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Industrial Marketing Management 35 (2006) 493 – 504 The impact of informationtechnologyon supply chain capabilities and firm performance: A resource-based view Fang Wu a, Sengun Yeniyurt b, Daekwan Kim c, SR Tamer Cavusgil d,* University of Texas at Dallas, United States University of Nevada, Reno, United States c Florida State University, United States d The John W. Byington Endowed Chair in Global Marketing, Department of Marketing and Supply Chain Management, The Eli Broad Graduate School of Management, Michigan State University, 370 North Business Complex, East Lansing, MI 48824, United States b a

Received 31 January 2005; received in revised form 5 May 2005; accepted 15 May 2005 Available online 11 July 2005 Abstract Organizations increasingly rely on information technology (IT) to improve the supply chain process. Yet, past evidence suggests that the investment in IT per se does not guarantee enhanced organizational performance. Drawing from the resource-based view, this study proposes that IT-enabled supply chain capabilities are firm-specific, and hard-to-copy across organizations. These capabilities can serve as a catalyst in transforming IT-related resources into higher value for a firm.

Based on data collected from surveying supply chain and logistics managers in various industries, the present study sheds light on these issues. The findings provide a new perspective in evaluating IT investment in the supply chain process. D 2005 Elsevier Inc. All rights reserved. Keywords: Information technology; Supply chain capabilities; Resource-based view 1. Introduction The use of information technology (IT) in managing the supply chain process has drawn increasing attention in the corporate world. Indeed, a recent study

conducted by Forrester Research indicates that U. S. anufacturers are increasingly dependent on the benefits brought about by IT to: improve supply chain agility, reduce cycle time, achieve higher efficiency, and deliver products to customers in a timely manner (Radjou, 2003). However, IT investment in the supply chain process does not guarantee a stronger organizational performance. The debate on the ‘‘ IT-productivity’’ paradox and other anecdotal evidence suggests that the impact of IT on firm performance remains unclear (e. g. , * Corresponding author. Tel. : +1 517 432 4320; fax: +1 517 432 4322. E-mail addresses:edu (F. Wu),edu (S.

Yeniyurt),acns. fsu. edu (D. Kim),edu (S. T. Cavusgil). 0019-8501/$ - see front matter D 2005 Elsevier Inc. All rights reserved. doi: 10. 1016/j. indmarman. 2005. 05. 003 Brynjolfsson, 1993; Lucas & Spitler, 1999). In fact, the adoption of a particular technology is easily duplicated by other firms, and it often does not provide a sustained competitive advantage for the adopting firms (e. g. , Powell & Dent-Micallef, 1997). Not surprisingly, determining how IT as a resource can create a sustained competitive advantage for a firm remains to be an unresolved issue (Barney, Wright, & Ketchen, 2001).

The primary objective of this paper is to provide some new perspectives in explaining how IT can create a sustained competitive advantage for the firm. In particular, drawing from the resource-based view and supply chain management literature, we propose that IT-enabled supply chain capabilities can serve as a catalyst in transforming ITrelated resources into higher value

for a firm. The value of IT can be enhanced when it is embedded throughout the supply chain process (Powell & Dent-Micallef, 1997). The implementation of IT in the supply chain can enable a firm to develop and accumulate knowledge stores about its 94 F. Wu et al. / Industrial Marketing Management 35 (2006) 493 – 504 customers, suppliers, and market demands, which in turn influences firm performance (Tippins & Sohi, 2003). Second, we explore two IT-related resources-IT advancement and IT alignment-and their roles in creating higher value for the firm. Past literature tends to examine IT as a stand-alone resource without considering the interrelationship between IT, a firm's strategic emphasis, and the overall business processes (Clemons & Row, 1991; Tippins & Sohi, 2003).

In this study, IT advancement measures the extent to which a firm applies the state-of-the-art technology to augment its supply chain capabilities while IT alignment reflects a firm's strategic emphasis in coordinating and integrating its own IT with that of its supply chain partners. By investigating these two specific IT-related resources that are organizationally embedded, we avoid the trap of treating IT as a stand-alone resource, leading to a sounder evaluation of the potential of IT in influencing firm performance.

Third, we develop a new conceptualization of supply chain capabilities as a higher-order construct, consisting of four dimensions: information exchange, coordination, activity integration and supply chain responsiveness. Past literature has discussed one or a few specific aspects of the above capabilities individually (e. g. , Frohlich, 2002; Leek, Turnbull, & Naude, 2003; Sahin & Robinson, 2002; Stump & Sriram, 1997). No previous study

provides a conceptualization of supply chain capabilities as a higherorder construct that encompasses all of the above dimensions.

Our measurement provides a composite index in measuring supply chain capabilities across organizations. Since IT in the supply chain process has various forms, we limit the context of this study to supply chaincommunicationsystem (SCCS)—a subset of supply chain management system (SCMS). An SCCS is defined here as an information system shared by channel partners in order to facilitate electronic transactions, quality and cost calibration, and collaborative forecasting and planning (Bowersox, Closs, & Stank, 1999).

