STEFAN STREMERSCH, ALLEN M. WEISS, BENEDICT G.C. DELLAERT, and RUUD T. FRAMBACH*

Technology-intensive markets consist of products that are often interdependent and operate together as a modular system. Although prior research has extensively addressed standardization and network externalities in such markets, it has not addressed the buying of modular systems. The authors identify two focal decision dimensions of the buyer, namely the decision of whether to outsource system integration and the decision of how much to concentrate the purchase of system components with one or more suppliers. The authors develop a comprehensive production- and transaction-cost framework to explain companies' positions on these two decisions. They find that especially leakage and the buyer's know-how, together with the technological volatility the buyer faces, drive the preference for outsourcing system integration and the purchase concentration of system components. An empirical test in the market for telecommunications systems supports the theory developed.

Buying Modular Systems in Technology-Intensive Markets

The burgeoning academic focus on technology-intensive (TI) markets parallels the understanding that TI markets are not only important but also unique (Capon and Glazer 1987; Glazer 1991). Unfortunately, research on TI markets remains largely unexplored. Organizational buying behavior in these markets is particularly underresearched, though scholars have established its theoretical uniqueness (Heide and Weiss 1995; Weiss and Heide 1993).

One characteristic of TI markets that has important implications for organizational buying behavior is that technological products are interdependent and often operate together in a modular system (Schilling 2000). A computer works and communicates with other computers and servers in a network. Transmissions and switches are necessary components in a network of a telecommunications operator to provide end users with the ability to communicate. Modular systems typically comprise "technologically divisible" components joined by a set of nonproprietary interfaces that enables the components to work (Katz and Shapiro 1994).

Modular systems raise two particularly interesting strategic decisions for buyers. First, because the system components must be integrated into a system, by either an outside system integrator or the buyer, the buyer needs to decide whether to outsource the system-integration function or to integrate the system in-house. *System integration* is defined as the installment and interconnection of a system's components (Wilson, Weiss, and John 1990). For example, telecommunications operators must decide whether to outsource the integration of switches, transmission, and billing in a new or enhanced telecommunications network to an external system integrator. Second, buyers need not buy all system components from the same manufacturer, regardless of whether they outsource the integration function; instead, they can mix and match components from different manufacturers. As a result, the buyer needs to decide whether to purchase all system components from a single supplier or from multiple suppliers. For example, telecommunications operators must decide whether to buy switches, transmission, and billing from the same manufacturer or to mix and match these network components from multiple suppliers. These two decisions result in various purchasing options being available to buyers (see Figure 1).

*Stefan Stremersch is Assistant Professor of Marketing, Erasmus University, Rotterdam (e-mail: stremersch@few.eur.nl). Allen M. Weiss is Professor of Marketing and David and Jeanne Tappen Fellow of Marketing, University of Southern California (e-mail: amweiss@marshall.usc.edu). Benedict G.C. Dellaert is Professor of Marketing and Meteor Research Chair, Maastricht University, Maastricht, the Netherlands (e-mail: b.dellaert@mw.unimaas.nl). Ruud T. Frambach is Professor of Marketing, Free University, Amsterdam (e-mail: rframbach@econ.vu.nl). The authors gratefully acknowledge the financial support of Alcatel Telecom, the Goldschmeding Center of Economics for Increasing Returns (Nyenrode University), and the Center for Economic Research (Tilburg University). The first author acknowledges the financial support of the Belgian Intercollegiate Center for Management Sciences. The third author acknowledges the financial support of the Dutch Science Foundation (NWO-ESR). The authors also thank Frederic Papeians and especially Derrick-Philippe Gosselin (at Alcatel) for their guidance and assistance. They value the research assistance by Vladislav Golounov and appreciate the helpful comments of Harry Commandeur, Christophe Van Den Bulte, and three anonymous *JMR* reviewers.

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Figure 1
PREFERENCES FOR MODULAR SYSTEMS

		Outsourcing System Integration	
		Outsourcing	*In-House*
Purchase Concentration of System Components	Single Sourcing	Outsourcing of system integration with system components from a single vendor	In-house system integration with system components from single vendors
	Multiple Sourcing	Outsourcing of system integration with system components from multiple vendors	In-house system integration with system components from multiple vendors

For example, consider the market for computer systems. Although there are companies that adopt an outsource–single-source policy, such as buying an integrated system from IBM, none of the purchasing strategies for modular systems is dominant. Buyers may also adopt multiple sourcing of components and outsource system integration to an outside party. Thus, they may prefer to buy a turnkey system from Accenture that integrates Compaq servers, Dell workstations, and Microsoft software into a single system. In contrast, buyers may prefer to have their own information technology (IT) department integrate the system, shop around, and buy IBM servers, Dell workstations, and Microsoft software (i.e., in-house system integration with multiple sourcing). Buyers may also prefer to single-source components from IBM and have their own IT department integrate the system (i.e., in-house system integration with single sourcing).

Such variation across these alternatives is likely the case in other industries as well. Discussion with industry observers and participants in the telecommunications systems market, which is the context of our study, has indicated that there is no dominant purchasing strategy in this market. Therefore, it would be useful to identify the conditions that make the various options attractive.

Prior literature may help in this regard. In particular, there are two streams of research that have examined companies' outsourcing decisions: neoclassical economics and institutional economics. Neoclassical economics has studied the outsourcing decision from a production-cost perspective, whereas institutional economics has studied the decision from a transaction-cost perspective (Rindfleisch and Heide 1997). With respect to organizations' purchase concentration decision, there is little literature, except for descriptive commentary in the trade and managerial press, that discusses the factors that drive a company's preference for single sourcing over multiple sourcing or that develops a theory that has particular relevance in TI markets. We take a similar production- and transaction-cost perspectives on the component purchase-concentration decision. As we argue subsequently, considerations of production costs and transaction costs may also drive buyers' decisions about the extent to which they will single-source system components.

These two perspectives (production and transaction costs) have been applied in various contexts but rarely in a technology context. Prior research suggests that the straightforward application of these perspectives to a technology context may be misguided. For example, Balakrishnan and Wernerfelt (1986) argue that technological volatility has unique consequences for outsourcing that the traditional environmental volatility in transaction-cost analysis does not capture. Although environmental volatility makes outsourcing less efficient, technological volatility has the opposite effect. An understanding of TI markets also requires a focus on the presence and transfer of know-how (Glazer 1991; John, Weiss, and Dutta 1999). Although prior literature on production costs and transaction costs has rarely examined these factors, research in TI markets has shown that the presence and potential leakage of (tacit) know-how is central to an understanding of how firms organize their interfirm relationships (e.g., Dutta and Weiss 1997; Pisano 1990).

We test our production- and transaction-cost framework using a field survey in which we conducted a conjoint experiment. Although conjoint is rarely used in an organizational context (for two exceptions, see Murry and Heide 1998; Wathne, Biong, and Heide 2001), it fits with the increasing use of experimental designs in organizational research. The following section presents our research hypotheses. The third section describes our research design and data collection methods. The fourth section discusses the model and statistical tests we used to analyze the data and presents the results of the study. The final section discusses the results, the study's limitations, and implications for marketing research and practice.

CONCEPTUAL BACKGROUND AND HYPOTHESES

Scholars have suggested that organizations consider both production costs and transaction costs in structuring their interfirm relationships (Walker and Weber 1984). Our conceptual framework builds on this insight to delineate a set of production- and transaction-cost variables that may affect a company's preference to outsource system integration and single-source system components. We first postulate our hypotheses on production-cost variables, after which we turn to transaction-cost variables.

Production-Cost Variables

Production costs are those costs associated with a firm's production function, and thus production-related variables influence the buyer's cost of task execution. We identify the relevant production-cost variables subsequently.

Presence of know-how. Know-how has been defined as scientific knowledge applied to useful purposes (Quinn, Baruch, and Zien 1997). The presence of know-how refers to the degree of technology expertise, experience, training, and competency of a buying organization. A buyer's know-how may influence the cost of in-house system integration, regardless of the identity of any specific system integrator. However, two seemingly contradictory predictions can be made, depending on how a buyer's level of know-how affects its ability and motivation.

One stream of literature suggests that the more know-how a company has, the less it prefers outsourcing to in-house system integration. This is because buyers with more know-how have a greater ability in system integration. For example, John, Weiss, and Dutta (1999) argue that when a company has developed a high level of know-how, the relative cost of using the know-how is low. The greater ability of high-know-how companies thus translates into increasingly lower costs of and a greater preference for in-house system integration.

