGS | | | | | |
| Pre-adoption | 64.05 | 62.70 | 1.34 | 18.59 | 0.7002 |
| Post-Adoption | 64.24 | 63.42 | 0.82 | 0.21 | 0.8306 |
| Change | 0.19 | 0.71 | (0.52) | 5.72 | 0.3146 |
| p-value, intra-sample change[c] | 0.8845 | 0.5599 | | | |

**Notes:**

[a] Firms are partitioned by net sales. 31 firms with net sales below the median are classified as small firms and the other 31 firms are large.

[b] OIBD = (sales – cost of goods sold – selling, general and administrative expenses) / sales. Relative to income before extraordinary and special items, this measure excludes depreciation, interest (income) expense, minority interest, and income taxes. SG&A = selling, general and administrative expenses / sales. CGS = cost of goods sold / sales. Pre-adoption OIBD = $(OIBD_{t-2} + OIBD_{t-1} + OIBD_{t0})/3$. Pre-adoption SG&A = $(SG\&A_{t-2} + SG\&A_{t-1} + SG\&A_{t0})/3$. Pre-adoption CGS = $(CGS_{t-2} + CGS_{t-1} + CGS_{t0})/3$.

[c] For intra-sample tests, paired differences of pre-adoption and post-adoption tests, p-values are from two-tailed t tests. P-values for tests of paired differences of changes in Operating income before depreciation, SG&A, and CGS are from one-tailed t-tests.

Some reduction in CGS is observed for smaller adopters. However, the reduction of 1.12 %, relative to matched firms, is only marginally significant; p = 0.12. The relative improvement of 0.52 % for large adopters is insignificant; p = 0.31. To summarize our assessment of Table 8 data, we conclude H4 through H6 are more strongly supported for small adopters than for large adopters. Thus, we find substantial support for H7.

To further explore the influences of firm size and B2B adoption on the changes in CGS and SG&A, we estimate full and reduced versions of the following model:

$$DIF\Delta PM = \alpha + \beta1(SIZEDUM) + \beta2(DIF\Delta SG\&A) + \beta3(DIF\Delta CGS) + \beta4(SIZEDUM \times DIF\Delta SG\&A) + \beta5(SIZEDUM \times DIF\Delta CGS) + \varepsilon \quad (7)$$

in which,

DIFΔPM is the adopter's pre- to post-adoption change in profit margin less the like change for the adopter's matched firm,

SIZEDUM is a dummy variable assigned the value of 1 for small adopters (those 31 firms with net sales below the median value for adopters) and 0 otherwise,

DIFΔSG&A is the adopter's pre- to post-adoption change in sales-scaled SG&A less the like change for the adopter's matched firm, and

DIFΔCGS is the adopter's pre- to post-adoption change in sales-scaled CGS less the like change for the adopter's matched firm.

Results of estimating equation 7 appear in Table 9. Model 1 results support our interpretation of Table 8 results: smaller adopters achieve greater relative improvement in profit margin than larger adopters. Model 2 results suggest that the relative improvement in profit margin derives from relative reductions in both CGS and SG&A. Finally, model 3 results suggest that both large and small adopters derive relative improvement in profit margin from reductions in relative CGS; however, smaller adopters derive significantly more relative improvement in profit margin from relative reductions in SG&A than larger adopters. We conclude these results provide further support for H4 through H7.

**Table 9: Regression of Paired Difference Change in PM on Paired Difference Changes in SG&A, CGS, and Size Dummy Variable**

DIFFΔPM = a + b1(SIZEDUM) + b2(DIFΔSG&A) + b3(DIFΔCGS) + b4(SIZEDUM*DIFΔSG&A) + b5(SIZEDUM*DIFΔCGS) + e

| | | Model 1 | | Model 2 | | Model 3 | |
|---|---|---|---|---|---|---|---|
| Variables[a] | Expected Sign | Parameter Estimates | p-value | Parameter Estimates | p-value | Parameter Estimates | p-value |
| Intercept | + | 0.16 | 0.8919 | -0.04 | 0.9625 | -0.23 | 0.8014 |
| SIZEDUM (1 = small firms) | - | 4.88 | **0.0031** | 2.79 | **0.0386** | 2.03 | 0.1302 |
| DIFΔSG&A | - | | | -1.02 | **<0.0001** | -0.25 | 0.1383 |
| DIFΔCGS | - | | | -0.81 | **<0.0001** | -0.67 | **0.0001** |
| SIZEDUM * DIFΔSG&A | - | | | | | -1.12 | **0.0042** |
| SIZEDUM * DIFΔCGS | - | | | | | -0.39 | 0.1097 |

