The Empirical Evidence for the Link between Knowledge Management Performance and Firm Market Performance

Abstract

Although anecdotal evidence and individual case studies suggest that effective knowledge management (KM) initiatives contribute to superior firm performance, quantitative empirical investigations are scarce, and more to the point, most of them are based on perceptions of survey participants embedded in the firms being studied. Moreover, studies analyzing the question of whether superior KM performance can predict superior market-based valuation appear to be non-existent. Findings of such studies would be of great value, not only to those who champion and direct a firm’s KM efforts, but also to the firm’s strategists, planners, and operational managers. Here, we empirically examine the relationship between KM performance and firm valuation; the former is assessed by international panels of independent KM experts and the latter is evaluated by market-based measures. The results based on data from 1998-2005 show that, in each of the eight years, superior KM performance has a statistically significant positive association with firm valuation in terms of Tobin’s $q$, price-to-book ratio, and price-to-sales ratio. This study contributes to the management literature by using independent expert judges and archival data to substantiate the notion that KM competencies are an important ingredient in a firm’s performance as indicated by market-based valuation.

Keywords: firm performance, KM, knowledge chain theory, knowledge management, market-based valuation, organizational learning, price-to-book, price-to-earnings, price-to-sales, resource-based view of the firm, Tobin’s $q$
Introduction

In today’s competitive and dynamic business environment, knowledge management (KM) is one of the strategic applications that make operations more efficient and provide competitive advantages in the marketplace (Gates 1999). Correspondingly, many organizations have invested substantial resources in KM initiatives in the last decade (Haas 2006). For example, International Data Corporation (IDC), a market research and analysis firm, estimates that the global business spending on KM was $4.8 billion in 2007 (Babcock 2004), and the spending in US reached $2.9 billion in 2006 (Motsenigos and Young 2002). Meanwhile, researchers have devoted considerable attention to understanding KM, ranging from what are the basic components of KM episodes to how to improve knowledge generation and realization processes. Because KM is considered as a principle success factor, much of the growing literature on KM in organizations embraces, explicitly or implicitly, the notion that KM can bring important strategic consequences to organizations – accelerating business growth, improving competitive position, achieving higher corporate valuation, and so forth (Edwards et al. 2003).

Although anecdotal evidence and individual case studies are available on the link between effective KM initiatives and superior firm performance, quantitative empirical investigations are scarce, and more to the point, most of them are based on perceptions of embedded participants. Focusing on KM-related capability evaluations in large multinational firms, Denrell and colleagues (2004) suggest that individuals’ perceptions about their respective firms’ abilities are not particularly reliable. Consequently, there remains lingering uncertainty about the veracity of the notion that effective KM initiatives are indeed an antecedent or predictor of superior firm performance. Specifically, while many people think the linkage exists,
it is still under a cloud or even dubious. Hence, scholars call for empirical research to resolve the issue (Argote and Ingram 2000, Feng et al. 2004).

As a response to this call, the present study extends the relevant literature by empirically examining the relationship between KM efficacy and firm valuation—the latter being a market-based indicator of firm performance. To provide a solid theoretical basis for the link, this research draws on the resource-based view of the firm, organizational learning theory, and knowledge chain theory. Applying these theories to multi-industry organizations suggests that firms with superior KM performance are likely to enjoy better bottom-line performance and higher market value.

By KM performance, we mean the degree to which KM activities harness organizational resources to achieve the goals or purposes of KM initiatives. This meaning is in line with Darroch’s (2005) view that effective KM serves as a coordinating mechanism for transforming all available resources into capabilities and thus allows a firm to glean greater value from the resources (not just its knowledge resources). We adopt the common view that a firm’s market-based valuation is indicative of its performance and performance prospects.

Our assessments of KM performance do not depend on perceptions of individuals embedded within firms being studied, but rather on eight years of ratings by international panels of KM experts independent of the assessed firms. Similarly, in measuring firm performance, we do not rely on perceptions of those within the firms, but rather on market-based firm performance figures. As an alternative to the standard accounting measures (e.g., return on assets and return on sales), financial market-based measures reflect firms’ intangible assets, which are pervasive in KM-intensive organizations and are often discounted by accounting-based ratios (Bharadwaj et al. 1999, Lavie 2007). For this reason, market-based performance measures are
preferred over traditional accounting-based ones. Using an organizational level of analysis, we assess the association between business effectiveness and successful KM initiatives within a multi-industry context, suggesting that the results are likely to be applicable and generalizable across organizations as well as industries (Zacharia and Mentzer 2004).

1. **Background**

   In the presentation of a collaboratively engineered KM ontology, Holsapple and Joshi (2004) define knowledge management as “an entity’s systematic and deliberate efforts to expand, cultivate, and apply available knowledge in ways that add value to the entity, in the sense of positive results in accomplishing its objectives or fulfilling its purpose” (p. 593). This definition is in keeping with that advanced by Ofek and Sarvary (2001): as a set of business processes, KM captures and provides access to the firm’s collective experience that helps create business solutions for strategic and competitive advantage. As noted by Bill Gates (1999), the ultimate goal of KM is to increase institutional intelligence, or corporate IQ, which is greatly needed by a company pursuing success in today’s dynamic markets.

   Prior research suggests that KM can contribute to firm performance in several ways: (1) enhancing the effectiveness and efficiency of business processes; (2) facilitating employees’ learning from internal and external sources; and (3) fostering the development of new knowledge-based products or the improvement of existing ones that provide significant additional value (Argote and Ingram 2000, Conner and Prahalad 1996). However, some other studies contend that KM initiatives do not always positively impact business performance and often fail to result in improved task outcomes in organizations (Sabherwal and Sabherwal 2007). These inconsistent observations indicate that KM’s effects on firm performance are not yet well understood and still open for investigation (Smith and McKeen 2005). Of course, addressing
these inconclusive effects is of great importance not only to researchers eager to identify crucial drivers of superior business performance, but also to practitioners struggling to comprehend if, and the extent to which, KM initiatives impact firm performance.