A typical SCCS incorporates electronic interface systems such as electronic data interchange (EDI) and the Internet, to link the various parts of supply chain management system together including enterprise resource planning, customer relationship management, advanced planning, transportation management, and warehouse management systems (Angeles & Nath, 2003; Bowersox, Closs, & Cooper, 2002; Edwards & Peters, 2001; Sanders & Premus, 2002; Shah, Goldstein, & Ward, 2002; Subramani, 2004).

Radio frequency exchange and satellite technology have emerged recently as key elements in SCCS to meet the increasing demand for information in the supply chain process (Bowersox et al. , 2002). By limiting the scope to SCCS, we are able to control the respondents’ evaluations to a specific type of supply chain system. The rest of this article is organized as follows. We begin with a brief review of the resource-based view related to IT and supply

chain management. Then, a four-dimensional conceptualization of supply chain capabilities is proposed and discussed.

Next, a framework that links the IT-related resources to supply chain capabilities and the performance outcomes is presented. This is followed by a discussion of the survey methodology, empirical findings, managerial implications, and limitations. 2. Resource-based view and supply chain capabilities According to the resource-based view, sources of competitive advantage begin with the notion that firm resources may be heterogeneous and immobile (Barney, 1991). Differences in market performance are fundamentally due to the distinctive resources and capabilities that are valuable, rare, inimitable and non-substitutable (e. . , Barney, 1991; Wernerfelt, 1984). In addition, a firm’s competitive advantage can be sustained when it implements a strategy that is not easily duplicated by its competitors (Barney, 1991). How to leverage resources in creating and sustaining competitive advantage for a firm has become the central focus for marketing scholars that link various types of market-based assets (Srivastava, Shervani, & Fahey, 1998; Srivastava, Shervani, & Fahey, 1999) and capabilities (e. g. , Day, 1994) with the ultimate financial performance of a firm (e. g. , Hunt & Morgan, 1995; Srivastava, Fahey, & Christensen, 2001).

IT, as part of a firm’s resource portfolio, may not meet the resource-based view criteria when acting alone. Due to the relatively low barriers to imitation and acquisition by other firms, IT-based advantage tends to diminish fairly quickly (Clemons & Row, 1991). As a result, how IT as a resource can provide a sustained competitive advantage for a firm has become one of the key

research topics in recent years. For example, Powell and Dent-Micallef (1997) have shown that the value of IT can be augmented only when it is embedded in an organization through resource complementarity and co-specialization.

In the present study, we examine the implementation of IT in the supply chain communication system (SCCS). We propose that through embedding IT in a firm’s supply chain process, IT can facilitate the development of higher-order organizational capabilities, namely supply chain capabilities, which are firm specific and hard to duplicate across organizations. The information advantage achieved through the adoption of sophisticated technologies and the synergistic benefits achieved through an integrated system provide the sources of sustained competitive advantage for a firm (Bharadwaj, 2000). . 1. Supply chain capabilities In this study, we focus on examining one unique set of organizational capabilities –supply chain capabilities, and their mediating role between IT-related resource and firm performance. Supply chain capabilities refer to the ability of an organization to identify, utilize, and assimilate both F. Wu et al. / Industrial Marketing Management 35 (2006) 493 – 504 495 internal and external resources/information to facilitate the entire supply chain activities (Amit & Schoemaker, 1993; Bharadwaj, 2000; Collis, 1994).

We conceptualize supply chain capabilities as a second-order construct that encompasses four dimensions: information exchange, coordination, interfirm activity integration, and supply chain responsiveness. These four dimensions are chosen because they represent all the important activities involved in

the supply chain process. Each of the four dimensions reflects an ability to perform cross-functional as well as interorganizational activities which are required in supply chain management.

In addition, they highlight the dynamic nature of the supply chain capabilities that enable a firm to learn and respond to environmental changes (Amit & Schoemaker, 1993; Teece, Pisano, & Shuen, 1997). Our field interviews with supply chain and logistic managers also confirmed this conceptualization. We believe that supply chain capabilities represent a higher level (if not the highest) in the hierarchy of organizational capabilities (Grant, 1996), where they require a wide range of knowledge integration as indicated above.

This type of higher-order capability is harder to achieve and thus enjoys a higher level of protection against competitive imitation (Collis, 1994; Grant, 1996). It possesses the virtues of a valuable source of sustained competitive advantage (Barney, 1991). 2. 2. Information exchange Information exchange refers to the ability of a firm to share knowledge with its supply chain partners in an effective and efficient manner. The information shared in an SCCS encompasses information between direct channel partners as well as throughout the entire supply chain network (Clemons & Row, 1993).

In order for channel partners to use it effectively and efficiently, information has to be exchanged when needed. It needs to come from a credible source and in an adequate format (Mohr & Sohi, 1995). An effective information exchange has been identified as one of the most fundamental abilities in the supply chain process (Shore & Venkatachalam, 2003). 2. 3. Coordination Interfirm coordination refers to the ability of a firm to coordinate transaction-

related activities with supply chain partners (Clemons & Row, 1993; Malone, Yates, & Benjamin, 1987; Shin, 1999).

Coordination with supply chain partners includes the coordination of materials, money, manpower and capital equipment from order-taking to order follow-up (Sahin & Robinson, 2002). Improving coordination between supply chain partners can help reduce transaction costs and improve operational efficiency between supply chain partners, and thus it is one of the key indicators in evaluating a firm’s supply chain capabilities (Sahin & Robinson, 2002; Shin, 1999). 2. 4. Activity integration Firms are integrating their activities both internally and across channel partners (Clark & Stoddard, 1996).