Other streams of literature point to the motivation of low-know-how firms to acquire a certain threshold level of know-how in order to assimilate new know-how (Cohen and Levinthal 1990). For example, the literature on technology adoption points out the prevalence of "learning by doing" and not bypassing the ability to gain important technological learning that accrues with experience (Grenadier and Weiss 1997). Such an argument suggests that buyers with the least know-how are the most likely to prefer in-house system integration.

Combining the ability and motivation arguments, we propose a curvilinear relationship between the presence of know-how and the preference for outsourcing system integration, in which companies with moderate levels of know-how have the greatest preference for outsourcing. A moderate-know-how company will already have crossed a threshold level of know-how and will have gained sufficient ability to assimilate new knowledge obtained through the system integrator (Cohen and Levinthal 1990), which thus makes the decision to outsource system integration more likely. In addition, a moderate-know-how buyer may still have a substantial cost disadvantage compared with an external system integrator, which also increases its preference for outsourcing system integration.

> H_1: The preference for outsourcing over in-house system integration is greatest for buyers with moderate levels of know-how and is least for buyers with low or high levels of know-how.

Conflicting arguments can be advanced about the effect of know-how on a buyer's preference for single sourcing over multiple sourcing. On the one hand, industrial buying theory states that high-know-how buyers face little task uncertainty and thus have low motivation to seek more information (McQuiston 1989). This is also consistent with Dougherty's (1992) finding that the better developed an organization's know-how is, the less likely it wants to acquire or access new information from external sources. Thus, we expect a high-know-how buyer to attach little value to the more diverse information that multiple suppliers provide. Consequently, we expect high-know-how buyers to have a greater preference for single sourcing over multiple sourcing, compared with low-know-how buyers. On the other hand, Weiss and Heide (1993) argue that the less know-how buyers have, the less they are able to discriminate between different offerings. Therefore, low-know-how buyers may lack the prime motivation to mix and match components from multiple vendors. From this contrasting perspective, single sourcing may also be convenient for low-know-how buyers.

Buyers with moderate know-how may have the lowest preference for single sourcing over multiple sourcing. In contrast with low-know-how buyers, they are able to discriminate between different offerings. In contrast with high-know-how buyers, they may be more eager to increase information inflow from suppliers, because they may still considerably improve their know-how and perceive moderate task uncertainty (Bunn 1993). Therefore,

> H_2: The preference for single sourcing over multiple sourcing of system components is least for buyers with moderate levels of know-how and greatest for buyers with low or high levels of know-how.

Technological heterogeneity. Technological heterogeneity refers to the presence of multiple, partially discrepant product offerings (Tushman and Anderson 1986). In the context of systems, technological heterogeneity captures the technological differences between possible system configurations, and it affects a buyer's information-processing costs. A buyer facing greater technological heterogeneity is likely to face higher information acquisition and processing costs for all possible system configurations. Weiss and Heide (1993) argue that high levels of heterogeneity may create information-processing problems of such a magnitude that organizations may suppress information search. In addition, heterogeneity imposes a need to sort the possible system configurations into more homogeneous classes (Leblebici and Salancik 1981). Firms can minimize information-processing costs by contracting with an external system integrator that typically acquires and processes information as part of its core competencies.

In environments with high technological heterogeneity, buyers are also more likely to choose existing vendors with which they are familiar (Heide and Weiss 1995). Organizations in such environments are also expected to have more routine, formal decision procedures (Leblebici and Salancik 1981). Buyers' inclination to buy routinely from suppliers when technology is heterogeneous leads to a tendency to restrict the number of component suppliers. Therefore, we hypothesize:

> H_3: The greater the technological heterogeneity, the greater a buyer's preference is for (a) outsourcing over in-house system integration and (b) single sourcing over multiple sourcing of system components.

In H_3, we stipulate that organizations may have a higher preference for outsourcing under conditions of high technological heterogeneity, because they deliberately use only part of the information available and want to minimize the information they need to process to cope with complexity. At the same time, in H_1, we argue that knowledgeable organizations seek less new information than do less knowledgeable organizations (Dougherty 1992). These theoretical arguments seem to suggest that knowledgeable organizations, compared with low-know-how buyers, restrict information inflow more easily through outsourcing in reaction to high technological heterogeneity. We also argue that firms in environments with high technological heterogeneity attempt to work with existing, familiar vendors (Heide and Weiss 1995), and we expect high-know-how firms to adopt such a strategy easily. In contrast, low-know-how firms attempt to maximize information inflow to deal with the greater uncertainty they experience (see H_2). Therefore, we expect that less knowledgeable organizations, compared with more knowledgeable buyers, prefer less to develop strong relationships with a single source in reaction to high technological heterogeneity.

> H_4: The positive relationship between technological heterogeneity and a buyer's preferences for (a) outsourcing over in-house system integration and (b) single sourcing over multiple sourcing is greater for high-know-how buyers than for low-know-how buyers.

Component-supplier specialization. Component-supplier specialization refers to the differentiation that component suppliers achieve by focusing on a narrow subset of products or technologies. A dominant reason that high-technology firms specialize in one or a few system components is to maintain their technological leads (John, Weiss, and Dutta 1999). In general, such specialization enables manufacturers to create higher quality in a specialized set of components. However, perceived quality differences among various specialized manufacturers create a major incentive for buyers to mix and match the components of different vendors into a modular system (Schilling 2000). By doing so, buyers are able to build a system that better fits their idiosyncratic needs (Wilson, Weiss, and John 1990). Another argument to this effect is that suppliers that specialize may achieve economies of scale, which reduce the cost of their components to the buyer. Thus,

> H_5: The greater the component-supplier specialization, the lower a buyer's preference is for single sourcing over multiple sourcing of the system components.

Supplier concentration in the system-integration market. Supplier concentration in the system-integration market pertains to the number of capable, reliable system integrators. A large (small) number of integrators represents a low (high) concentration degree. High concentration in the system-integration market raises the ex ante price a system integrator charges the buyer, which is due to monopoly power. The higher price reduces the cost disadvantage for a buyer of in-house system integration. In addition, when supplier concentration is low, the cost of switching to an alternative system integrator is relatively low (Lieberman 1991). Thus, the more alternative suppliers there are, the more a buyer tends to prefer outsourcing to in-house system integration. Conversely,

> H_6: The greater the supplier concentration in the system-integration market, the lower a buyer's preference is for outsourcing over in-house system integration.

Acquisition expertise. Buyers may also vary as to the extent of their acquisition expertise, which is often gained through experience, on the different suppliers in the market.[1] Acquisition expertise affects the costs of executing the focal administrative task of evaluating the abilities and characteristics of various suppliers. A buyer with less expertise on the supplier market faces a greater need for information search in supplier choice. The buyer's lack of expertise pertaining to suppliers presents the buyer with a novel purchase situation, which increases the perceived task uncertainty (McQuiston 1989). Purchasing literature has found that buyers increase their information search when faced with uncertainty (Sheth 1973). Weiss and Heide (1993) have shown that in TI markets, buyers that lack prior experience with suppliers increase information search. System integrators are typically highly expert in the supplier market, in view of their own experiences across projects. Contracting with an external system integrator may be an efficient way for buyers with little acquisition expertise to acquire information on the supplier market. Therefore,

> H_7: The more acquisition expertise a buyer has, the lower a buyer's preference is for outsourcing over in-house system integration.

Transaction-Cost Variables

Transaction costs are those costs associated with the exchanges between specific parties and enforcing agreements. In particular, transaction-cost variables tap the dangers of ex post opportunism by an exchange partner.

Leakage of tacit know-how. We previously related a buyer's know-how to various production costs. We now turn to an important governance problem that may be related to a buyer's know-how. If the buyer has (1) substantial proprietary know-how that (2) is tacit and (3) could be leaked when dealing with exchange parties, governance issues may be at play. If any of these three conditions is absent, governance may not be a problem, because efficient contracts can be drafted. Potential leakage of proprietary tacit know-how taps the increased danger of appropriation (without compensation) of the assets of one party by the exchange party. Transactions in TI markets often involve leakage of tacit know-how between transacting parties (John, Weiss, and Dutta 1999).