**Notes:**

(a) The 62 sample firms are partitioned by size (net sales). 31 firms with net sales below the median are classified as small firms, SIZEDUM = 1, and the other 31 firms are classified as large firms, SIZEDUM = 0. $DIF\Delta PM = \Delta PM_i - \Delta PM_j$, $DIF\Delta SG\&A = \Delta SG\&A_i - \Delta SG\&A_j$, $DIF\Delta CGS = \Delta CGS_i - \Delta CGS_j$. Where subcripts 'i' and 'j' represent adopter and matched firm (See Equations 2, 5, and 6).

## RESULTS OF SUPPLEMENTARY TESTS

As a robustness check, we evaluate whether differences between adopters and matched firms in profit margin changes are driven by differences in pre- to post-adoption changes in net sales. In untabulated results we calculate the pre-to post-adoption change in sales for adopters and matched firms. The sales changes for the two samples do not significantly differ based on either a t-test or Wilcoxon test.

Finally, we explore the possibility that even though differences between adopters and matched firms in pre- to post-adoption changes in net sales are statistically insignificant, such differences help explain differences in pre-to post-adoption changes in ROA, profit margin, SG&A and CGS. We estimate the following models:

$$DIF\Delta ROA = \alpha + \beta_1 DIF\Delta SALES + \beta 2 PREROADIF + \beta_3 DIFDEPR + \beta_4 DIFDEBT + \varepsilon \quad (8)$$

$$DIF\Delta PM = \alpha + \beta_1 DIF\Delta SALES + \beta_2 PREPMDIF + \beta_3 DIFDEPR + \beta_4 DIFDEBT + \varepsilon \quad (9)$$

$$DIF\Delta SG\&A = \alpha + \beta_1 DIF\Delta SALES + \beta_2 PRESG\&ADIF + \beta_3 DIFDEPR + \beta_4 DIFDEBT + \varepsilon \quad (10)$$

$$DIF\Delta CGS = \alpha + \beta_1 DIF\Delta SALES + \beta_2 PRECGSDIF + \beta_3 DIFDEPR + \beta_4 DIFDEBT + \varepsilon \quad (11)$$

in which,

DIFΔROA is the adopter's pre- to post-adoption change in ROA less its matched firm's pre- to post-adoption ROA change,

DIFΔPM is the adopter's pre- to post-adoption change in profit margin less its matched firm's pre- to post-adoption profit margin change,

DIFΔSG&A is the adopter's pre- to post-adoption change in SG&A less its matched firm's pre- to post-adoption SG&A change,

DIFΔCGS is the adopter's pre- to post-adoption change in CGS less its matched firm's pre- to post-adoption CGS change,

DIFΔSALES is the adopter's pre- to post-adoption percentage change in net sales less its matched firm's pre- to post-adoption percentage change in net sales,

PREROADIF is the pre-adoption ROA of the adopter less the pre-adoption ROA of its matched firm,

PREPMDIF is the pre-adoption profit margin of the adopter less the pre-adoption profit margin of its matched firm,

PRESG&ADIF is the pre-adoption SG&A of the adopter less the pre-adoption SG&A of its matched firm

PRECGSDIF is the pre-adoption CGS of the adopter less the pre-adoption CGS of its matched firm,

DIFDEPR is the adopter's $t_0$ ratio of depreciation to CGS less its matched firms' $t_0$ ratio of depreciation to CGS,

DIFDEBT is the adopter's $t_0$ ratio of total liabilities to total assets less its matched firm's $t_0$ ratio of total liabilities to total assets.