In the present inquiry, we focus on integration across channel partners. We view interfirm channel integration as a twodimensional process: interfirm technology integration and activity integration. Technology integration is reflected in the level of technology alignment with channel partners, while activity integration is conceptualized as the extent to which a firm coordinates its strategic channel activities such as planning and forecasting with its supply chain partners (Bowersox et al. , 1999). The existing literature fails to explicitly differentiate them as two separate dimensions.

We believe the distinction is important because a higher degree of activity integration is a desired outcome of technology integration with channel partners. In other words, technology integration with channel partners does not guarantee that the supply chain activities are automatically integrated after the deployment of such technology. Firms need to fundamentally shift

their ways of doing business with channel partners from discrete transactions to continuous and consistent transactions in order to achieve activity integration with their partners (Clark & Stoddard, 1996). Therefore, the level of activity integration, rather than echnology integration, is a good indicator of a firm’s supply chain capabilities. 2. 5. Supply chain responsiveness Supply chain responsiveness is defined as the extent to which channel members respond cooperatively to environmental changes. It elicits the dynamic nature of a firm’s supply chain capabilities, which allows a firm to develop and renew firm-specific competences and to better respond to shifts in theenvironment(Collis, 1994; Teece et al. , 1997). Today’s complicated marketplace requires reliable, efficient, and collaborative response from the entire supply chain (Rogers, Daugherty, & Stank, 1993).

Being able to take actions and to react subsequently to information gathered is the ultimate form of learning (Sinkula, Baker, & Noordewier, 1997). Thus, we consider supply chain responsiveness as one of the key dimensions of a firm’s supply chain capabilities. 3. Hypothesis development 3. 1. IT Advancement IT advancement for SCCS is defined as the extent to which a firm adopts the most sophisticated technology. It measures the degree of proactive adoption and implementation of advanced IT to find customer solutions ahead of competitors. 496 F. Wu et al. Industrial Marketing Management 35 (2006) 493 – 504 Firms increasingly invest more resources in their SCCS and IT departments in an effort to develop the internal skills necessary to make full use of advanced technologies (Booth & Philip, 1998). However, a higher level of IT investment does not necessarily imply better use of firm resources. Most often, huge expenditures in information and

communication technology do not necessarily result in muchanticipated benefits for a firm (e. g. , Barney et al. , 2001; Brynjolfsson, 1993; Taylor, 2003).

Yet, it is likely that firms successfully enhance efficiency in their business activities and processes by adopting advanced IT (Mukhopadhyay, Rajiv, & Srinivasan, 1997; Stank, Crum, & Arango, 1999). We argue that in order for IT to become a firm-specific resource and, thus, increase its appropriability, it has to be embedded within an organizational process or adopted ahead of competitors (e. g. , Barney, 1991; Powell & DentMicallef, 1997; Tippins & Sohi, 2003). Adopting advanced IT ahead of competitors increases the possibility that the owning firms receive some differential benefits.

When accumulated, a high level of IT advancement is likely to offer additional benefits that would not be available to late adopters. That is, IT advancement is a reflection of a firm’s strategic emphasis in adopting the most advanced technology in order to stay ahead of competitors. In such a situation, IT becomes unique and imperfectly mobile across firms, and it can provide the adopting firms with exclusive benefits through higher efficiency than those of its rivals for at least a certain time period (e. g. Collis, 1994; Philip & Booth, 2001). The advancement of IT in SCCS can help build stronger supply chain capabilities in several ways. First, the equipment of advanced SCCS has the potential to enhance the speed, quality and quantity of information transferred (Booth & Philip, 1998; Clemons & Row, 1993; Malone et al. , 1987). By accelerating the speed of information acquisition and information exchange, IT can ensure the availability and timeliness of

relevant and important information to each party involved (Tippins & Sohi, 2003).

Second, the deployment of an advanced information technology in the supply chain system can achieve better coordination and reduce transaction costs between partners (Clemons & Row, 1993). For example, Dell’s supply chain system is known for its ability to coordinate different parties efficiently in the just-in-time assembly of customized computer orders. This enables Dell to enjoy a long-term cost advantage than that of its competitors (Taylor, 2004). Third, an advanced SCCS can also improve interfirm integration between channel partners (Bowersox et al. , 1999).

Frohlich (2002) notes that a web-based technology now permits the upstream as well as downstream supply chain integration in areas such as inventory planning, demand forecasting, and order scheduling. An integrated flow of information between customers and suppliers can ease the task of balancing the supply and demand across the entire supply chain network. Fourth, an efficient SCCS gives partners greater ability to respond to market changes and customer requests in a timely manner along with efficient information exchange and coordination activities (Rogers et al. , 1993; Stank et al. , 1999). For example, Clemons and Row (1993, p. 3) claim that ‘‘ just-in-time inventory techniques with key suppliers or customers are reducing channel inventories and improving system responsiveness. ’’ Based upon the above discussion, we posit: H1. IT advancement affects supply chain capabilities positively. 3. 2. IT Alignment IT alignment in this study is defined as the extent to which a firm’s IT is compatible with that of its channel

partners. IT alignment reflects the degree of embeddedness of IT across the supply chain, and it requires channel partners to coordinate and align their business processes with each other in order to achieve efficiency (Powell, 1992).