The outsourcing of system-integration activities makes the buyer particularly prone to tacit know-how leakage. If the buyer decides to outsource, an external system integrator will have frequent contact with the buyer's organization and will gain access to the buyer's technology base. Such frequent contact and access enable transfer or leakage of tacit know-how (Teece 1981). Appropriation of the buyer's tacit know-how may lead to two negative consequences. First, the external system integrator may opportunistically use the leaked tacit know-how to endanger the buyer's bargaining position. Safeguards in the form of contractual (e.g., confidentiality) agreements are difficult for a buyer to put in place to avoid the opportunistic exploitation of this tacit know-how (Hennart 1988). This is because tacit know-how involves property rights that are difficult to control, because they are likely to be ambiguous and relatively undetectable, and thus contingent claims contracts are difficult to enforce (Williamson 1985). Second, because a system integrator often works for multiple customers in the same industry at the same time, it may inadvertently leak this tacit know-how to the buyer's competitors (Pisano 1990), which may severely endanger the buyer's competitive position. Therefore,

> H_8: The greater the tacit know-how of the buyer that can be leaked, the lower the buyer's preference is for outsourcing over in-house system integration.

For the component purchase-concentration decision, prediction may be less clear-cut. The adverse consequences of tacit know-how leakage may be fewer in a single-sourcing situation than in a multiple-sourcing one, because single sourcing may entail greater interdependence. This follows from prior research on marketing channels (e.g., trust) in which it is suggested that greater interdependence actually strengthens commitment and trust in relationships (Kumar, Scheer, and Steenkamp 1995).

[1]Note that an organization's acquisition expertise is distinct from its technological know-how. Know-how refers to scientific knowledge applied to useful purposes or is synonymous to the technology within a company (Capon and Glazer 1987), whereas acquisition-related expertise merely reflects how well the buyer knows the various suppliers' characteristics.

In addition, the number of parties to which the single source could leak the buyer's tacit know-how is likely to be more restricted than it is in a multiple-sourcing situation. For example, the single source of the buyer may have little contact with most of the buyer's main competitors, which makes leakage of the buyer's tacit know-how to these competitors less likely. In contrast, if the buyer uses multiple sources, it is unlikely that those sources all have little contact with the buyer's main competitors. In our context, if a component supplier has a single-sourcing relationship with a buyer, it is unlikely that the supplier develops close, single-source relationships with that buyer's main competitors. In this sense, even if tacit know-how is leaked, it restrains most of the hazards related to opportunistic behavior of the supplier that are associated with it. Such an argument is consistent with the strength-of-ties literature in sociology (e.g., Granovetter 1973) and marketing (Rindfleisch and Moorman 1999), which shows that knowledge transferred in a dense network often involves redundant knowledge. These arguments lead to the following hypothesis:

> H_9: The greater the tacit know-how of the buyer that can be leaked, the greater the buyer's preference is for single sourcing over multiple sourcing.

In contrast with H_9, it can also be argued that buyers prefer multiple sourcing when the hazard of tacit know-how leakage is great. Not only the extent to which leaked tacit know-how is exploited (which underlies H_9) but also the relative ease with which tacit know-how leakage may occur (see, e.g., Hansen 1999) varies from a single-sourcing to a multiple-sourcing situation. In particular, working with a single supplier rather than multiple suppliers may make leakage of tacit know-how more likely because the supplier and buyer have more frequent interaction and their engineers work more intensively together across the buyer's entire technology base. This intensive communication between personnel of the two organizations enables tacit know-how leakage (Teece 1981). Not only will leakage be easier, but the single source will obtain tacit know-how that encompasses all parts of the various system components. In this sense, the know-how the single source obtains may actually be richer than the know-how each of the multiple suppliers would obtain, which increases the appropriation hazard to the buyer.

Moreover, although the previous hypothesis states that supplier opportunism is likely to be lower in a single-sourcing situation, a single source may still "inadvertently" leak this tacit know-how to the buyer's competitors (Pisano 1990). This argument is consistent with Auster's (1992) and Dutta and Weiss's (1997) arguments that companies structure their interfirm relationships to avoid leakage of tacit know-how.

> H_{10}: The greater the tacit know-how of the buyer that can be leaked, the lower the buyer's preference is for single sourcing over multiple sourcing.

Technological volatility. Technological volatility refers to the extent to which changes in technology are rapid and unpredictable. In volatile markets, information is often inaccurate, unavailable, or obsolete (Bourgeois and Eisenhardt 1988). Institutional economics literature argues that organizations encounter contracting problems with outside suppliers because they may not be able to safeguard unforeseeable contingencies (Klein, Frazier, and Roth 1990). In consequence, volatility may hinder outsourcing; however, this reasoning, though valid for general environmental volatility, is inappropriate when it specifically involves technological volatility. The more volatile technology is, the greater the likelihood is that a technology becomes obsolete. As the likelihood of obsolescence increases, the expected profitability of and the incentive for any bargaining decreases (Balakrishnan and Wernerfelt 1986). Thus, because buyers are not vulnerable to ex post bargaining over quasi rents of the contract, the incentive for them to integrate the system in-house disappears. In addition, technological volatility may destroy competencies (Tushman and Nelson 1990). Thus, volatile environments discourage buyers from building their own system-integration know-how. In summary, we expect that companies respond to technological volatility by outsourcing rather than by in-house system integration.

In markets with high technological volatility, firms generally prefer a high degree of flexibility (Jackson 1985; Sheridan 1988). An increase in the number of component suppliers leads to greater decision-making flexibility, which is consistent with Eisenhardt's (1989) observation that decision makers in high-velocity environments increase rather than decrease their alternatives.

> H_{11}: The greater the technological volatility, (a) the greater a buyer's preference is for outsourcing over in-house system integration and (b) the lower a buyer's preference is for single sourcing over multiple sourcing of the system components.

As we do in H_4 (for technological heterogeneity), we explore whether the relationship between a buyer's perceptions of technological volatility and its preferences for system-integration outsourcing and component purchase concentration is likely to depend on the buyer's know-how. In H_{11}, we argue that firms have a higher preference for outsourcing over in-house system integration under conditions of technological volatility, because technological volatility may destroy any competencies built in this domain. On the basis of the absorptive capacity literature, we expect this to be especially true for low-know-how organizations. High-know-how organizations may be able to keep track of technological change and assimilate new know-how relatively easy, or at least they may be able to do it as well as any outside party could (Cohen and Levinthal 1990).

We also argue that firms in volatile environments prefer a high degree of flexibility and therefore have a lower preference for single sourcing over multiple sourcing (H_{11}). However, in H_2, we argue that low-know-how firms want more information from multiple sources to reduce task uncertainty. Therefore, under increasing technological volatility, it is conceivable that knowledgeable buyers are less inclined to seek flexibility than less knowledgeable buyers are. In consequence, we expect the following:

> H_{12}: The positive relationship between technological volatility and a buyer's preferences for outsourcing over in-house system integration is greater for low-know-how buyers than for high-know-how buyers.
>
> H_{13}: The negative relationship between technological volatility and a buyer's preferences for single sourcing over multiple sourcing of system components is greater for low-know-how buyers than for high-know-how buyers.

Transaction-specific assets. Transaction-specific assets (TSAs) or investments are worth more within a particular relation than outside it (Williamson 1985). In the case of system integration, TSAs predominantly include human asset specificity, or investment in knowledge about the specific system, and physical asset specificity, or other equipment and software engineered to work optimally with the specific system. It is possible that TSAs create a "holdup" problem in the sense that the buyer is more or less "locked in" to a relationship with a particular system integrator. This creates the potential for supplier opportunistic behavior, because the supplier will try to acquire a larger part of the quasi rents. An effective organizational response to asset specificity may be in-house system integration (Williamson 1985). Therefore,

> H_{14}: The greater the TSAs involved in system-integration activities, the lower a buyer's preference is for outsourcing over in-house system integration.

Other Variables

We included two control variables in our statistical tests to account for determinants of outsourcing system integration and supplier concentration other than our focal theoretical variables. The first control variable was system importance. Studies in institutional economics have argued that activities with a high impact on company profits are mostly integrated within the company (Lieberman 1991). Therefore, we expect firms to prefer in-house system integration to outsourcing of system integration when it involves an important system. Single sourcing may make the buyer more dependent on a particular component supplier, which is undesirable if the consequences are great (Klein, Crawford, and Alchian 1978). The second variable was the country in which the company is located. Because our study is global, it was important to account for the different environmental conditions particular to its location that a company may face. We included country dummy variables to capture this effect.

METHOD

Research Context

We chose the purchasing of telecommunications systems by telecommunications operators as the setting for testing our substantive hypotheses. These systems consist of switches, transmission, and billing software. We chose this context for two reasons: (1) There is sufficient heterogeneity of the focal theoretical variables among companies in this industry, and (2) telecommunications systems at this aggregation level are modular.