1. A Resource-Based View of the Firm

Rooted in strategic management literature, the resource-based view (RBV) of the firm suggests that a firm’s ability to create value is primarily based on its unique set of resources that are valuable, rare, irreplaceable, and not readily reproduced (Barney 1991; Conner 1991). Basically, the RBV focuses on the impacts of a firm’s internal characteristics on its performance and explains why the firm is able to gain and sustain competitive advantages (Amit and Schoemaker 1993; Wernerfelt 1984). The RBV embraces several important assumptions: (1) a firm’s unique resources include not only tangible assets but also intangible ones that tied semi-permanently to the firm (Spanos and Lioukas 2001); (2) the resources are usually rent-yielding and likely to survive competitive imitation when protected by isolating mechanisms (Dierickx and Cool 1989); and (3) the strategically important resources are heterogeneously distributed across firms, and thus are expected to explain differences in firm performance (Grant 1991).

Previous research suggests that the unique firm resources involve brand names, financial capital, skilled personnel, efficient business processes, in-house knowledge of technology, and so forth (Bharadwaj 2000, Spanos and Lioukas 2001). More recently, several studies grounded in the RBV assert that knowledge is a rare, valuable, and difficult-to-imitate resource and can be applied in ways that add value to an organization (Feng et al. 2004, Uhlenbruck et al. 2006). Specifically, the studies contend that knowledge is a basic source of competitive advantage and performance differences among firms can be attributed to asymmetries in knowledge and its management (Edwards et al. 2003, Lee and Choi 2003).
One step further, researchers have extended the RBV and developed the knowledge-based view (KBV) of the firm (Conner and Prahalad 1996, Decarolis and Deeds 1999). Reflecting the RBV essence, the KBV posits that knowledge is the most strategically important firm resource and KM is a key determinant of performance differences (Felin and Hesterly 2007, Sabherwal and Sabherwal 2007). That is, the KBV highlights the importance of firm-specific KM capabilities and focuses full attention on intangible resources that play a critical role in firm valuation and performance. The KBV echoes calls for creating knowledge-based organizations (Gupta and Sharma 2004).

2. **Organizational Learning Theory**

Rooted in management and economics literature, the organizational learning theory (OLT) aims to provide a framework for interpreting the processes of learning and their outcomes at an organizational level. Organizational learning is comprised of the ways firms build, supplement, and organize knowledge and routines around their activities and within their cultures, and adapt and develop organizational efficiency by improving use of the broad skills of their workforces (Dodgson 1993). The generic term “routines” includes not only the conventions, procedures, strategies, and policies under which firms are constructed and operated, but also the structure of codes, beliefs, cultures, and frameworks that shape and define the firms (Levitt and March 1988).

The concept of organizational learning can be characterized in terms of four attributes: existence, breadth, elaborateness, and thoroughness (Huber 1991). Existence of organizational learning is associated with the assertion that an organization learns if any of its units (no matter how many) acquires knowledge that is potentially useful to the organization. Breadth of organizational learning asserts that more organizational learning occurs when more of the
organization’s units obtain the knowledge and recognize it as potentially useful. Elaborateness of organizational learning is concerned with the claim that more organizational learning occurs when more and more varied interpretations are developed. Finally, thoroughness of organizational learning corresponds to the statement that more organizational learning occurs when more organizational units develop uniform comprehensions of the various interpretations.

Friedlander (1983) argues that “the crucial element in learning is that the organism be consciously aware of differences and alternatives and have consciously chosen one of these alternatives. The choice may be not to construct behavior but, rather, to change one’s cognitive maps or understandings” (p. 194). In line with this argument, Dodgson (1993) contends that organizational learning can be perceived as the highest form of adaptation, raising the probability of survival in changing environments. Accordingly, many studies grounded in the OLT assert that learning can enhance firm performance by keeping the firm in tune with trends and developments in its business.

For example, Bennet and Bennet (2003) suggest that as a purposive quest, organizational learning helps retain and improve productivity and innovativeness to cope with dynamic business situations. Similarly, Uhlenbruck and colleagues (2006) argue that organizational learning leads to new routines to deploy resources and to identify and respond quickly to new opportunities. Focusing on both learning processes and outcomes, Dodgson (1993) states that learning is a key feature in the process whereby firms accumulate technology to possess leading competitive positions. As noted by Jack Welch, former chairman and CEO of General Electric, “An organization’s ability to learn, and translate that learning into action rapidly, is the ultimate competitive advantage.” (Gates 1999, P.237).
From a KM perspective, organizational learning is an integral part of KM strategy and reflects an organization’s KM capacity (Bennet & Bennet, 2003). KM helps define and specify what should be learned, why and when it should be learned, and who should be learning it. Therefore, KM efforts can influence employees to develop positive attitudes toward learning. Such attitudes are likely to stimulate organizational learning because individuals and teams come to believe that learning can help their firm handle change, uncertainty, and complexity in the ever-changing business environment. KM can also create a culture of peer collaboration and open communication (Liebowitz 2008). Both of these lead to a setting conducive to organizational learning. Moreover, organizational learning is often facilitated by such KM activities as knowledge acquisition, distribution, assimilation, and storage (Huber 1991). In particular, knowledge acquisition promotes organizational learning by motivating individuals to obtain new knowledge from external sources and to make it suitable for future use. In summary, the OLT indicates that through organizational learning, KM can be reasonably linked to firm performance and valuation.

3. **Knowledge Chain Theory**

Employing Porter’s (1985) analysis approach, Lee and Yang (2000) have developed a “knowledge value chain” (KVC) framework. It identifies infrastructure and process activity as two KM components that enable a firm to provide valuable products and services to its customers. Resembling the value chain model, their framework is comprised of four categories of KM infrastructure and five categories of KM process activity. They argue that these nine elements can be performed in ways that increase a firm’s competency with respect to one or more of Porter’s five primary activities (e.g., inbound logistics). These focal points for value creation are thus capable of being shaped by the firm’s KM performance. Maintaining that it is
difficult to gauge this KM performance via accounting measures, they suggest two alternatives. First, they propose learning measures such as the size of communities of practice or the level of training for employees. Second, they propose that KM performance can be measured in terms of operating performance metrics such as lead time or level of customer satisfaction.

In a separate research stream, Holsapple and Singh (2001) have advanced the knowledge chain theory (KCT). Grounded in a descriptive, collaboratively-engineered KM ontology, the KCT identifies and characterizes nine KM activities: five first-order activities that an organization performs in manipulating knowledge resources and four second-order activities that support and guide performance of the primary activities. The KCT posits that these nine KM activities combine to yield two kinds of organizational outcomes: learning and projections. That is, how well an organization learns and how well it projects are key determinants of the organization’s viability and success in a competitive environment. The theory asserts that the nine activities enable a firm to leverage its knowledge into a competitive advantage. Specifically, any of these activities can be carried out in ways that improve a firm’s competitiveness and performance. The theory further asserts that such superior firm performance can be achieved in four main directions: superior productivity, agility, innovation, and/or reputation (PAIR).