The advancement and alignment of information technology are equally important for the functional adequacy of SCCS (Hausman & Stock, 2003). Yet, IT alignment between partners is difficult to achieve (Clemons & Row, 1993), and it requires resource commitment and coordination across the channel relationship. In fact, one of the biggest challenges in supply chain management is the integration between trading partners (Frohlich, 2002; Taylor, 2003).

Since many supply chain software packages are offered by a variety of vendors and are built using a wide range of technologies (Philip & Booth, 2001), failureto achieve system integration across the supply chain has become one of major growing pains in supply chain management (Taylor, 2003). The investment in advanced IT helps achieve higher system compatibility and integration between channel partners (Philip & Booth, 2001). For example, the transition of SCCS from proprietary EDI to Internet-based EDI is widely observed across industry for companies seeking better system compatibility (Bowersox et al. 1999). The newly introduced XML technology allows even more powerful interaction and integration between channel partners (Xml. org, 2002). In addition, the need of IT alignment calls for supply chain partners to share the costs and responsibilities in the adoption of a new technology (Bowersox et al. , 1999; Taylor, 2003). For

those partners that have yet to adopt a new system, the pressures from the entire supply chain network and the potential synergistic benefits through an integrated system can serve as an impetus for the adoption of advanced technologies to enhance IT alignment.

Therefore, we believe a higher level of IT advancement helps build higher IT alignment across the supply chain. H2. IT advancement affects interfirm IT alignment positively. The achievement of IT alignment requires an organization to develop a higher order of integrative capability that is tacit and complex in nature (Powell, 1992). In the process of F. Wu et al. / Industrial Marketing Management 35 (2006) 493 – 504 497 aligning different business processes in the supply chain network, firms are able to develop a higher level of supply chain capability that is otherwise hard to achieve when acting alone.

This kind of capability requires the integration of resources across the supply chain process, and IT alignment provides the basis for such integration. Through an integrated supply chain system, a firm is able to combine complementary resources into a synergic bundle that will generate higher rents for all partners (Amit & Schoemaker, 1993; Day, 1994). In today’s information-intensive environment, improvement in IT alignment can smooth out the flow of active information and resource sharing within and across firms (Kearns & Lederer, 2003).

It allows supply chain partners an opportunity to jointly codify valuable market knowledge into explicit strategies. It also helps the firm coordinate strategic planning process, which is critical in organizing and allocating

resources to achieve organizational effectiveness (Segars, Grover, & Teng, 1998). In addition, the complex process of IT alignment is likely to improve supply chain responsiveness and collaboration with partners to address the changing market needs (Malone et al. , 1987; Philip & Booth, 2001). H3. IT alignment affects supply chain capabilities positively. . 3. Impact of supply chain capabilities on firm performance In the present study, we propose that supply chain capabilities serve as a mediating role between IT-related resource and firm performance (Collis, 1994). We examine two performance variables-marketing performance and financial performance. Following Venkatraman and Ramanujam (1986), our definition of marketing performance includes sales growth, market share, product development, and market development. Financial performance is defined in terms of profitability, ROI, and cash flow from operations.

In the context of this study, enhancing SCCS can impact firm performance in several ways. First, information flows facilitated by the communication system can potentially increase the sales volume by reaching customers directly and promptly whenever a new product is introduced, and by tapping into markets that were inaccessible on account of distribution or other infrastructure constraints (Wu, Mahajan, & Balasubramanian, 2003). Second, the synergistic benefits achieved through an integrated system allow a firm to respond better to customer problems and requests (Rogers et al. 1993). For example, through its interface with customer relationship management system, an SCCS allows a firm to: respond to customer inquiries, track customer orders, and provide better after-sale service (Bowersox et al. , 1999). Supply chain capabilities can also potentially improve a firm’s

financial performance through a cost advantage over competitors. Information sharing in the supply chain may reduce demand uncertainty, and the cost of inventories in the process of matching supply with demand in the supply hain network (Frohlich, 2002). It can also help a firm produce and deliver products or services to customers at lower cost and higher speed through the improvement in coordination between supply chain partners (Lin, Huang, & Lin, 2002). In addition, a seamless supply chain system simplifies the organizational process and reduces lead times with suppliers (Christopher & Ryals, 1999). It allows a firm the ability to adjust its strategies and implement them throughout the supply chain ahead of competitors when opportunities arise.

This can ultimately enhance shareholder value due to flexible business processes (Srivastava et al. , 1999). Therefore, we believe the enhancement of supply chain capabilities through IT can have a direct impact on a firm’s market performance as well as financial performance. H4. Supply chain capabilities of a firm affect its market performance positively. H5. Supply chain capabilities of a firm affect its financial performance positively. 3. 4. Control variable Firm size can have a great impact on firm performance.

Larger firms could, ceteris paribus, derive greater synergy effects from human and financial resources that lead to better performance. Therefore, size of the strategic business unit (SBU), measured by the total number of employees in the SBU and sales volume of past year, is included as a control variable in this study when we test the main effect of supply chain capabilities on firm performance. This enables us to identify the nature of

relationship between supply chain capabilities and firm performance more effectively. 4. Research methods 4. 1.