Because exploratory interviews revealed that decisions about buying telecommunications systems are the prerogative of the executive committee, we used high-level executives as key informants. The executives were mostly vice presidents of technology, vice presidents of purchasing, or chief executive officers of telecommunications companies. This selection ensured that respondents had sufficient knowledge and ability to report on all aspects of organizational decision making about systems purchasing.

We conducted the study globally, and our sample represented 19 countries in Europe, Asia, North America, and South America. A global study increases the generalizability of our findings. To a large extent, today's telecommunications industry is a global industry, which makes a global study of practical interest. Because there are many international interfirm agreements with U.S. telecommunications companies, respondents were fluent in English, which minimized any extra effort involved in gathering international data.

Research Design

The phenomenon we studied posed significant research-design challenges. After considering various alternatives, we opted for a field experiment administered through mail to key informants in telecommunications operating companies. In the research design, we applied experimental tasks similar to those in conjoint analysis but structured to reflect the specific hypotheses and context of our study. In particular, we presented respondents with two-stage tasks that first described hypothetical scenarios of different market and system features ("buying scenarios"); second, for each scenario, we asked respondents to indicate their preferences for different integration and sourcing arrangements ("buying options") given the scenario.

We preferred this type of experimental task to the more commonly used retrospective surveys because it enabled us to isolate focal theoretical constructs. This was possible because by using statistical experimental designs with orthogonal factors we could create hypothetical buying scenarios in which the theoretical variables of interest varied independently from one another (Murry and Heide 1998). Experimental tasks such as conjoint analysis allow for more direct probing of the presumed theoretical mechanisms (Dutta and John 1995) and avoid the confounding of effects that typically occurs in real markets. Another benefit of experimental tasks is that they allow for efficient data collection because multiple observations can be made for each organization, which is difficult to achieve in retrospective studies. Our exploratory interviews with telecommunications operators also showed that confidentiality was less of a concern to respondents in the case of hypothetical scenarios than it would be if they were requested to report on real historical decisions.

On the basis of our pretesting, we concluded that we could credibly manipulate most of our variables in the experimental tasks. The variables were leakage of tacit knowledge (TACKNOW), technological volatility (TECHVOL), technological heterogeneity (TECHHET), supplier concentration in the system-integration market (INTCONC), component-supplier specialization (SUPPSPEC), TSAs related to system integration (TSA), and system importance (SYSIMP). Two variables appeared to be so specific to each organization and stable over time that it was difficult for respondents to imagine that these variables could be (hypothetically) changed in different scenarios: know-how (KNOWHOW) and acquisition expertise (ACQEXP). On the basis of these considerations, we decided not to include these two variables in the experimental task but rather to ask separate questions that measured each organization's know-how and acquisition expertise using semantic differential scales.

Experiment. In the experimental part of the questionnaire, we presented respondents with eight full-profile experimental tasks (pretests revealed that respondents were only willing to go through eight tasks). Each experimental task included two parts. In the first part, we presented respondents with the buying scenario, which comprised seven factors. Each factor had two levels (for factors, their levels, and coding, see Table 1). As such, respondents faced different scenarios that varied in their characteristics; for example, technological volatility was high in half of the scenarios and low in the other half. In this manner, the buying scenario defined the buying context for the respondents. We asked respondents to study the scenario carefully, and then we asked them to go on to the second part of the task, which was presented just below the scenario.

Table 1
BUYING SCENARIOS: FACTORS AND LEVELS

I. Leakage of tacit knowledge (TACKNOW; adapted from Polanyi 1962)
- 1: Our company has substantial proprietary knowledge, which is difficult to document in writing and blueprints, that could be leaked when dealing with this particular system integrator.
- −1: Our company does not have any proprietary knowledge, which is difficult to document in writing and blueprints, that could be leaked when dealing with this particular system integrator.

II. Technological volatility (TECHVOL; adapted from Heide and John 1990; Klein, Frazier, and Roth 1990)
- 1: Changes in telecom technology are rapid and unpredictable.
- −1: Changes in telecom technology are slow and predictable.

III. Technological heterogeneity (TECHHET; adapted from Achrol and Stern 1988; Heide and Weiss 1995)
- 1: There are large technological differences between possible configurations of the telecommunications system.
- −1: There are only small technological differences between possible configurations of the telecommunications system.

IV. Supplier concentration in the system-integrator market (INTCONC)
- 1: There is only a small number of suppliers (three or less) that are competent and reliable in system-integration activities.
- −1: There is a large number of suppliers (seven or more) that are competent and reliable in system-integration activities.

V. Component-supplier specialization (SUPPSPEC)
- 1: All component suppliers specialize in a limited set of system components.
- −1: No component supplier specializes in a limited set of system components.

VI. TSAs (TSA; adapted from Anderson and Weitz 1992; Heide and John 1988)
- 1: We will have to invest a lot of time and effort in employees' knowledge, procedures, and equipment to deal with this particular system integrator. The transferability of such investments to an alternative supplier will be very limited.
- −1: We will not have to invest a lot of time and effort in employees' knowledge, procedures and equipment to deal with this particular system integrator. The transferability of any investments to an alternative supplier will be very high.

VII. System importance (SYSIMP; adapted from Heide and Weiss 1995; McQuiston 1989)
- 1: The system has a major impact on our company's profits.
- −1: The system has a minor impact on our company's profits.

In the second part, we asked respondents to give their preference for six different buying options (see Table 2), given the specific buying scenario. The buying options varied on our two focal buying dimensions, namely outsourcing versus in-house system integration (in two levels) and single versus multiple sourcing (in three levels: one, two, or three suppliers). This structure enabled us to measure respondents' preferences for the different buying options under the specific buying scenarios without confounding the different dimensions of the buying decision or the different factors in the scenarios.

Respondents were required to complete eight such tasks. Each of the eight tasks represented a different buying scenario. Although the factors for each buying scenario were the same, we showed different levels of the factors. For example, a first scenario that a respondent might have encountered was a buying context in which transferability of tacit know-how was high, technological volatility was low, technological heterogeneity was high, number of integrators was large, component suppliers were specialized, TSAs were high, and system importance was high. A second scenario might have been one in which transferability of tacit know-how was low, technological volatility was high, technological heterogeneity was high, number of integrators was large, component suppliers were specialized, TSAs were high, and system importance was high. Because buying scenarios changed between each experimental task, we asked respondents to read the specific buying scenario carefully each time and then rate their preferences for the six buying options.

For the manipulation of the seven factors in the eight buying scenarios, we used an orthogonal fraction in 16 profiles of a 2^8 full-factorial design. We used seven of the eight variables in the design to manipulate the seven factors orthogonally (TACKNOW, TECHVOL, TECHHET, INTCONC, SUPPSPEC, TSA, and SYSIMP) in the buying scenario. We used the remaining variable to split the set of 16 profiles into two sets of 8 profiles (respondents were only willing to go through eight experimental tasks). In this way, we guaran-

Table 2
BUYING OPTIONS AND PREFERENCE RATINGS

	Very Low Preference 1	2	3	4	5	6	*Very High Preference* 7
Transmission, switching, and billing system are sourced from one single supplier and their integration is outsourced	☐	☐	☐	☐	☐	☐	☐
Transmission, switching, and billing system are sourced from two different suppliers and their integration is outsourced	☐	☐	☐	☐	☐	☐	☐
Transmission, switching, and billing system are sourced from three different suppliers and their integration is outsourced	☐	☐	☐	☐	☐	☐	☐
Transmission, switching, and billing system are sourced from one single supplier and they are internally integrated	☐	☐	☐	☐	☐	☐	☐
Transmission, switching, and billing system are sourced from two different suppliers and they are internally integrated	☐	☐	☐	☐	☐	☐	☐
Transmission, switching, and billing system are sourced from three different suppliers and they are internally integrated	☐	☐	☐	☐	☐	☐	☐

teed that the seven factors in the buying scenarios were not confounded with the two sets of 8 profiles.

To control for order effects, we developed an additional version of each of the two sets of eight profiles in which we randomized the order of the experimental tasks. Thus, we obtained four versions of the experiment, which we then randomly assigned to respondents.

Measures for variables not manipulated in the experiment. For reasons cited previously, we opted to measure respondents' firm know-how and acquisition expertise rather than manipulate these constructs in the experiment. To rate KNOWHOW, we asked respondents to assess whether on the technology of telecommunications systems (five items) and on the integration of telecommunications components or subsystems (five items) their organizations were (1) not at all knowledgeable–very knowledgeable, (2) not at all competent–very competent, (3) not at all expert–highly expert, (4) not at all trained–very well trained, or (5) not at all experienced–very experienced. To rate ACQEXP, we asked respondents to assess whether their company was expert on the characteristics of suppliers on the same five-item scale.