4. **Prior Empirical Studies**

Employing both the resource-based and the knowledge-based views of the firm, Bogner and Bansal (2007) argue that a sustained competitive advantage stems from a firm’s ability to develop rare and valuable knowledge through learning, and to subsequently build upon and spread that knowledge throughout the organization. They deconstruct a firm’s complex KM capability into three key components: the firm’s ability to produce new knowledge, its ability to build on that knowledge, and its effectiveness in capturing the potential value of the knowledge.
To examine the impacts of the KM capability components on firm performance, they develop patent-citation measures for each of them: cited patents, citing patents, and citing patents owned by the innovator. They analyze the data from 30,022 patent records of 42 firms and find that a firm’s growth rate is positively associated with its ability to generate rare and valuable knowledge, and to build on that knowledge.

Darroch (2005) develops a model that includes both tangible and intangible knowledge resources as being enablers of a firm’s routines (e.g., knowledge dissemination and responsiveness to knowledge) which, in turn, are positively related to the firm’s innovations and financial performance. Using a multi-item scale, she surveys 443 CEOs from New Zealand firms for their perceptions about their respective firm’s status regarding innovation, comparative and internally reflective performance, and its KM initiatives and practices (i.e., knowledge acquisition and dissemination, and responsiveness to knowledge). She finds that KM initiatives and practices are important determinants of a firm’s ability to innovate, and knowledge acquisition has a significant impact on firm performance through responsiveness to knowledge.

Arguing that there is little empirical evidence that KM is a profitable enterprise, Castillo (2003) empirically tests the linkage between firm performance and KM initiatives. His data analysis suggests that there is little payoff from organizational KM efforts and KM initiatives are not significantly related to any of the three accounting-based ratios: return on sales, return on assets, and return on equity. Based on these findings, he argues that companies emphasizing KM may not excel over similar firms within their specific industries and managing knowledge may be a tricky business.

In a survey of 131 major firms in Korea, Choi and colleagues (2008) investigate the relationship between KM strategies and firm performance by drawing on complementarity
theory from economics. Categorizing KM strategies based on KM focus and KM source, they suggest that KM strategies can be explicit- and tacit-oriented, as well as internal- and external-oriented. While explicit-oriented strategy emphasizes knowledge codification and reuse to improve organizational efficiency, tacit-oriented strategy focuses on a personalization approach where tacit knowledge is shared through interpersonal interactions and socialization processes. While external-oriented strategy brings in knowledge from outside sources via acquisition, internal-oriented strategy accentuates the need to generate new knowledge within a firm. Their results show that superior firm performance can be achieved by implementing explicit-, external-, or internal-oriented strategy, and an organization employing both external- and internal-oriented strategies can achieve even better performance.

In a study of 222 Spanish firms in biotechnology and telecommunications industries, Marques and Simon (2006) survey senior business managers about their respective firms’ KM practices and firm performance. They view KM practices as innovative organizational activities that bring important changes to business processes and to traditional management paradigms. Using a 7-point Likert scale, they assess KM practices in terms of six dimensions (e.g., knowledge transfer, continuous learning) and measure firm performance via profitability, growth, efficiency, stakeholder satisfaction, and competitive position. Analysis of the survey data leads to their conclusion that there is a strong and positive relationship between the implementation of KM practices and firm performance.

5. **Summary**

Synthesizing prior work on the relationship between KM and firm performance, we observe several major themes. First, it appears that KM assets (e.g., KM initiatives, resources, and practices) are a key component for organizations’ efforts to create value. Second, while some
studies find a significant link between some aspect(s) of KM performance and some aspect(s) of firm performance, other studies fail to do so. The mixed results indicate the linkage is worthy of further investigation. Third, most of the empirical findings are based on perceptions of survey participants embedded in the firms being studied. Denrell and colleagues (2004) suggest that individuals’ perceptions on their respective firms’ KM capabilities may not accurately reflect reality. Thus, they imply that researchers should devise and employ more reliable methods to measure firm performance and KM performance. Fourth, few studies examine whether a firm’s actual market-based performance is related to its KM performance. To better appreciate the market-based effects of superior KM performance, we offer the following quantitative empirical evidence.

3. Research Hypotheses

As a market-based firm performance measure, Tobin’s $q$ is the ratio of the market value of a firm and the replacement value of its total assets (Tobin 1978). Unlike traditional accounting ratios (e.g., return on assets and return on sales), Tobin’s $q$ reflects the contribution of intangible assets to firm value and is also a forward-looking measure because it provides a market-based view of investor expectations of a firm’s future performance (Bharadwaj et al. 1999, Rao et al. 2004). A higher Tobin’s $q$ ratio indicates greater unmeasured firm value attributed to the intangible assets, suggesting better market-based firm performance. Tobin’s $q$ has been used in finance to study managerial performance (Lang and Litzenberger 1989) and equity ownership (McConnell and Servaes 1990), in marketing to study marketing communication’s credibility (Luo and Donthu 2006) and brand equity (Simon and Sullivan 1993), and in information systems to study IT capability (Bharadwaj et al. 1999) and e-commerce competence (Saeed et al. 2005).
According to the RBV, KM resources should play an important role in improving long-run firm performance, because they are rare, valuable, and inherently difficult to imitate. In line with the OLT, firms with superior KM performance should experience a learning effect in which they improve over time in their abilities for creating value (Galunic and Rodan 1998, Gold et al. 2001). Similarly, the KCT asserts that a firm potentially can execute any of the knowledge chain activities in ways that boost productivity, increase agility, enhance innovation, and/or augment reputation to provide sustainable competitive advantage (Holsapple and Singh 2001). Consistent with these theories and aforementioned research findings, we argue that firms, which are relatively successful in leveraging KM resources, in turn enjoy superior market-based firm performance. Formally, we hypothesize:

Hypothesis 1. Superior KM performance is positively related to a higher Tobin’s q ratio.