The sampling frame and data collection This study examines supply chain partnerships at the strategic business unit (SBU) level, incorporating both buyer and supplier relationships. From our field interviews, appropriate respondents were determined to be supply chain managers, logistics managers, or procurement/purchasing managers who are responsible for a firm’s supply chain activities. After considering various trade associations, we sought the cooperation from the Council of Supply Chain Management Professionals (CSCMP), formerly known as the Council of Logistics Management (CLM), which provided us with the database of member companies.

We excluded consultants, freight forwarders, and third-party logistics companies, which resulted in a pool of 1949 managers. We employed two established criteria to select informants in this study (e. g. , Li & Calantone, 1998). First, following Seidler (1974, p. 817), was the informant in a 498 Table 1 Results of second order CFA Item F. Wu et al. / Industrial Marketing Management 35 (2006) 493 – 504 Std. loading . 853 . 831 . 703 . 775 . 834 t value – 12. 699 9. 920 11. 406 12. 778 Composite reliability . 90

IT advancement My BU uses the most advanced IT for SCCS Our IT for SCCS is always state-of-art technology Relative to our competitors, our SCCS are more advanced My BU is always first to use new IT for SCCS in our industry My BU is regarded as an IT leader in our industry for SCCS IT alignment My BU’s IT for SCCS is well aligned with our partner My BU invests in IT to align

our technology with our partner Our partner invests in IT to align their technology with us Both my BU and our partner always work together for the best IT alignment IT advances for SCCS, between my BU and our partner, are well aligned for best supply chain performance Size (as reported by nformant) Ln (Sales) Ln (Employees) Supply chain capabilities -Information Exchange My BU exchanges more information with our partner than our competitors do with their partners Information flows more freely between my BU and our partner than between our competitors and their partners My BU benefits more from information exchange with our partner than do our competitors from their partners Our information exchange with our partner is superior to the information exchanged by our competitors with their partners -Coordination My BU is more efficient in coordination activities with our partner than are our competitors with theirs My BU conducts transaction follow-up activities more efficiently with our partner than do our competitors with theirs My BU spends less time coordinating transactions with our partner than our competitors with theirs My BU has reduced coordinating costs more than our competitors My BU can conduct the coordination activities at less cost than our competitors -Activity Integration My BU develops strategic plans in collaboration with our partner My BU collaborates actively in forecasting and planning with our partner My BU projects and plans future demand collaboratively with our partner Collaboration in demand forecasting and planning with our partner is something we always do in my BU My BU always forecasts and plans activities collaboratively with our partner -Responsiveness Compared to our competitors, our supply chain responds more quickly and effectively to changing customer and supplier

needs Compared to our competitors, our supply chain responds more quickly and effectively to changing competitor strategies Compared to our competitors, our supply chain develops and markets new products more quickly and effectively In most markets, our supply chain is competing effectively The relationship with our partner has increased our supply chain responsiveness to market changes through collaboration Financial performance My BU performs much better than competitors in profitability My BU performs much better than competitors in ROI My BU performs much better than competitors in cash flow from operations . 871 . 837 . 757 . 874 . 917 – 13. 827 11. 645 15. 004 16. 517 . 93 . 946 . 640 – 2. 498 . 78 . 851 . 884 . 921 . 902 – 14. 18 15. 868 15. 273 . 94 . 844 . 881 . 728 . 816 . 843 – 14. 033 10. 460 12. 402 13. 077 . 91 . 697 . 735 . 840 . 940 . 919 . 875 . 874 . 708 . 765 . 666 – 8. 765 9. 956 11. 017 10. 812 – 14. 366 10. 262 11. 552 9. 418 . 92 . 89 . 913 . 930 . 830 – 18. 493 14. 605 . 92 F. Wu et al. / Industrial Marketing Management 35 (2006) 493 – 504 Table 1 (continued) Item Marketing performance My BU performs much My BU performs much My BU performs much My BU performs much better better better better than than than than competitors competitors competitors competitors in in in in sales growth market share market development product development Std. loading . 822 . 811 . 87 . 782 t value – 11. 640 13. 180 11. 068 499 Composite reliability . 90 Second order supply chain capabilities factor Information exchange Coordination Activity integration Responsiveness Model fit statistics v 2 statistic (df) Bentler – Bonett nonnormed fit index (NNFI) Bentler – Bonet normed fit index (NFI) Comparative fit index (CFI) Root mean square error of approximation (RMSEA) . 780 . 856 . 618 . 821 – 8. 162