The final sample shows mean KNOWHOW and ACQEXP scores of 5.55 ($\sigma = 1.18$) and 5.39 ($\sigma = 1.12$). We subjected the scale items to a confirmatory factor analysis, which confirmed that a two-factor solution, with KNOWHOW (ten items) and ACQEXP (five items) as factors, fitted the data well. Reliability analysis (KNOWHOW: $\alpha = .9617$; ACQEXP: $\alpha = .9319$) of the two constructs revealed high reliability (Nunnally 1978).

Finally, we inventoried other company descriptors, including total revenues, total profits, number of employees, number of decision-making unit members for telecommunications systems purchasing, telecommunications services that the company offered, and length of time for decision making about telecommunications systems purchasing. We also included scale items that measured how expert and involved the key respondent was in the company's decision-making process in order to check whether he or she was a valid key informant. This was the case for all respondents in the analysis.

Questionnaire structure. The questionnaire consisted of four parts. The first part explained the context of the study and provided relevant definitions of the telecommunications system being studied. The second part inventoried respondent job description, services the company provided, respondent expertise and involvement in the company decision-making process, and company know-how and acquisition expertise. The third part included the eight experimental tasks, preceded by an explanation of the task composition, one example task, and one practice task. The fourth part inventoried past purchasing practices and general company descriptives, such as sales, profits, return, and number of employees.

Pretesting and Data Collection

Pretesting. We developed the conjoint scenarios in cooperation with a global manufacturer of telecommunications systems. We organized four meetings at the company with two marketing managers who were responsible for different geographical regions and the vice president of marketing for the company worldwide. Following their advice, we pretested the questionnaire in two European countries: Belgium and the United Kingdom. In three stages, we conducted on-site interviews with vice presidents of purchasing and purchasing managers at five major telecommunications operators, two in Belgium and three in the United Kingdom. After the first stage, we revised the phrasing of some of the factors in the experiment, again after consulting with our business partner. After the second stage, we made some minor revisions. We used the final stage to check for remaining problems. The pretests revealed that respondents did not suffer from information or task overload when confronted with the conjoint task and that they understood all measures employed.

Data collection. Data collection proved a challenge. Our targeted respondents were top-level executives in a highly dynamic industry fraught with merger-and-acquisition activity. This not only created severe time constraints on potential respondents but also made information exchange critical. We spent many hours and a significant amount of money (estimated data collection costs were $40,000) to obtain the data. People in the industry rated our study as one of the most elaborate studies that has been conducted on telecommunications operators' strategic decision making.

We used four interrelated approaches to obtain our sample. In a first stage, we sent questionnaires to telecommunications operators in the United States and nine European countries; we randomly drew the operators from telecommunications license databases. We contacted the companies by telephone to (1) check on the list's accuracy, (2) identify key informants in the company, and (3) check the mailing address. The net sample in this stage comprised 273 companies. After receiving a notification letter, respondents received a questionnaire after two weeks, a reminder card after three weeks, a new questionnaire after five weeks, and reminder calls after six and seven weeks.

In a second approach to contact respondents, we asked key account managers of a global telecommunications systems manufacturer to deliver the questionnaire personally to the key decision maker at 27 telecommunications companies in the United States, Europe, South America, and Asia. Third, in a joint effort with the telecommunications research center of a renowned U.S. research university, we contacted 20 U.S. telecommunications companies that participated in the research center's activities. Fourth, we contacted 9 European telecommunications operators to conduct personal, on-site interviews.

In total, we contacted 329 telecommunications operators in Europe, the United States, South America, and Asia. Of these, 55 participated in the study and returned usable questionnaires, for a total response rate of 16.7%. Although this response rate is rather low, it is not unusual for research in (international) industrial settings (John 1984) or for research with high-level executives as key informants (Calantone and Schatzel 2000; Gatignon and Robertson 1989; Phillips 1981). In addition, the total sample size at the unit of analysis, 55 companies, is not unusual in marketing literature (Agrawal and Lal 1995; Olson, Walker, and Ruekert 1995) and industrial purchasing in particular (Dawes, Lee, and Dowling 1998; Money, Gilly, and Graham 1998). Note that we obtained much information per respondent, because we obtained preference statements on six buying options for eight buying scenarios per respondent.

We assessed nonresponse bias by comparing early respondents with late respondents, as Armstrong and Over-

Table 3
SAMPLE CHARACTERISTICS

	Sample Mean
Investments in telecommunications systems	
Revenues for 1998	
Profits for 1998	
Employees for 1998	
Number of countries in sample	19
Number of European respondents[a]	34
Number of U.S. respondents	17
Number of Asian respondents[b]	2
Number of South American respondents[c]	2

[a]European countries in the sample are Austria, Belgium, Denmark, Finland, France, Germany, the Netherlands, Norway, Russia, Spain, Sweden, and the United Kingdom.
[b]Asian countries in the sample are China and Taiwan.
[c]South American countries in the sample are Argentina and Mexico.

Table 4
RESPONDENT CHARACTERISTICS

	Sample Mean
Time with the company (years)	
Time since promotion to present function (years)	4.5
Time working in telecommunications industry (years)	16
Functional Domains of Respondents	
Purchasing	31%
Technical/operations management	43%
Marketing/sales management	2%
General management	24%
Involvement in purchasing of telecommunications systems in last two years[a]	4.4 (maximum score = 5)
Interest in telecommunications systems[b]	6.7 (maximum score = 7)

[a]1 = never; 2 = once; 3 = sometimes; 4 = frequently; 5 = always.
[b]1 (not at all interested)–7 (very interested).

ton (1977) suggest. We defined the first 75% of returned questionnaires as "early" and the remaining 25% as "late." We found no significant differences on descriptive variables such as revenues, profits, number of employees, or investment in telecommunications systems. Classification of the first 50% of returned questionnaires as "early" and the other 50% as "late" gave the same result. Accordingly, we assumed that nonresponse bias was not a significant problem. Table 3 gives an overview of the sample characteristics. Because the sample included companies from different countries, we compared the same descriptive variables for companies across the different countries to determine whether companies in the different countries had widely divergent characteristics. We found no significant differences. Table 4 gives an overview of the characteristics of the individual respondents within each participating company.

ANALYSIS AND RESULTS

Model Specification

To test our hypotheses developed in the theory section, we first modeled buyers' preferences as a function of the explanatory variables. This yielded two parameter vectors that represent the effect of the explanatory variables on buyers' preferences for outsourcing of system integration versus in-house system integration and for single sourcing versus multiple sourcing of system components. Because our theoretical framework separated the two decision dimensions, we also separated them in our analysis. Note that we presented respondents with all possible combinations of outsourcing versus in-house system integration and purchase-level concentration. Therefore, we estimated the impact of the explanatory variables on respondents' preferences in each decision dimension independently of their preferences in the other dimension. We then tested for differences in parameter estimates within each equation or decision dimension using a Wald statistic. Thus, in the outsourcing equation, we compared coefficients for outsourcing versus in-house system integration, and in the purchase-concentration equation, we compared coefficients for single sourcing versus multiple sourcing.