All equations are structurally similar as each includes controls for the pre-adoption level of the profit or expense metric that comprises the dependent variable as well as controls for leverage and fixed costs.

**Table 10: Regression of Paired Differences in Changes In Performance Measures**

**Panel A: DIFΔROA = a + b1(DIFΔSALES) + b2(PREROADIF) + b3(DIFDEPR) + b4(DIFDEBT) + e**

| n=62 | Expected Sign | Model 1 | P-value | Model 2 | P-value |
|---|---|---|---|---|---|
| Intercept | + | **3.0483** | **0.0111** | **2.3014** | **0.0546** |
| DIFΔSALES | + | -0.0041 | 0.8073 | -0.0029 | 0.8597 |
| PREROADIF | + | 0.2213 | 0.1398 | -0.1176 | 0.5031 |
| DIFDEPR | ? | | | **0.2292** | **0.0418** |
| DIFDEBT | ? | | | 0.0558 | 0.4066 |

**Panel B: DIFΔPM = a + b1(DIFΔSALES) + b2(PREPMDIF) + b3(DIFDEPR) + b4(DIFDEBT) + e**

| n=62 | Expected Sign | Model 1 | P-value | Model 2 | P-value |
|---|---|---|---|---|---|
| Intercept | + | **2.6659** | **0.0307** | **1.8222** | 0.1256 |
| DIFΔSALES | + | -0.0009 | 0.9616 | 0.0029 | 0.8648 |
| PREPMDIF | + | -0.1342 | 0.3738 | -0.0657 | 0.6714 |
| DIFDEPR | ? | | | **0.3149** | **0.0056** |
| DIFDEBT | ? | | | 0.0481 | 0.4305 |

**Panel C: DIFΔSG&A = a + b1(DIFΔSALES) + b2(PRESG&ADIF) + b3(DIFDEPR) + b4(DIFDEBT) + e**

| n=62 | Expected Sign | Model 1 | P-value | Model 2 | P-value |
|---|---|---|---|---|---|
| Intercept | - | **-1.0012** | **0.0721** | -0.9638 | **0.0992** |
| DIFΔSALES | - | 0.0033 | 0.6735 | 0.0030 | 0.7124 |
| PRESG&ADIF | + | -0.0693 | 0.1002 | -0.0651 | 0.1565 |
| DIFDEPR | ? | | | -0.0150 | 0.7879 |
| DIFDEBT | ? | | | -0.0008 | 0.9777 |

**Panel D:Diff DIFΔCGS = a + b1(DIFΔSALES) + b2(PRECGSDIF) + b3(DIFDEPR) + b4(DIFDEBT) + e**

| n=62 | Expected Sign | Model 1 | P-value | Model 2 | P-value |
|---|---|---|---|---|---|
| Intercept | - | -0.7311 | 0.2928 | -0.5904 | 0.4036 |
| DIFΔSALES | - | -0.0043 | 0.6637 | -0.0045 | 0.6487 |
| PRECGSDIF | + | 0.0169 | 0.6867 | 0.0152 | 0.7531 |
| DIFDEPR | ? | | | -0.0711 | 0.3310 |
| DIFDEBT | ? | | | -0.0472 | 0.1821 |

**Notes:**

DIFΔROA = $\Delta ROA_i - \Delta ROA_j$, DIFΔPM = $\Delta PM_i - \Delta PM_j$, DIFΔSG&A = $\Delta SG\&A_i - \Delta SG\&A_j$, and DIFΔCGS = $\Delta CGS_i - \Delta CGS_j$, where subscript 'i' and 'j' represent adopter and matched control firm (See Equations 1, 2, 5, and 6). DIFΔSALES is the adopter's pre- to post-adoption ROA change in net sales less its matched firm's pre- to post-adoption net sales change. PREROADIF = pre-adoption $ROA_i$ – pre-adoption $ROA_j$, PREPMDIF = pre-adoption $PM_i$ – pre-adoption $PM_j$, PRESG&ADIF = pre-adoption $SG\&A_i$ – pre-adoption $SG\&A_j$, PRECGS = pre-adoption $CGS_i$ – pre-adoption $CGS_j$. DIFDEPR = $DEPR_i$ at t0 – $DEPR_j$ at t0, where DEPR = depreciation / cost of goods sold. DIFDEBT = $DEBT_i$ at t0 – $DEBT_j$ at t0, where DEBT = total assets / total liabilities.