5. 905 8. 105 . 86 1085. 957 (646) . 968 . 931 . 971 . 061 ‘‘ – ’’ indicates a fixed scaling parameter. All items except for size were measured using a 7-point Likert scale ranging from 1 = strongly disagree to 7 = strongly agree. osition to generalize ‘‘ about patterns of (relevant) behavior, after summarizing either observed or expected organizational relations? ’’ Since all of our respondents are corporate managers who handle supply chain activities (i. e. , supply chain management and logistics), it is reasonable to expect that the respondents can offer an adequate overview of the supply chain activities. Second, was the informant knowledgeable about the content of the inquiry? Following Kumar, Stern, and Anderson (1993), we asked informants to provide a self-assessment of their expertise on research topics. On a seven-point scale with ‘‘ 7 = best qualified,’’ the mean response was 5. 3, suggesting adequate qualification for this study. During data collection, a preliminary request with an URL link to the web-survey was emailed to these managers, requesting their participation. There were 223 undeliverable emails, and another five managers indicated no interest in participation. Ten days later, a reminder was sent out. From the two requests, 264 responses were received within the three-week time frame, yielding an effective response rate of 15. 3% (264 / 1726). The final usable sample contained 184 responses (usable response rate of 10. 7%), with the following industry-wise distribution: consumer products (17. 9%), industrial machinery (15. %), computer and communication (13. 0%), automotive (9. 2%), electronic equipment (9. 2%), medical equipment (6. 5%), chemical (4. 9%), others (21. 2%), and not reported (2. 3%). To assess non-response bias, we compared early and late respondents (Armstrong & Overton, 1977). The first 75% (n =

138) of the responses were classified as ‘‘ early respondents’’. The last 25% of them were considered as ‘‘ late respondents’’ and were deemed representative of firms that did not respond to the survey (Li & Calantone, 1998; Wu et al. , 2003). The results of t-tests reveal that there is no significant difference on major constructs between the two groups.

In addition, we compared the responses of our final sample with the available responses from 30 managers who opted to drop out before completing the online survey. T-test results revealed no significant difference on sample characteristics and on one available key construct, IT advancement (t = 0. 092). Therefore, it appears that non-response bias does not pose a significant problem for this study. The Harman one-factor test (Podsakoff & Organ, 1986) was utilized to test for common method bias. A principal component analysis of all the items included in the study was performed. Since no dominant factor emerged (the first factor explains only 11. 3 % of the total variance), we conclude that there is no evidence suggesting the presence of common method bias in the study. 4. 2.

Measurement, reliability and validity We followed the procedures suggested by Churchill (1979) in scale development. First, the domain of each construct was clearly defined in terms of what would be included or excluded. Second, the literature was searched to locate any relevant scales. Measures were adopted or adapted from the existing literature where appropriate. If none were available or appropriate, new measures were developed. All items except for firm size were measured using a seven-point Likert scale with 1 = strongly disagree and 7 = strongly agree. The scales for IT advancement

were adapted from the measurement of technological orientation in Gatignon and Xuereb (1997).

We modified the scales to reflect IT advancement within an organization. Activity 500 F. Wu et al. / Industrial Marketing Management 35 (2006) 493 – 504 integration scales were modified from Bowersox et al. (1999) where the degree of interfirm collaboration was measured. Scales for IT alignment, information exchange, and partner coordination were developed especially for this study. Supply chain responsiveness was adapted from McGinnis and Kohn (1993), with adjustments from the firm to the supply chain level. For market performance, scales were adapted from Venkatraman and Ramanujam (1986) including sales growth, market share, market development, and product development.

Financial performance was measured in terms of profitability, ROI, and cash flow from operations. Finally, the company size was measured in terms of sales and number of employees of each SBU as reported by the informant. The firm size variable was transformed by taking the natural log to alleviate univariate non-normalities and account for nonlinear effects (Wooldridge, 2000). 4. 3. Reliability and validity A second-order confirmatory factor analysis was carried out (Bentler, 1989) to investigate the convergent and discriminant validity of each construct. The measurement model including all constructs was fitted by the elliptical reweighted least squares (ERLS) procedure of the EQS program (Bentler, 1989).

The results of the analysis are shown in Table 1. The model provides an excellent model fit (v 2 = 1085. 96 with 646 df, CFI = 0. 971, NNFI = 0. 968,

NFI = 0. 931, RMSEA= 0. 061) given the complex nature of the second-order confirmatory factor analysis (Bentler, 1989). All items loaded on their respective constructs and were statistically significant. Further, the composite reliability for all constructs was above the 0. 7 level suggested by Nunnally (1978), indicating adequate reliability. Table 1 describes the measures and the reliability of each construct. Convergent validity was established by examining significant factor loadings on each construct.

Following Anderson (1987), convergent validity is suggested when items load significantly on their designated latent variables. The standardized CFA loadings in Table 1 present evidence of convergent validity. The loadings of the four first-order factors on the supply chain capabilities are positive and statistically significant, indicating convergent validity at the second order factor level. We assessed the discriminant Table 2 Descriptive statistics Mean Standard deviation validity of each construct using the procedure recommended by Bagozzi, Yi, and Phillips (1991). This entails analyzing all possible pairs of constructs in a series of two-factor confirmatory factor analysis (CFA) models using EQS (Bentler, 1989).

Each model was run twice — once constraining the correlation between constructs to unity and another freeing the parameter. A chi-square (v 2) difference test was then performed on the nested models to assess if the v 2 values were significantly lower for the unconstrained models. The critical value (Dv 2(1) > 3. 84) was exceeded in all pairs. The results indicate that the chisquare values are significantly lower for the unconstrained models at the one percent level, which suggests that the constructs exhibit

discriminant validity. Supply chain capabilities were hypothesized to have a second-order structure consisting of four dimensions: information exchange, coordination, activity integration and supply chain responsiveness.