Marketing scholars have argued that preference ratings are closer to ordinal-scaled measures than to interval-scaled measures (Steenkamp and Wittink 1994). Therefore, we modeled buyers' preferences using an ordered probit structure, which accounted for the ordered nature of preference ratings. To allow for heterogeneity in respondents' preferences in different buying scenarios, we used a random coefficient specification of the parameters for the variables that we manipulated in the experimental tasks. We also included country dummies to account for the heterogeneity related to possible differences in the markets that respondents face. For the preference for outsourcing versus in-house system integration, we specified the following equation:

$$(1)\quad PREF_{ij} = \left[\alpha_O + (\beta_O + \varepsilon_i^{O1})'X_j^C + \eta_O' X_i^M + \zeta_O' X_i^k X_j^t\right] \times Z_O + \left[\alpha_I + (\beta_I + \varepsilon_i^{O2})X_j^C + \eta_I' X_i^M + \zeta_I' X_i^k X_j^t\right] \times (1 - Z_O) + \gamma_O' C_i + \lambda_O' A_j + \varepsilon_{ij}^O.$$

The dependent variable in Equation 1, $PREF_{ij}$, represents the latent preference of company i for buying scenario j. The dummy Z_O has the value 1 for outsourcing options (Buying Options 1 through 3) and the value 0 for in-house system-integration options (Buying Options 4 through 6). The vector X_j^C represents the factors for buying scenario j as manipulated in the conjoint design, TACKNOW, TECHVOL, TECHHET, SUPPSPEC, INTCONC, TSA, and SYSIMP. The vector X_i^M represents the factors KNOWHOW, KNOWHOWSQ (KNOWHOW × KNOWHOW), and ACQEXP for company i, which were not manipulated in the conjoint task but were measured by semantic differential scales. The constant α_O (respectively [resp.] α_I) represents the average preference for outsourcing (resp. in-house integration). The vector β_O (resp. β_I) represents parameters that capture the impact of the seven conjoint factors on a company's preference for outsourcing (resp. in-house integration). The vector η_O (resp. η_I) represents parameters that capture the impact of the measured factors KNOWHOW and ACQEXP on a company's preference for outsourcing (resp. in-house integration). The vector ζ_O (resp. ζ_I) represents parameters that capture the interaction between KNOWHOW of company i (X_i^k) and a vector of two conjoint factors of interest TECHVOL and TECHHET (X_j^t) for buying scenario j. The vectors ε_i^{O1} and ε_i^{O2} represent company-specific error terms in the effect of the conjoint factors on preference. We assumed these error terms to be independently normally distributed with zero mean. The standard deviations of ε_i^{O1} and ε_i^{O2} are estimated and express heterogeneity in preference among companies. The company-specific error terms capture heterogeneity in the β parameters. The country in which the respondent firm is active is represented by C_i. The corrections through $\gamma_O'C_i$ capture heterogeneity among companies in different countries for the different market conditions they may face. Finally, with the term $\lambda_O'A_j$, we included fixed effects for possible differences in averages between preference statements (see Table 2). This captures possible heteroskedasticity between preference statements.[2] The remaining errors, ε_{ij}^O, vary across companies and conjoint factors and are assumed to be distributed independently as N[0,1], as is common in ordered probit models.

For the preference of single over multiple sourcing, we specify

$$(2)\quad PREF_{ij} = \left[\alpha_S + (\beta_s + \varepsilon_i^{S1})'X_j^C + \eta_S'X_i^M + \zeta_S'X_i^kX_j^t\right] \times Z_S + \left[\alpha_M + (\beta_M + \varepsilon_i^{S2})'X_j^C + \eta_M'X_i^M + \zeta_M'X_i^kX_j^t\right] \times (1 - Z_S) + \gamma_S'C_i + \lambda_S'A_j + \varepsilon_{ij}^S$$

The dependent variable, $PREF_{ij}$, represents the latent preference of company i for buying scenario j. The variable Z_S represents a dummy that has the value 1 for single-sourcing options (Buying Options 1 and 4) and the value 0 for multiple-sourcing options (Buying Options 1, 2, 5, and 6). The vectors X_j^C, X_i^M, X_i^k, and X_j^t have the same meaning as in Equation 1. The constant α_S (resp. α_M) represents the average preference for single sourcing (resp. multiple sourcing). The vector β_S (resp. β_M) represents parameters that capture the impact of the seven conjoint factors on a company's preference for single sourcing (resp. multiple sourcing). The vector η_S (resp. η_M) represents parameters that capture the impact of the seven conjoint factors on a company's preference for single sourcing (resp. multiple sourcing). The vector ζ_S (resp. ζ_M) represents parameters that capture the interactions between KNOWHOW (X_i^k) and the vector of conjoint factors TECHVOL and TECHHET (X_j^t). The vectors ε_i^{S1} and ε_i^{S2} represent company-specific independently normally distributed error terms in the effect of conjoint factors on preference. The vectors $\gamma_S'C_i$ and $\lambda_S'A_j$ have the same meaning as previously. We assume ε_{ij}^S to be independently distributed as N[0,1].

Estimation and Testing

Using a smooth simulated maximum likelihood procedure (Hajivassiliou and Ruud 1994), we estimated multivariate models 1 and 2. At the base of this approach is the recognition that, conditional on the company-specific errors, our model is a traditional ordered probit model. The log-likelihood of this conditional model is (Maddala 1983)

$$(3)\quad L^* = \log L = \sum_{i=1}^{n}\sum_{j=1}^{m}\sum_{g=1}^{k} z_{ijg} \log\left[\Phi(\mu_g - PREF_{ij}^*) - \Phi(\mu_{g-1} - PREF_{ij}^*)\right],$$

where n is the total number of companies (i) in the sample, m is the number of scenarios (j) to which a company responds, and k is the total number of ordered response categories (g). The dummy variable z_{ijg} has the value 1 if the response falls in the gth category and 0 otherwise. The cumulative standard normal is Φ, and $PREF_{ij}^*$ is the systematic part of preference function 1 or 2.

The unconditional likelihood can be expressed as the expected value of the conditional contribution of each observation with the expectation taken over the joint density of the company-specific error components. This is a multidimensional integral for which no analytical solution can be given. Therefore, in the simulated maximum likelihood procedure, the integral is approximated by a mean of simulated conditional likelihoods. In our estimations, we based this simulated mean on 100 independent draws from a standard normal error term per random coefficient. We then transformed the draws with different parameters to allow for estimation of differences in variance between random variables. Instead of the true likelihood, the simulated likelihood was maximized. It can be shown that this procedure is asymptotically equivalent to regular maximum likelihood procedures, provided that the number of independent draws is large enough (e.g., Hajivassiliou and Ruud 1994). The latter result implies that standard ways of obtaining maximum likelihood estimates and standard errors can be used.

We tested our hypotheses using a Wald statistic for linear restrictions. In our case, we tested restrictions of the form $R\beta = 0$, $R\eta = 0$, and $R\zeta = 0$, where the difference in the estimates for the outsourcing versus in-house system integration was significantly different from zero (e.g., $\beta_{OI} - \beta_{II} = 0$; $\eta_{OI} - \eta_{II} = 0$; $\zeta_{OI} - \zeta_{II} = 0$). We tested for the difference in the estimates for the single-sourcing versus multiple-sourcing options in an analogous manner. In general, we can specify the test as

$$(4)\quad W = [Rb]'\{Rvar(b)R'\}^{-1}[Rb].$$

Results

The results of the estimation of the models, as in Equations 1 and 2, are depicted in Tables 5 and 6. Columns 2 and 3 of Table 5 present the parameter vectors for the main effects (β_O, β_I, η_O, η_I) and interaction effects between KNOWHOW and TECHVOL and TECHHET (ζ_O and ζ_I) in Equation 1. Columns 4 and 5 give the Wald statistic for the coefficients for outsourcing versus the coefficients for in-house integration. We present both the sign of the effect, as well as the χ^2, and the effect's significance. Column 6 presents an overview of our hypotheses. We also report the latent thresholds of the ordered probit model together with the standard deviations of the random coefficients,[3] the fit, and the sample size of the model. Table 6 presents similar results but for Equation 2.

[2]We allow for different intercepts for all preference statements. This enables one of the latent cutoff points in the ordered probit model to differ across preference statements, which enables the different preference statements to have different variances, allowing for heteroskedasticity in the preference statements.

[3]Note that we also estimated a common slopes specification of the model, which gave similar results as the random coefficient specification.

In general, the results support our theoretical framework, grounded in production and transaction costs. They also support our central notion that the presence and leakage of know-how and the technological environment a buyer faces drive buyer preferences toward outsourcing of system integration and single sourcing of system components.