To provide a multi-angle and in-depth analysis of the focal relationship, we also measure market-based firm performance with three other ratios: price-to-book (P/B), price-to-sales (P/S), and price-to-earnings (P/E). Calculated as the market price to book value per share, the P/B measure indicates how much value the market expects a firm to be able to extract from its pool of assets (Tuschke and Sanders 2003). The P/B measure is also an indication of the valuation of intangible assets and the existence of any hidden reserves (e.g., undervalued assets). Like Tobin’s q, the higher the P/B ratio, the greater the potential and value of a firm as viewed by its investors. A P/B ratio less than 1.0 indicates the firm’s lack of potential and the presence of obsolete assets (Li et al. 2004). Accordingly, we hypothesize:

Hypothesis 2. Superior KM performance is positively related to a higher P/B ratio.

As the ratio of stock price to revenue per share, the P/S measure shows how much the market values each dollar of a company’s sales. A high P/S ratio means that investors are willing
to pay more for every dollar of sales, indicating that they expect relatively high profits from that
dollar (Nathan et al. 2001). In other words, it often signals a company’s competitive advantage in
terms of high profit margins. The P/E measure, which is the ratio of stock price to net profit per
share, reflects the money investors are willing to pay for the earnings a company makes.
Logically, a high P/E ratio means that the market is ready to pay more for the earnings,
suggesting that there is high expectation of fast earnings growth for the company in the future
(Sudarsanam and Mahate 2003). On the other hand, a low P/E ratio indicates that investors have
less confidence in the company’s growth potential. Regarding both P/S and P/E as useful
measures of market-based firm valuation and expected future performance, we hypothesize:

Hypothesis 3. **Superior KM performance is positively related to a higher P/S ratio.**

Hypothesis 4. **Superior KM performance is positively related to a higher P/E ratio.**

Although our hypotheses for P/S and P/E are as above, three important distinctions
between the two should be noted at the outset. First, prior research suggests that the P/S measure
is highly related to profitability experienced by a firm (Nathan et al. 2001). That is, a company
that can generate substantial profit from every dollar in sales usually has a higher price-to-sales
ratio than a company that generates very little profit from each dollar in sales (Carlson 2000). In
contrast, the P/E measure is strongly associated with investors’ expectations of earnings growth
in the near future (Shroff 1995). Compared with P/S, the P/E ratio is a more future-oriented
market-based valuation, reflecting something relatively uncertain and elusive (i.e., growth
expectation). The P/S ratio is comparatively present-oriented and tells more about the status quo
of a firm’s performance (i.e., current profitability). Second, compared with earnings, revenues
are more stable and predictable, and thus are more difficult to be manipulated (Senchack and
Martin 1987). Consequently, the P/S measure is less subject to accounting gimmickry and serves
as a more reliable indicator of how the market values firm performance than the P/E measure (Nathan et al. 2001). Third, the P/S ratio provides a meaningful relative measure of how the market values firm performance, even when the firm is losing money – in which case the P/E ratio is meaningless (Senchack and Martin 1987).

4. Methodology

1. **Matched Sample Comparison Group Method**

   We employ the Matched Sample Comparison Group (MSCG) method to test the research hypotheses. The MSCG method involves statistical analysis that compares the levels of a variable of interest across two samples over some time period (Megginson and Weiss 1991). In this study, a treatment sample is comprised of firms with superior KM performance. A carefully selected control sample is comprised of firms that match the treatment sample in terms of firm size and industry type. The variables of interest are the foregoing market-based ratios used to compare how the market values firm performance for each of the two groups. The time period for analysis is a five-year window.

   The major direct benefit of the MSCG method lies in its capability to allow the performance of the matched control sample of firms to serve as a benchmark and help remove the confounding effects of extraneous factors and market forces that could influence firm performance (Bharadwaj 2000). Here, the method thus enables us to decide whether the effects (i.e., higher Tobin’s q, P/B, P/S, and P/E) are really associated with the independent variable – superior KM performance. As an important statistical procedure, the MSCG method has been applied in a variety of fields. For instance, it has been adopted in management research (Garby 2002), finance research (Jain and Kini 1995), marketing research (Kalwani and Narayandas
1995), information systems research (Feng et al. 2004), and accounting research (Balakrishnan et al. 1996).

2. **Most Admired Knowledge Enterprises**

   As the treatment sample of firms with superior KM performance, we use the Most Admired Knowledge Enterprises (MAKE\textsuperscript{sm}). Annually, since 1998, these organizations are determined and publicly reported by Teleos and its KNOW Network (http://www.knowledgebusiness.com). Teleos is an independent KM and intellectual capital research company based in the United Kingdom. The company operates the KNOW Network – an international Web-based professional knowledge-sharing network that aims to help practitioners achieve the best possible levels of KM performance.

   Internationally recognized, the MAKE\textsuperscript{sm} study has a dual aim: identification of organizations that are leaders (most admired) in the practice of KM and learning from these organizations. Employing a Delphi-oriented approach, the study uses a large panel of KM experts to determine those organizations that have demonstrated superior KM initiative and performance over the most recent year. Members of the panel are high-level executives from Fortune’s Global 500 companies (i.e., CEO, CFO, CIO), about 300 chief knowledge officers from a broad base of organizations around the world, and various prominent knowledge management practitioners.

   The initial Delphi round constructs a worldwide set of candidate organizations based on nominations elicited from the panelists. In the study’s second round, each panelist selects up to three candidates that he/she deems to have exhibited superior KM performance within the main business sector of his/her organization. Each panelist also selects – across the entire set of candidate organizations – up to three more that he/she deems to have exhibited superior KM
performance. Every organization that is selected by at least 20% of the panelists is designated as being a finalist. In the last round, panelists are given eight criteria that Teleos and its KNOW Network have found to be keys for characterizing strong KM performance:

- success in establishing an enterprise knowledge culture
- top management support for managing knowledge
- ability to develop and deliver knowledge-based goods/services
- success in maximizing the value of the enterprise’s intellectual capital
- effectiveness in creating an environment of knowledge sharing
- success in establishing a culture of continuous learning
- effectiveness in managing customer knowledge to increase loyalty and value
- ability to manage knowledge in ways that create shareholder value

For each finalist, each panelist uses a 1 to 10 scale (poor to excellent) to provide a rating on each criterion. With the eight criteria being equally weighted, eighty is the highest possible score that a panelist can give to a nominated organization. For each finalist, scores are summed across all panelists’ ratings. The twenty finalists receiving the highest totals are designated as MAKEsm study winners of the year.