In order to further assess the validity of supply chain capabilities as a second-order construct, we conducted additional analysis by comparing the model fit of a second-order model by pulling the four constructs together with another model where the four constructs were treated as first-order constructs only. The second-order model consisting of the four constructs indicated an adequate model fit for the proposed structure (v 2 = 348. 147 with 148 df, CFI = 0. 962, NNFI = 0. 956, NFI = 0. 936, RMSEA= 0. 086). Given the parsimonious nature of the second-order factor, and the insignificant difference in fit indices between the two measurement models, the second-order factor structure for supply chain capabilities is preferred (Hull, Tedlie, & Lehn, 1991). 5.

Results The effects of IT advancement and IT alignment on supply chain capabilities and the performance outcomes were assessed using a full model specification. The correlations between the factors included in the full model and their standard deviations based on the second order CFA output are presented in Table 2. Standardized path coefficients and the fit statistics are shown in Fig. 1. The overall fit statistics indicate an excellent model fit for the full model (v 2 = 1088. 75 with 752 df, CFI = 0. 971, NNFI = 0. 969, NFI = 0. 931, RMSEA= 0. 061). Regarding the hypothesized rela- Correlations 1 2 1. 000 . 201 . 402 . 396 . 564 3 4 5 1 2 3 4 5 6

IT advancement IT alignment Firm size Financial performance Marketing performance Supply chain capabilities 3. 560 3. 699 6. 481 4. 776 4. 859 4. 287 1. 478 1. 320 2. 141 1. 241 1. 067 . 910 1. 000 . 687 . 199 . 433 . 391 . 540 1. 000 . 197 . 134 . 097 1. 000 . 769 . 532 1. 000 . 559 Mean values are based on average factor scores; correlations and standard deviations are from the second-order CFA output. F. Wu et al. / Industrial Marketing Management 35 (2006) 493 – 504 501 IT Alignment . 365** Supply Chain Capabilities . 566** Marketing Performance . 537** . 689** . 306* . 067 IT Advancement Firm Size . 130 Financial Performance Chi-square: 1088. 75 (652 df; p < . 01), NNFI: . 969, NFI: . 931, CFI: . 971, RMSEA: . 61 * p < . 05; **p < . 01 Fig. 1. Full model estimates — Standardized parameters. v 2: 1088. 75 (652 df; p < . 01), NNFI: . 969, NFI: . 931, CFI: . 971, RMSEA: . 061 * p < . 05; **p < . 01. tionship, IT advancement has a significant positive effect on both IT alignment (t = 8. 570, p < . 01) and supply chain capabilities (t = 2. 563, p < . 05). Thus, H1 and H2 are supported. The results also indicate that IT alignment has a positive and significant effect on supply chain capabilities (t = 3. 019, p < . 01). Therefore, H3 is supported. Further, the effects of supply chain capabilities on marketing performance (t = 4. 970, p < . 1) and on financial performance (t = 4. 989, p < . 01) are positive and significant. Hence, the results support both H4 and H5. Finally, firm size, as the control variable, reveals no significant effect on performance variables. The analysis of the total effects indicates that the total effects of IT advancement on market performance (t = 4. 845, p < . 01) and financial performance (t = 4. 885, p < . 01) are positive and significant. Similarly, the total effects of IT alignment on marketing performance (t = 2. 972, p < . 01)

and financial performance (t = 2. 981, p < . 01) are positive and significant, as mediated by supply chain capabilities.

Further, to assess the mediation effect of supply chain capabilities on the relationships between the ITrelated antecedents and firm performance, two alternative models were estimated (Venkatraman, 1989). First, the construct of supply chain capabilities was removed and only the direct effects of IT advancement and IT alignment on performance variables were estimated. In this model, the direct effects of IT variables on performance variables were positive and significant at the . 01 level. Second, the direct effects of IT advancement and IT alignment on the performance variables were added to the original model, including the indirect effects, as mediated by supply chain capabilities. In this specification, none of the direct effects of the IT variables on performance variables was significant at the . 10 level.

Hence, we conclude that the effects of IT alignment and IT advancement on firm performance are fully mediated by supply chain capabilities (Venkatraman, 1989). 6. Discussion and implications 6. 1. The mediating role of supply chain capabilities In this research we explored the role of supply chain capabilities as a key mediator between IT investment and firm performance. Results indicate that supply chain capabilities are able to transform IT-related resource into higher value for a firm. Through embedding IT into a firm’s supply chain system, the firm is able to enhance channelspecific assets through effective information exchange and better coordination with supply chain partners. A higher level of supply hain capabilities bestows the firm an information advantage over competitors

through gaining access to and even integrating knowledge from multiple sources that are not available when acting alone. The improvement in supply chain capabilities through IT allows the firm to learn and respond to market changes better and quicker than competitors. In addition, a firm possessing these capabilities can shield itself from immediate competitive imitation since such capabilities are developed over time and are deeply embedded in organizational routines. This provides the basis of sustained competitive advantage (e. g. , Barney, 1991; Bharadwaj, 2000).

The mediation effect of supply chain capabilities also implies that incorporating proper mediators may help better explain the impact of IT on firm performance. The present study provides some explanations regarding the inconsistent effects of IT on firm productivity (Brynjolfsson, 1993). The findings suggest that examining the impact of IT in a specific setting, such as a firm’s supply chain system, can help better gauge the effect of IT on firm performance (Barney et al. , 2001). The results also provide some implications for managing the supply chain system. In particular, managers need to recognize the role of supply chain capabilities in realizing the value of IT resources.