Table 5

PREFERENCE FOR OUTSOURCING OVER IN-HOUSE SYSTEM INTEGRATION

			Preference (Outsourcing over In-House)		
Variables[a]	*Coefficient Outsourcing*	*Coefficient In-House*	*Sign*	χ^2 *(Significance Level)*	*Hypothesis*
Production Costs					
Technological know-how	–.2020	.1200		17.49	
(KNOWHOW)[a]	(.054)	(.055)		(<.01)	
(Technological know-how)^2	–.1007	–.0267		2.75	
(KNOWHOWSQ)[a]	(.031)	(.032)		(.097)	
Technological heterogeneity	–.0248	–.0643		.62	
(TECHHET)	(.036)	(.035)		(.430)	
Component-supplier specialization	–.0245	–.0007		.24	
(SUPPSPEC)	(.035)	(.034)		(.624)	
Supplier concentration in system-integration market	.0261	–.0361	+	1.62	– (H_6)
(INTCONC)	(.035)	(.034)		(.202)	
Acquisition expertise	–.0689	–.2711	+***	9.34	– (H_7)
(ACQEXP)[a]	(.042)	(.051)		(<.01)	
Transaction Costs					
Leakage of tacit knowledge	–.1340	.0659	–***	14.43	
(TACKNOW)	(.038)	(.036)		(<.01)	
Technological volatility	.0440	–.0842	+**	6.59	
(TECHVOL)	(.035)	(.036)		(.010)	
TSAs	.0247	–.0067	+	.43	
(TSA)	(.034)	(.034)		(.514)	
Interactions					
Know-how[a] × technological heterogeneity	.0348	–.0569	+*	3.32	
	(.035)	(.036)		(.069)	
Know-how[a] × technological volatility	.0125	.0182		.01	
	(.034)	(.037)		(.910)	
Other Variables					
System importance	–.0628	.0467		5.07	
(SYSIMP)	(.035)	(.034)		(.024)	
Latent Thresholds (Ordered Probit)					
μ_1	–2.641 (.350)		N.A.	N.A.	N.A.
μ_2	–1.964 (.292)		N.A.	N.A.	N.A.
μ_3	–1.433 (.253)		N.A.	N.A.	N.A.
μ_4	–.982 (.226)		N.A.	N.A.	N.A.
μ_5	–.441 (.203)		N.A.	N.A.	N.A.
μ_6	.213 (.195)		N.A.	N.A.	N.A.
Standard Deviations of Random Coefficients					
s.d. TECHHET	.0206	.1478	N.A.	N.A.	N.A.
	(.328)	(.305)			
s.d. SUPPSPEC	.0039	.0990	N.A.	N.A.	N.A.
	(.290)	(.268)			
s.d. INTCONC	.0750	.0007	N.A.	N.A.	N.A.
	(.262)	(.273)			
s.d. TACKNOW	.5514	.0077	N.A.	N.A.	N.A.
	(.269)	(.283)			
s.d. TECHVOL	.1324	.2229	N.A.	N.A.	N.A.
	(.291)	(.273)			
s.d. TSA	.0032	.0015	N.A.	N.A.	N.A.
	(.276)	(.294)			
s.d. SYSIMP	.2197	.5311			
	(.297)	(.251)	N.A.	N.A.	N.A.
χ^2 (degrees of freedom = 62)	279.8 ($p < .01$)				
N (number of companies = 55; number of observations = 2640)					

*$p < .10$.
**$p < .05$.
***$p < .01$.
[a]Variables that we measured; we manipulated all other variables in the conjoint experiment.
Notes: N.A. = not applicable.

• As we predicted in H_1 and H_2, we find that (1) an inverted U-shaped relationship exists between a buyer's preference for outsourcing and in-house system integration ($\chi^2 = 2.75$), and (2) a curvilinear U-shaped relationship exists between a buyer's know-how and its preference for single sourcing over multiple sourcing of system components ($\chi^2 = 4.57$). Because these

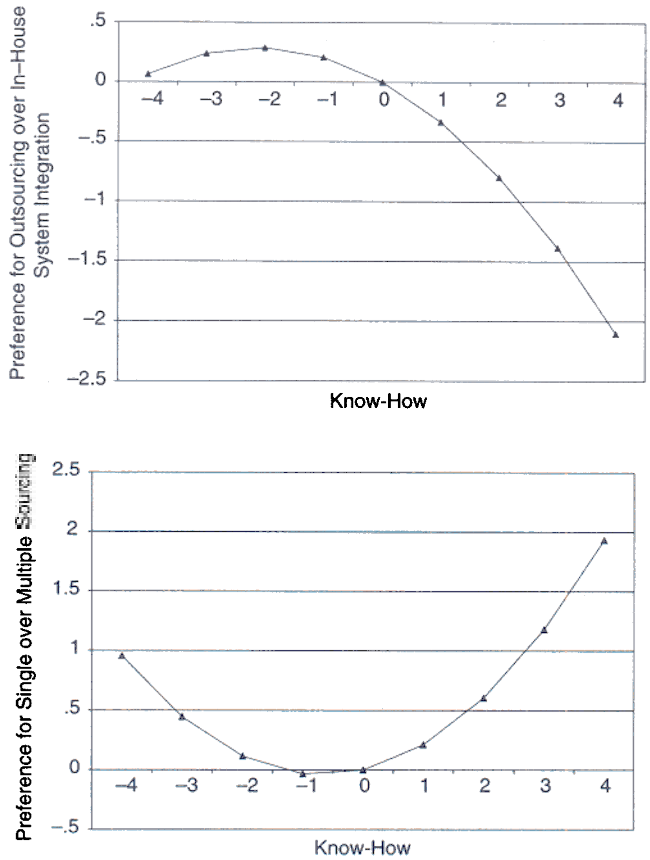
Table 6

PREFERENCE FOR SINGLE OVER MULTIPLE SOURCING

Variables[a]	Coefficient Single	Coefficient Multiple	Preference (Single over Multiple Sourcing): Sign	Preference (Single over Multiple Sourcing): χ^2 (Significance Level)	Hypothesis
Production Costs					
Technological know-how (KNOWHOW)[a]	.0593 (.069)	–.0901 (.047)	+*	3.23 (.072)	U (H_2)
(Technological know-how)^2 (KNOWHOWSQ)[a]	.0076 (.042)	–.1045 (.032)	+**	4.75 (.033)	
Technological heterogeneity (TECHHET)	–.0826 (.057)	–.0345 (.031)		.56 (.456)	+ (H_3)
Component-supplier specialization (SUPPSPEC)	–.1626 (.053)	.0582 (.031)	–***	12.84 (< .01)	– (H_5)
Supplier concentration in system-integration market (INTCONC)	–.0302 (.050)	.0032 (.030)	+	.33 (.566)	N.A
Acquisition expertise (ACQEXP)[a]	–.0743 (.0578)	–.2219 (.045)	+**	4.07 (.044)	N.A.
Transaction Costs					
Leakage of tacit knowledge (TACKNOW)	–.1493 (.056)	.0134 (.030)		6.48 (.011)	+ (H_9) – (H_{10})
Technological volatility (TECHVOL)	–.0934 (.051)	.0128 (.030)	–*	3.22 (.073)	– (H_{11})
TSAs (TSA)	–.0130 (.050)	.0209 (.030)		.33 (.563)	
Interactions					
Know-how[a] × technological heterogeneity	–.0493 (.049)	–.0023 (.031)	+	.66 (.417)	
Know-how[a] × technological volatility	.0410 (.045)	.0000 (.031)		.57 (.451)	+ (H_{13})
Other Variables					
System importance (SYSIMP)	–.0796 (.051)	.0281 (.030)		3.31 (.069)	
Latent Thresholds (Ordered Probit)					
μ_1	–2.543 (.323)		N.A.	N.A.	N.A.
μ_2	–1.834 (.263)		N.A.	N.A.	N.A.
μ_3	–1.277 (.226)		N.A.	N.A.	N.A.
μ_4	–.808 (.204)		N.A.	N.A.	N.A.
μ_5	–.243 (.194)		N.A.	N.A.	N.A.
μ_6	.442 (.209)		N.A.	N.A.	N.A.
Standard Deviations of Random Coefficients					
s.d. TECHHET	.0083 (.403)	.0107 (.231)	N.A.	N.A.	N.A.
s.d. SUPPSPEC	.0073 (.409)	.3787 (.278)	N.A.	N.A.	N.A.
s.d. INTCONC	.0068 (.339)	.0014 (.237)	N.A.	N.A.	N.A.
s.d. TACKNOW	.0591 (.343)	.0017 (.245)	N.A.	N.A.	N.A.
s.d. TECHVOL	.8705 (.260)	.0013 (.235)	N.A.	N.A.	N.A.
s.d. TSA	.1122 (.379)	.0084 (.261)	N.A.	N.A.	N.A.
s.d. SYSIMP	.4164 (.316)	.4890 (.235)	N.A.	N.A.	N.A.
χ^2 (degrees of freedom = 62)	259.6 ($p < .01$)				
N (number of companies = 55; number of observations = 2640)					

*$p < .10$.
**$p < .05$.
***$p < .01$.
[a]Variables that we measured; we manipulated all other variables in the conjoint experiment.
Notes: N.A. = not applicable.

Figure 2
THE QUADRATIC EFFECT OF KNOW-HOW ON BUYING PREFERENCES



effects may be difficult to interpret, we included Figure 2, which depicts the effects of know-how on both preferences (note that know-how can be negative and positive because it pertains to factor scores).