3. Sample Selection

The procedure for creating the treatment sample is as follows. We first construct a sample that includes all organizations recognized as MAKEsm study winners in any of the eight years from 1998 through 2005. This initial sample consists of 42 organizations, as many of them have been winners in multiple years. Eleven of these are organizations for which no COMPUSTAT data are available (i.e., firms not traded in a U.S. stock exchange – some foreign firms, privately held firms, not-for-profit organizations). Because our study requires financial data from
COMPUSTAT, the eleven are dropped. This gives 31 firms in the final treatment sample – each of which has been collaboratively determined to exhibit superior KM performance by a large panel of experts.

A widely-accepted procedure (see Barber and Lyon 1996, Bharadwaj 2000, Feng et al. 2004, and Przasnyski and Tai 2002) is employed to establish the control sample. First, we obtain the primary four-digit Standard Industrial Classification (SIC) code for each of the 31 superior KM performers. Second, for each treatment firm, we identify a set of candidate control firms that have the same primary four-digit SIC code as the treatment firm. Third, we reduce each candidate set by keeping only those firms whose eight-year average sales are within a range of 70% to 130% of the corresponding treatment firm. Fourth, if more than one candidate control firm satisfies the 30%-range target, we choose the one whose eight-year average sales are closest to the treatment firm; if no candidate control firm satisfies the target, we identify a corresponding control firm (that meets the 30%-range target) at the treatment firm’s primary three-digit or two-digit SIC code. Finally, if no firm satisfies the 30%-range target at primary four-, three-, or two-digit SIC code, we then apply the treatment firm’s non-primary SIC code to identify a corresponding control firm that meets the 30%-range target. Most firms in this study have one primary SIC code and several non-primary SIC codes. For example, Canon has the primary SIC code of 3577 (computer peripheral equipment) and two non-primary SIC codes: 3861 (photographic equipment and supply) and 3559 (special industry machinery). Appendix A lists the treatment firms (superior KM performers) and their control firms (not superior KM performers).

The procedure described above enables us to match pairs of firms by size and type. The paired firms are of similar size in that the eight-year average sales of the control firm are within
70% to 130% of its treatment firm. Previous research asserts that this 30%-range target is a fundamental specification for defining comparison groups (Barber and Lyon 1996, Bharadwaj 2000). The firms in each pair are also drawn from the same industry type due to the same four-, three-, or two-digit SIC code they have.

The underlying rationale of the procedure is (1) an appropriate industry benchmark can explain cross-category and firm-size-based variations in organizational performance (Denis and Denis 1993; Kaplan 1989), and (2) similar-sized firms in the same industry usually employ similar accounting methods, and thus their financial ratios are directly comparable (Bharadwaj 2000). The whole procedure also provides a solid foundation for this study’s basic assertion that potential differences between the two groups of firms in market-based ratios are attributed to the primary between-group distinction: firms in treatment group have been recognized as superior KM performers, while firms in control group have not.

4. Comparability Test and Choice of Statistical Tests

To find out how well the two groups are matched, we test their comparability by using several general firm size measures: sales, total assets, and number of employees. Also, as both the treatment and control firms are relatively large, they tend to be highly diversified (Bharadwaj 2000). To ensure their degrees of diversification are not significantly different, we also compare these 31 pairs of firms by using the entropy measure of related diversification (Choi and Russell 2005). Given that none of the data sets for firm size and entropy are normally distributed (see Table 1), the non-parametric Wilcoxon Signed Ranks Test is used to examine the comparability of the two groups. The normality tests are performed using the Shapiro-Wilk method, which

---

1 Entropy measure of related firm diversification is defined as the sum of related diversification (RD) and unrelated diversification (UD) where, and.
is defined as the sales share of the business segment of the industry group ’s total sales; is defined as the sales share of industry group of the firm’s total sales; and is a function of .
compares sample distributions with a normal distribution and is especially suitable for small samples (Ezzamel et al. 1987).

Descriptive statistics and results of comparability tests are shown in Table 2. These are based on eight-year averages (1998 – 2005). For the comparability test, averages should be more reliable than single-year observations (the averages are more normal and less variable). Mean sales for control firms are about 94% of the treatment firm level. Because the non-parametric tests find no statistically significant differences between the two groups for any of the four variables in Table 2, we conclude that the two groups of firms are well matched with respect to both firm size and diversification.

Insert Table 1 and 2 about here

5. **Financial Performance Halo Effect Test**

Prior research suggests that the perception-based identifications of MAKEsm study winners may suffer from a financial performance halo effect (Bharadwaj 2000). As a major threat to the validity of this study, a halo effect is a cognitive bias whereby the perception of a particular trait is influenced by a general impression (Rosenzweig 2007). For the current study, the halo effect refers to a possible bias that the recognition of MAKEsm study winners has been influenced by their past financial performance. If such bias exists, then it may be that selection of winner firms is actually due to prior financial performance that is superior, rather than superiority of their KM performance.

To address this critical issue, we use the approach developed by Brown and Perry (1994) to examine whether there is a financial performance halo effect in the MAKEsm study data. The approach is applicable to various contexts and especially useful for a data set derived from large-scale survey results that may be heavily influenced by factors extraneous to the constructs of
interest. The Brown and Perry halo technique involves analysis of the following financial measures: average return on assets (AROA), sales, growth, risk, and relative value (RV).\(^2\) Here, the analysis tests a logistic regression model: \(Y = B_0 + B_1\text{AROA} + B_2\text{SALES} + B_3\text{GROWTH} + B_4\text{RISK} + B_5\text{RV} + e\). The dependent variable in this model is binary, with \(Y = 1\) for winning firms and \(Y = 0\) for control firms. The five financial measures serve as independent variables. If a halo effect exists, we would observe one or more statistically significant p-values for the independent variable coefficients.

In keeping with prior research, we use five-year averages of these measures to examine the halo effect. The five years are those immediately preceding the first recognition of each MAKE\(^{sm}\) study winner. For instance, if a firm was first recognized as a MAKE\(^{sm}\) study winner in 1998, then financial performance data from 1993 to 1997 are used for that firm; if a firm was first recognized as a MAKE\(^{sm}\) study winner in 2005, then financial performance data from 2000 to 2004 are used to test the logistic regression model for that firm.