As the resource-based view argues, IT resources offer benefits when they are embedded in specific organizational processes (Barney, 1991). The study examines the impact of IT resources on firm performance in the context of SCCS. Findings suggest that a proper deployment of IT resources in SCCS can help realize the benefits of IT through building higher supply chain capabilities in such areas as information exchange, coordination, activity

integration, and supply chain responsiveness. The study also provides support for conceptualizing supply chain capability as a higher order construct. Managers need to realize that the different dimensions of supply chain capabilities are interrelated.

The investment in the supply chain system needs to be coordinated throughout the channel partners in order to realize the full potential of IT investment in the supply chain system. Moreover, a firm’s supply chain capabilities are likely to contribute more 502 F. Wu et al. / Industrial Marketing Management 35 (2006) 493 – 504 to firm performance when stemming from well-balanced supply chain activities rather than from fragmented and imbalanced activities. 6. 2. IT-related resources and supply chain capabilities Despite the crucial role of supply chain capabilities in realizing the value of IT on firm performance, achieving such capabilities is not an easy task.

Supply chain capabilities, as higher-order organizational capabilities, represent a firm’s abilities to effectively combine resources using informationbased organizational processes to serve customers (e. g. , Amit & Schoemaker, 1993). A higher level of knowledge integration from multiple sources and multiple partners throughout the supply chain is required to perform the tasks effectively and efficiently (e. g. , Grant, 1996). The findings suggest that IT advancement and IT alignment are able to facilitate the development of supply chain capabilities. By deploying the newest technology for SCCS, especially before it is diffused widely, firms are expected to achieve higher efficiency than their competitors in channel

activities, both within the firm and with partners (Boone & Ganeshan, 2001; Philip & Booth, 2001; Porter, 2001).

The adoption of an advanced IT for SCCS can improve information sharing and coordination between channel partners (Sahin & Robinson, 2002). Due to the interconnectedness enabled by information technology, the once-isolated decision making process from upstream suppliers to the downstream customers is becoming more intertwined (Bowersox et al. , 1999). In fact, Vakharia (2002, p. 497) indicates that the purpose of information sharing is to ‘‘ facilitate integrated and/or coordinated decision making in supply chain. ’’ In addition, sharing information across the supply chain network can help firms forecast market demands better, reduce inventory costs, and be more responsive to customer orders (Lin et al. , 2002).

Due to high costs, supply disruption, and the potential loss of confidential information, supply chain partners often resist the changes in the process of e-integration across the supply chain (Frohlich, 2002). The technology incompatibility is often cited as one of the major causes of supply chain disruption (Taylor, 2003). The findings suggest that IT alignment with channel partners is equally important, if not more, in enhancing a firm’s competitive advantage through supply chain communication systems. Previous research has examined the role of strategic alignment between IT and overall business strategy of a firm (Kearns & Lederer, 2003). The current study broadens the scope of IT alignment to the entire supply chain. It provides some useful guidelines for managing the supply chain.

Specifically, we find that channel partners not only have to adopt an adequate technology in the process of supply chain management but also are required to strive for technology compatibility across the supply chain (Hausman & Stock, 2003). That is, a simultaneous investment in IT by all partners is required to achieve the full potential of their IT commitment. However, due to the multiple technology platforms often encountered in the supply chain system and the high level of financial commitment required from all channel partners, IT alignment provides both opportunities and challenges for effective supply chain management (Hausman & Stock, 2003). The study also suggests that a successful deployment of IT involves not only advanced, state-of-the-art IT infrastructure but also the identification of the context in which IT will be utilized.

That is, managers need to identify the appropriate context related to IT resource deployment and reconfigure the organizational processes in a way that can realize the full potential of IT (Swanson, 1994). In the supply chain context, managers need to realize that IT alignment is an important element of successful IT deployment. Only when managers are able to coordinate IT investments in the supply chain systems across channel partners efficiently and effectively, will the returns from IT be optimized. 7. Limitations and future research Several limitations of this study can be addressed in future research. First, this study relied on cross-sectional data.

Although surveying corporate managers become increasingly challenging and costly, collecting data over time from the participating managers can offer richer implications. Future research may consider validating the

findings of this study using a time-series data. Second, the study framework was tested primarily with a single informant from each organization. A dataset with multiple informants from each organization can enhance the validity of the findings. Third, this study used perceived measures of market and financial performance by managers. Future work can attempt to blend in objective data in an effort to validate the findings. Fourth, we included firm size as a control variable in this study which revealed no significant effect on firm performance.

Other variables such as a firm’s IT experience or industry experience could shed light on the relationship between supply chain capabilities and firm performance. Finally, this study explored only two specific types of IT resources — IT advancement and IT alignment. Other types of IT resources could influence a firm’s supply chain capabilities as well. For example, IT utilization, internal IT integration, and management commitment to IT for supply chain management, among others, are possible IT-related resources that deserve further research attention. Future research should incorporate these in exploring the effects of IT on supply chain relationships as well as firm productivity. References Amit, R. , & Schoemaker, P. J. H. (1993). Strategic assets and organizational rent.

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