Results of estimating equations 8 through 11 appear in Table 10. Table 10 results indicate the coefficient on DIFΔSALES is statistically insignificant in all equations. Thus, we conclude that differential growth in sales does not account for pre- to post-adoption differences in changes in ROA, profit margin, SG&A, or CGS between adopters and matched firms.

Also of note in Table 10 are statistically significant intercepts (at p = .10) for the ROAΔDiff and SG&AΔDiff equations. The intercepts in the other two equations are not statistically significant. These results further support our earlier findings that (1) there is a greater ROA improvement among adopters than matched firms, and (2) the ROA effect may be more related to SG&A improvement than CGS improvement.

## COMPARING B2B ADOPTION TO JIT ADOPTION

In this subsection, we offer a comparison between B2B and JIT, which is a popular procurement technology that has been popular for many years. This discussion is included because we follow the methodology used in JIT study. Finding that B2B buy-side adoption benefits accrue more to smaller firms than to larger firms is in contrast to the prior study of JIT adoption which finds larger JIT adopters benefit to a greater extent than smaller adopters (Kinney & Wempe, 2002). This difference in results is informative relative to the origins of the financial benefits of each technology and to the relative opportunity to improve market transparency and improve transparency of internal processes and transactional efficiency for the two technologies. This finding, when contrasted with the JIT studies, suggests that smaller firms have relatively more to gain than larger firms from improving market transparency; and, that the benefits of B2B buy-side are largely derived from that area.

JIT actually constrains, rather than promotes, competition by reducing the set of vendors to a select few. Thus, JIT provides no leverage to improve market transparency. However, JIT improves transparency of internal processes, and improves transactional efficiency by reducing the volume of transactions and the number of vendors. Because larger adopters are found to benefit more significantly than smaller adopters, we can speculate that larger firms benefit to a greater extent than smaller firms from improving transparency of internal processes and improving transactional efficiencies.

Finally, we find that B2B buy-side adopters experience deterioration in SG&A expense in years prior to adoption, and that B2B buy-side adoption may be viewed as a tactical move (i.e., a quick fix) to address deteriorating SG&A expense efficiency. Since implementation is relatively simple, its benefits are realized relatively quickly but disappeared after two years of adoption. In contrast, JIT adoption can be considered a strategic move since full benefits are usually not realized for several years after adoption (Kinney & Wempe, 2002). This difference in adoption-related performance effects may arise because JIT systems are more complex than B2B buy-side systems, and may require closer coordination and re-arrangement of production processes.

## CONCLUSIONS

This study evaluates the effect of B2B buy-side adoptions on the marketing supply chain, specifically, profitability of adopters relative to matched firms. A sample of 62 adopters and size- and industry-matched firms was identified for the period in which B2B systems were first being adopted. The results suggest that adopters outperform matched firms following adoption, and that adopters' ROA improvement is primarily the result of an increase in profit margin. Mean and median paired differences in ROA and profit margin changes are significantly positive, whereas mean and median paired differences in asset turnover changes are not. Detailed analyses indicate that improvement in paired profit margin derives from improvement in paired SG&A and to a lesser extent, improvement in paired CGS. The results are consistent with the expectation that B2B buy-side adoption reduces purchasing and transaction costs.

Smaller firms appear to gain greater benefits from adoption than larger firms. We speculate this result may be attributable to the inability of smaller firms to exploit scale economies using traditional purchasing tactics to the same extent as large firms. This finding implies that greater transparency of prices created by B2B systems create benefits that are not homogeneous across firm sizes.