Results of the logistic regression analysis, as shown in Table 3, suggest that none of the p-values for the independent variable coefficients is statistically significant. Also, the p-value (0.36) for the model chi-square (7.68) is not significant. Lacking statistically significant p-values, we conclude that the five financial measures are neither individually, nor collectively, factors in the designation of MAKE\(^{sm}\) winners. Thus, there is no evidence of a financial halo effect that could introduce bias into our study.

\[\text{Insert Table 3 about here}\]

\(^2\) Return on assets = net income/total assets;
Sales = logarithm of the average sales for past five years;
Growth\(_t\) = (%change in sales\(_{t-1}\) + \ldots + %change in sales\(_{t-5}\))/5;
Risk = debt/equity; where \(t\) is year in which a firm is first recognized as a MAKE\(^{sm}\) winner;
Relative value = (market value/shareholder equity\(_{\text{firm}}\))/(market value/shareholder equity\(_{\text{industry}}\)).
5. Results

Multiple methods have been proposed for calculating Tobin’s $q$ ratio. This study employs the method developed by Chung and Pruitt (1994) (Appendix B shows the details), which has been adopted by various business disciplines such as finance (Weber and Dudney 2003), information systems (Saeed et al. 2005), marketing (Fang et al. 2008), and management (Youndt et al. 2004).

The key advantage of this method is that it uses a simple formula that relies on financial and accounting information available from a firm’s financial reports (Bharadwaj et al. 1999). As a very effective method, it is a good surrogate for the more traditional and complex method developed by Lindenberg and Ross (1981). For example, by using 10 years of data, Chung and Pruitt find that their method of calculating $q$ ratio can explain at least 96.6% of the variance in Tobin’s $q$ obtained via Lindenberg and Ross’s model.

Consistent with prior research (Lubatkin and Shriives 1986, Olson and Pagano 2005, Otchere and Abou-Zied 2007), we employ a five-year window method to decide whether a winner firm should be included in the data analysis for a specific year. That is, if a firm is recognized as a winner in year $t$, then it will be included in the data analysis for each of the five years from year $t-1$ to year $t+3$. This five-year window method has been widely used in accounting, finance, and management to study issues related to firm performance (Hoskisson and Hitt 1988, Lavie and Rosenkopf 2006, Rosner 2003).

Observing that the four market-based ratios are not normally distributed, we once again use the non-parametric Wilcoxon Signed Ranks Test to evaluate the research hypotheses. Table 4 shows the Shapiro-Wilk normality test results for these ratios by using the data of treatment firms from 1998 to 2005.
As shown in Table 5, the results indicate that in each of the eight years, Tobin’s $q$, P/B, and P/S are significantly higher for superior KM performers than for control firms, thus supporting hypotheses 1-3. Figure 1 depicts means of Tobin’s $q$ ratios of treatment firms and control firms in all eight years. The P/E ratio is higher for superior KM performers in six of the eight years, with statistical significance found in the year of 1999 and 2004. Overall, the results are consistent with the predictions, suggesting that firms with superior KM performance are likely to achieve better firm performance in terms of market-based valuations.

6. Discussion

As KM has attracted tremendous attention from both academy and industry, its relationship with market valuation of firm performance is a highly important and timely research topic. Drawing on three relevant theories and prior research findings, we argue that KM is a core driver of competitive advantage and empirically investigate the relationship between superior KM performance and superior market-based valuation, signaling competitive advantage and reflecting relatively strong firm performance in terms of Tobin’s $q$, P/B, P/S, and P/E.

1. Insights into the Results

Although Tobin’s $q$ and the P/B ratio are calculated differently, they are very close to each other (Li et al. 2004). The positive results for them suggest that KM assets (i.e., knowledge resources, knowledge processors, knowledge processes) can indeed be captured by forward-
looking, market-based measures and that superior KM performers enjoy higher firm market value. Such higher valuation is explained by investors’ confidence that the MAKE study winner firms will gain/sustain a competitive advantage and glean greater value from their tangible and intangible assets. Such confidence makes the investors more willing to provide capital to the firms at a relatively lower cost, something that is ultimately reflected in higher market value. In other words, the stock market rewards firms having superior KM performance. The results are also consistent with the notion that as strategically important applications, well-designed KM initiatives create an intangible asset for the implementing firm and strengthen the firm’s future performance potential.

The positive result for the P/S ratio indicates that firms successful in leveraging knowledge resources receive higher market valuation for each dollar of their sales. Such higher valuation is based on the expectation that the firms can generate more profit for each dollar of products they sell than firms of comparable size in the same industry. Thus, the result suggests that superior KM performance is positively associated with higher profitability. This is in accord with Bogner and Bansal’s (2007) finding that a firm’s profitability is impacted by its ability to generate rare and valuable knowledge, and to apply that knowledge to business activities.

The inconclusive result for Hypothesis 4 shows that superior KM performance may not be significantly related to higher P/E ratio, suggesting that MAKE study winner firms do not necessarily benefit from investors’ willingness to pay more for the earnings they make. This means that, even if there exists an expectation of fast earnings growth for superior KM performers, such expectation is not necessarily significantly higher for these performers than for firms of comparable size in the same industry. It may well be that, within a particular industry, the market tends to overvalue firms with relatively low earnings per share. Such overvaluation
boosts stock prices of the firms and thus makes the P/E ratios higher than they might otherwise be. However, this statistically insignificant result is to some extent in line with the argument that, compared with P/S, the P/E ratio is a somewhat less reliable indicator of firm performance due to the relative ease with which it may be manipulated.

There are three perspectives for interpreting the positive relationship between KM performance and firm performance in terms of market-based valuation: (1) undertaking the strategies and behaviors that yield superior KM performance constitute an antecedent for superior market-based valuation; (2) superior market-based valuation motivates a firm to design and execute superior KM initiatives; or (3) superior market-based valuation and superior KM performance are joint consequences of some undetermined third factor. We prefer the first over the other two because it is in line with the three theories, reported anecdotes, and individual case studies. The second perspective would be inconsistent with all of these logical relations and theoretical rationales. While the third perspective is a possibility, we adopt the first until some such factor can be determined. In short, the findings suggest that superior KM performers have a knack for managing knowledge assets in ways that produce superior firm performance.

2. **Implications**

The findings of this study have important implications for practice. By substantiating the link between KM performance and firm performance, this study provides support to managers who have invested considerable resources in KM, especially to those who have implemented successful KM strategies and initiatives. The results suggest that it is not enough for firms to merely have some form of KM practice; they must develop a clear strategy for making their KM performance superior (e.g., along the lines of realizing the MAKE™ study’s eight criteria).
Although there is little well-developed or one-size-fits-all guidance for managers on how to achieve superior KM performance, some insights can be drawn from the literature. First, an important step toward achieving superior KM performance is self-assessment, which requires firms to effectively assess their own KM capability by looking broadly and deeply. Second, management support is indispensable for superior KM performance because the implementation of KM initiatives is resource-intensive and the necessary resources are more likely to be allocated when top management support is available. Finally, effective management of KM assets involves various facets, from developing a culture of continuous learning to implementing a computer-based system for knowledge creation and sharing.

By identifying the importance of KM, this study also encourages practitioners to pay careful attention to the management of their unique and valuable resources. To enable the resources to survive competitive imitation, firms must protect them by isolating mechanisms such as time-compression diseconomies, historical uniqueness, embeddedness, and causal ambiguity. In this way, the firms can maximize the rent-yielding advantage of the resources and achieve and sustain a superior competitive position – resulting in superior firm performance.

Our empirical results also provide important implications to researchers. Although the current study indicates that superior KM performance leads to higher market valuation in recognition/anticipation of improved firm performance, the underlying mechanisms whereby this is achieved are not fully clear. Previous research suggests that KM may impact firm performance indirectly through other variables such as innovation, product leadership, and customer intimacy (McKeen et al. 2006), or through the knowledge chain theory’s PAIR dimensions of productivity, agility, innovation, and reputation (Holsapple and Singh 2001). Therefore, an alternative conceptualization would be a two-stage model that examines the effects of KM on
intermediate variables, which in turn are positively associated with superior firm valuation, performance, or competitiveness. Future research is encouraged to develop and empirically test such a model.

As noted earlier, the third possible perspective for interpreting the positive results of this study is that superior firm and KM performances are joint consequence of an X factor. In light of this, another useful direction of future research would be to determine whether there exists such a factor and what would be it. Addressing this important and interesting research question will allow researchers to enrich studies of effective KM, extend the literature on organizational competitiveness, and arrive at a better understanding of the relationship between KM and firm performance.

3. Contributions and Limitations

This study contributes to the growing literature on organizational effects of KM by using a forward-looking approach to evaluating firm performance. Specifically, in line with the notion that KM is mainly an organization’s intangible asset, we measure firm performance with market-based ratios that effectively reflect the value of such asset. Furthermore, in gauging KM performance, we adopt ratings by international panels of KM experts. Thus, our empirical data avoid possible bias due to reliance on perceptions of individuals embedded within firms being studied. Finally, we collect and analyze eight years’ data from 1998-2005 to examine the relationship between KM performance and firm performance. Therefore, this longitudinal study should not only yield reliable results on the focal relationship but also enable researchers to effectively track the organizational effects of KM over a long time period.

The results and implications of this study should also be considered in light of its limitations. As described in the methodology section, we use MAKE™ study results to identify
firms with superior KM performance. Because the MAKE’s determination of superior KM firms is based on perceptions of KM experts from around the world, its results may reflect some bias. Another limitation is the selection of some of the control firms. That is, for some winner firms, an appropriate control firm of similar size is not found at the primary four-digit SIC level, but at a primary three-/two-digit or non-primary SIC code. Moreover, both the treatment and control samples consist of relatively large organizations, so it is possible that the relationship between KM performance and firm performance found in this study is limited to these relatively large firms. Finally, the generalizability of our findings may be limited by the moderately small sample size.

References


Table 1: Shapiro-Wilk Normality Test Results for Firm Size and Entropy

<table>
<thead>
<tr>
<th>Measurement</th>
<th>Statistic (W-Value)</th>
<th>P-Value</th>
<th>Accept Null Hypothesis</th>
<th>Normally Distributed</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sales</td>
<td>0.78</td>
<td>&lt;0.01</td>
<td>No</td>
<td>No</td>
</tr>
<tr>
<td>Total Assets</td>
<td>0.86</td>
<td>&lt;0.01</td>
<td>No</td>
<td>No</td>
</tr>
<tr>
<td>Number of Employees</td>
<td>0.76</td>
<td>&lt;0.01</td>
<td>No</td>
<td>No</td>
</tr>
<tr>
<td>Entropy</td>
<td>0.85</td>
<td>&lt;0.01</td>
<td>No</td>
<td>No</td>
</tr>
</tbody>
</table>

Note. The null hypothesis of Shapiro-Wilk test is that there is no difference between the distribution of a sample data set and a normal one.

Table 2: Descriptive Statistics and Comparability Test Results

<table>
<thead>
<tr>
<th>Variable</th>
<th>MAKE™ Study Winners</th>
<th>Control Firms</th>
<th>Wilcoxon Signed Ranks Test for Paired Samples</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Median</td>
<td>Mean</td>
<td>Median</td>
</tr>
<tr>
<td>Sales (billion $)</td>
<td>25.66</td>
<td>42.78</td>
<td>19.95</td>
</tr>
<tr>
<td>Assets (billion $)</td>
<td>26.86</td>
<td>49.34</td>
<td>27.54</td>
</tr>
<tr>
<td>Employees</td>
<td>72,746</td>
<td>95,802</td>
<td>81,546</td>
</tr>
<tr>
<td>Entropy</td>
<td>0.44</td>
<td>0.63</td>
<td>0.47</td>
</tr>
</tbody>
</table>

Table 3: Results of Halo Effect Test

<table>
<thead>
<tr>
<th>Statistic</th>
<th>AROA</th>
<th>Sales</th>
<th>Growth</th>
<th>Risk</th>
<th>RV</th>
</tr>
</thead>
<tbody>
<tr>
<td>Coefficient (B Value)</td>
<td>0.051</td>
<td>0.197</td>
<td>0.000</td>
<td>-</td>
<td>0.001</td>
</tr>
<tr>
<td>P-Value</td>
<td>0.35</td>
<td>0.54</td>
<td>1.00</td>
<td>0.86</td>
<td>0.88</td>
</tr>
<tr>
<td>Model Chi-Square: 7.68</td>
<td>P Value for Model: 0.36</td>
<td>Model Degree of Freedom: 7</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Table 4: Shapiro-Wilk Normality Test Results for the Four Ratios