Although the results suggest that B2B e-commerce adoption has a positive impact on company performance, the results should be interpreted in light of the study's limitations. The sample is limited to the 62 adopters and size- and industry-matched firms; this limitation was necessary as to limit observations to the B2B e-commerce initial adoption period. Second, the sample may be biased toward large companies because there is an incentive for the buy-side provider to announce contracts with larger firms. Nevertheless, we find smaller adopters realized a greater profit improvement than the larger adopters in our sample. Finally, this study evaluates the profitability effects of adoption of B2B buy-side only for operating inputs, which is a subset of B2B e-commerce. Therefore, the results should not be generalized to adoption of all types of B2B e-commerce technology.

Even after about a decade of use, B2B e-commerce is still relatively young and is projected to grow and to evolve to be more integrated with other company internal processes. This study provides important evidence suggesting that adoption of one subset of B2B e-commerce does, in general, lead to improvement in financial performance. Future research might evaluate the impact of B2B initiatives for different industries, characteristics of adopters, level of integration, and other types of platforms such as sell-side platforms.

## ENDNOTES

1. Hereafter, we abbreviate "B2B buy-side for operating input" to "B2B buy-side." B2B buy-side is a subset of B2B configurations as depicted in Table 1.
2. *The B2B Internet Report*, written by Phillip and Meeker (2000) is available on the Internet at http://msdw.com.
3. These eight firms have "procurement" included in their target markets.
4. Data were not collected beyond June 2000 for two reasons. First, by June 2000 adoption of B2B buy-side systems was no longer the newsworthy event it was previously. Accordingly, after June 2000 it is more difficult to distinguish adopters from nonadopters. Second, after June 2000, firms tend to adopt B2B systems as a package with other systems, most notably ERP systems. Prior to June 2000, the tendency for firms was to purchase B2B buy-side systems as stand-alone systems. Thus, the adoption event becomes much more heterogeneous after June 2000. A large number of news announcements (or follow up news announcement) indicate that the customers implement and use this B2B buy-side system.
5. Both the specific vendor platform and the language of the announcement are used to determine the type of B2B buy-side adoption. For example, in November 1998 Ariba announced an adoption of its Operating Resource Management System™ (ORMS) by Cypress Semiconductor. ORMS is the Ariba platform for B2B buy-side for operating inputs. Excerpts of the announcement follow.
"Ariba…today announced that Cypress Semiconductor Corporation will implement the Ariba Operating Resource Management System™ as the foundation of a strategic procurement initiative….Cypress will leverage the Ariba ORMS to reduce the costs of *nonproduction goods and services* that the company acquires and manages (emphasis added)."
6. The definition of profit margin in this paper uses income before extraordinary and special items as the numerator. Therefore, it is necessary to remove other non-operating items such as depreciation and interest expenses to allow better evaluation of performance: OIBD = Net Sales – Cost of Goods Sold – Sales and General Administrative Expenses. Hence, non-operating items are removed from OIBD.
7. Pre-and post-adoption OIBD, CGS, and SG&A expense are scaled by net sales of the respective periods.
8. Ideally, we would analyze accounts such as "purchasing and administrative expenses" and "general supplies, repair and maintenance expenses." However, such detailed classifications are not available on Compustat.
9. Wilcoxon sign-rank tests are used for all median tests.
10. Although predetermined criteria were used to select the matched firms, we still found adopters have larger net sales in 41 of the 62 observations. Kinney and Wempe (2002) document that firms with higher net sales are more likely to adopt JIT technology. They suggest firms with greater resources may be more inclined to adopt new technology.
11. Detailed results of test follow.

| | Mean | Median | t-test p-value | Wilcoxon p-value |
|---|---|---|---|---|
| Margin Effect | 2.96 | 0.54 | 0.07 | 0.11 |
| Turnover Effect | (0.06) | 0.00 | 0.87 | 0.89 |
| Difference Effect | 3.02 | 0.64 | 0.06 | 0.09 |

The relative ROA effect of relative changes in profit margin and asset turnover are calculated as follows: Margin effect = paired difference in the change in profit margin × B2B adopter's pre-adoption asset turnover. Turnover effect = paired difference in the change in asset turnover × B2B adopter's pre-adoption

profit margin. The Difference effect is tested to assess the relative importance of profit margin and asset turnover performance in B2B buy-side adopter's relative ROA changes.

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