<table>
<thead>
<tr>
<th>Ratio</th>
<th>Statistic (W-Value)</th>
<th>P-Value</th>
<th>Accept Null Hypothesis</th>
<th>Normally Distributed</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tobin’s q</td>
<td>0.78</td>
<td>&lt;0.01</td>
<td>No</td>
<td>No</td>
</tr>
<tr>
<td>Price to Book</td>
<td>0.43</td>
<td>&lt;0.01</td>
<td>No</td>
<td>No</td>
</tr>
<tr>
<td>Price to Sales</td>
<td>0.61</td>
<td>&lt;0.01</td>
<td>No</td>
<td>No</td>
</tr>
<tr>
<td>Price to Earnings</td>
<td>0.71</td>
<td>&lt;0.01</td>
<td>No</td>
<td>No</td>
</tr>
</tbody>
</table>

Table 5: Statistical Results

<table>
<thead>
<tr>
<th>The First Four Ratios</th>
<th>Year</th>
<th>Firm</th>
<th>Tobin’s q</th>
<th>P/B</th>
<th>P/S</th>
<th>P/E</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Mean</td>
<td>Median</td>
<td>Z Value</td>
<td>Mean</td>
<td>Median</td>
<td>Z Value</td>
</tr>
<tr>
<td>1998 N=18</td>
<td>4.24</td>
<td>3.36</td>
<td>-2.69*</td>
<td>9.15</td>
<td>4.87</td>
<td>-2.10*</td>
</tr>
</tbody>
</table>
Appendix A: Treatment Firms and Corresponding Control Firms

<table>
<thead>
<tr>
<th>Year</th>
<th>Superior KM Performers</th>
<th>Control Firms</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Company Name</td>
<td>SIC</td>
</tr>
<tr>
<td></td>
<td></td>
<td>1999</td>
</tr>
<tr>
<td></td>
<td>3M CO</td>
<td>2670</td>
</tr>
<tr>
<td></td>
<td>1ACCENTURE LTD</td>
<td>7371</td>
</tr>
<tr>
<td></td>
<td>AMAZON.COM INC</td>
<td>5961</td>
</tr>
<tr>
<td></td>
<td>BP PLC</td>
<td>2911</td>
</tr>
<tr>
<td></td>
<td>1CANON INC</td>
<td>3861</td>
</tr>
<tr>
<td></td>
<td>CHEVRONTEXACO</td>
<td>2911</td>
</tr>
<tr>
<td></td>
<td>1CISCO SYSTEMS INC</td>
<td>3661</td>
</tr>
<tr>
<td></td>
<td>DELL INC</td>
<td>3571</td>
</tr>
<tr>
<td></td>
<td>GENERAL ELECTRIC CO- PRE FASB</td>
<td>9997</td>
</tr>
<tr>
<td></td>
<td>GOOGLE INC-REDH</td>
<td>7370</td>
</tr>
<tr>
<td></td>
<td>HEWLETT-PACKARD CO</td>
<td>3570</td>
</tr>
<tr>
<td></td>
<td>1INTL BUSINESS MACHINES CORP</td>
<td>3570</td>
</tr>
<tr>
<td></td>
<td>INFOSYS TECHNOLOGIES</td>
<td>7371</td>
</tr>
<tr>
<td></td>
<td>INTEL CORP</td>
<td>3674</td>
</tr>
<tr>
<td>Device</td>
<td>ADR</td>
<td>Communication equipment</td>
</tr>
<tr>
<td>--------------------------------</td>
<td>------------------------------------------</td>
<td>-------------------------</td>
</tr>
<tr>
<td>JOHNSON &amp; JOHNSON</td>
<td>MERCK &amp; CO</td>
<td>Pharmaceutical preparations</td>
</tr>
<tr>
<td>LUCENT TECHNOLOGIES INC</td>
<td>NORTEL NETWORKS CORP</td>
<td>Pharmaceutical preparations</td>
</tr>
<tr>
<td>MICROSOFT CORP</td>
<td>ELECTRONIC DATA SYSTEMS CORP</td>
<td>Computer programming, data process</td>
</tr>
<tr>
<td>MONSANTO CO</td>
<td>SYNGENTA AG</td>
<td>Agricultural chemicals</td>
</tr>
<tr>
<td>NOKIA CORP</td>
<td>MOTOROLA INC</td>
<td>Radio, TV broadcast, Communication equipment</td>
</tr>
<tr>
<td>PFIZER INC</td>
<td>GLAXOSMITHKLINE PLC -ADR</td>
<td>Pharmaceutical preparations</td>
</tr>
<tr>
<td>ROYAL DUTCH/SHELL GRP COMB</td>
<td>EXXON MOBIL CORP</td>
<td>Petroleum refining</td>
</tr>
<tr>
<td>SCHLUMBERGER LTD</td>
<td>HALLIBURTON CO</td>
<td>Oil and gas field exploration services</td>
</tr>
<tr>
<td>SCIENCE APPLICATIONS INTL CORP</td>
<td>VNU NV -ADR</td>
<td>Engineering, accounting, research, management, public relations services</td>
</tr>
<tr>
<td>1SIEMENS AG</td>
<td>MATSUSHITA ELECTRIC -ADR</td>
<td>Electric, other electronic equipment</td>
</tr>
<tr>
<td>SONY CORP</td>
<td>TOSHIBA CORP</td>
<td>Electric, other electronic equipment</td>
</tr>
<tr>
<td>SUN LIFE FINANCIAL INC</td>
<td>NORTHEASTERN MUTUAL LIFE INS</td>
<td>Life insurance</td>
</tr>
<tr>
<td>SUN MICROSYSTEMS</td>
<td>APPLE INC</td>
<td>electronic computers</td>
</tr>
<tr>
<td>TOYOTA MOTOR CORP</td>
<td>GENERAL MOTORS CORP-PRE FASB</td>
<td>Motor vehicles &amp; car bodies</td>
</tr>
<tr>
<td>UNILEVER PLC</td>
<td>GROUPE DANONE</td>
<td>Food and kindred products</td>
</tr>
<tr>
<td>WIPRO LTD</td>
<td>CACI INTL INC -CLA</td>
<td>Computer integrated system design</td>
</tr>
<tr>
<td>XEROX CORP</td>
<td>SANYO ELECTRIC CO</td>
<td>Office Machines</td>
</tr>
</tbody>
</table>

1Control firm identified based on the winner firm’s non-primary SIC code.