- •Contrary to H_3, we find that technological heterogeneity has no significant effect on a buyer's preference for either (1) outsourcing over in-house system integration ($\chi^2 = .62$) or (2) single sourcing over multiple sourcing of system components ($\chi^2 = .56$).
- •As we predicted in H_{4a}, we find that the positive relationship between technological heterogeneity and a buyer's preference for outsourcing over in-house system integration is greater for high-know-how buyers than for low-know-how buyers ($\chi^2 =$ 3.32). However, contrary to H_{4b}, we found no significant interaction effect between technological heterogeneity and know-how for a buyer's preference for single sourcing over multiple sourcing of system components ($\chi^2 = .66$).
- •As we predicted in H_5, we find that component-supplier specialization negatively affects a buyer's preference for single over multiple sourcing of system components ($\chi^2 = 12.84$).
- •Contrary to H_6, we do not find supplier concentration in the system-integration market to affect a buyer's preference significantly for outsourcing over in-house system integration ($\chi^2 =$ 1.62).
- •Contrary to H_7, acquisition expertise positively affects a buyer's preference for outsourcing over in-house system integration ($\chi^2 = 9.34$).
- •As we predicted in H_8, we find that the greater the tacit know-how of the buyer that can be leaked, the lower a buyer's preference is for outsourcing over in-house system integration ($\chi^2 =$ 14.43). As for the competing hypotheses we posited in H_9 and H_{10}, we find support for H_{10} in that the greater the tacit know-how leakage of the buyer, the lower is its preference for single sourcing over multiple sourcing ($\chi^2 = 6.48$).
- •As we predicted in H_{11}, we find that technological volatility (1) positively affects a buyer's preference for outsourcing over in-house system integration ($\chi^2 = 6.59$) and (2) negatively affects a buyer's preference for single sourcing over multiple sourcing of system components ($\chi^2 = 3.22$).
- •Contrary to H_{12} and H_{13}, we find no significant interaction effect between technological volatility and know-how, both for a buyer's preference for outsourcing over in-house integration ($\chi^2 = .01$) and for single over multiple sourcing ($\chi^2 = .57$).
- •Contrary to H_{14}, we find that TSAs have no significant effect on a buyer's preference for outsourcing over in-house integration ($\chi^2 = .43$).

As for the control variables, we find that system importance (1) negatively affects a buyer's preference for outsourcing over in-house system integration ($\chi^2 = 5.07$) and (2) negatively affects a buyer's preference for single sourcing over multiple sourcing of system components ($\chi^2 =$ 3.31). We also find that most country dummies yield significant coefficients, which we do not report here for reasons of brevity.

DISCUSSION

Theoretical Implications

This article is the first in marketing to study the buying of modular systems. It delineates underlying dimensions of modular systems (system integration and system components) and focuses on two particularly interesting buyer decisions, namely the outsourcing of system integration and component purchase concentration. In this manner, this article could be a first step toward more research on the particulars of modular systems, such as IT, telecommunications, and medical systems, which occupy a substantial part of today's economy.

Prior literature has extensively studied outsourcing decisions from both a production- and a transaction-cost perspective. However, outsourcing has rarely been studied in a technology context. Our results show that outsourcing's direct application to this context may be misguided. We find that in technology markets, particular production- and transaction-cost factors are at play or play out differently.

Although know-how plays a moderate role, if any, in prior theories on outsourcing, we find that in high-technology markets, a buyer's knowledge stock strongly affects its preference for outsourcing. Buyers prefer to integrate systems in-house to safeguard their tacit knowledge (H_8). We also find evidence for an inverted U-shaped effect of a company's (technological) know-how on a buyer's outsourcing preference (H_2). Moderate-know-how firms have a greater preference for outsourcing system integration than do either high-know-how or low-know-how firms. Moderate-know-how buyers presumably are satisfied with their present know-how and have sufficient know-how to evaluate suppliers' performance and assimilate new knowledge effectively. At the same time, they have fewer positive feedback effects from using their know-how than do more knowledgeable competitors. These results not only confirm the focal role of know-how in TI markets but also empirically confirm prior theorizing by Ghosh and John (1999) that a firm's resource endowments affect its governance choices. This is especially valuable, because we experimentally manipulated tacit know-how leakage. Thus, our result does not suffer from endogeneity problems, which plagued Nickerson, Hamilton, and Wada's (2001) research.

Another factor focal to TI markets is technological volatility. Interestingly, we find that buyers react differently to technological volatility (H_{11}) than they do to general environmental (e.g., demand) volatility, which is more common in prior transaction-cost analysis literature. Although governance theory predicts that volatility decreases a company's preference to outsource, we find that when it specifically concerns technological volatility, it increases a firm's preference for outsourcing.

In contrast with outsourcing, purchase concentration has received little academic attention. We find that know-how and technological volatility also significantly affect buyer's preferences to single-source. Moderate-know-how buyers especially have a low preference for single sourcing, compared with high- and low-know-how buyers. Moderate-know-how buyers are able to discriminate among different offerings and assimilate knowledge inflow from multiple suppliers, which motivates them to mix and match system components from multiple vendors (H_2). We also find that buyers tend to avoid single-sourcing situations when they fear tacit knowledge leakage (H_{10}) and when they perceive the technological environment as volatile (H_{11}). These findings strengthen our conclusion that organizational behavior in TI markets is influenced quite heavily by the knowledge stock companies possess and the technological turbulence they experience.

Although we explored interaction effects between technological volatility and buyers' know-how, we did not find any significant results (H_{12} and H_{13}). Because we posited these interactions as exploratory, the lack of support is not notable. Still, in view of the focal role of know-how and technological volatility in TI markets, we encourage further research that examines whether knowledgeable buyers react differently than novices do to technological volatility.

A worthwhile contribution of this research is that we demonstrate the effects of (technological) know-how and technological volatility beyond the effects that are more commonly posited within the existing production-cost and transaction-cost literature streams. As such, we find that outsourcing and single sourcing are less preferred for important systems than they are for systems that are of less importance to the company. In line with Wilson, Weiss, and John (1990), we find that component-supplier specialization increases a buyer's inclination to mix and match components from different vendors. In contrast with H_7, we find that acquisition expertise is positively related to outsourcing preference. A possible reason for this incongruent result is that buyers with expertise on the supplier market are more confident in hiring a system integrator, and they have a stronger bargaining position (Walker and Weber 1984). This is consistent with our finding that buyers with high acquisition expertise also are more confident in hiring a single source.

We also find that some factors in our theoretical framework did not affect a company's preference for outsourcing and single sourcing. We do not find a significant effect of TSAs on a buyer's preference for outsourcing. There may be several reasons this is the case. First, technology-intensive markets may be a boundary condition, in which TSAs may be of little relevance to outsourcing decisions. That the effect of TSAs may be somewhat contingent is not a new idea but has been found in prior research (Weiss, Anderson, and MacInnis 1999). Second, the way we manipulated TSAs may be inadequate for two reasons: (1) TSAs have been shown to have multiple dimensions and levels, which we collapsed into a single experimental manipulation, and (2) we anchored TSAs on the prospective investments required to deal with an external system integrator rather than with the system-integration task.

We find only mixed support for the effects of technological heterogeneity (H_3–H_4). This is not surprising in view of the weak explanatory power of this variable in previous studies on TI markets (Weiss and Heide 1993); the influence of technological heterogeneity may be consistent but weak, which makes it more difficult to pick up in statistical analyses. It is also conceivable that contrary effects are at play. As such, increasing differences between alternative system configurations may increase an organization's information-processing requirements and make restricted searches inadequate (Nelson and Winter 1982). Both outsourcing system integration and single sourcing system components may restrict information inflow to the buyer, which may be undesirable.

Implications for Marketing Management

First, we find that buyers' preferences for outsourcing system integration and single sourcing system components are contingent on the presence and transferability of know-how and the technological uncertainty that buyers perceive. This combination nuances the position of industry observers that push firms toward outsourcing and single sourcing. Outsourcing and single sourcing also yield many hazards, which the trade press does not always recognize. Most important, outsourcing and single sourcing make tacit knowledge leakage more likely, which for some companies, such as European incumbent telecommunications operators, is an argument for spreading purchases among several suppliers and not outsourcing. Buyer firms also have varying degrees of know-how, which affects their position on outsourcing and single sourcing. In summary, this article provides a much more nuanced perspective of the outsourcing and single-sourcing debate than is common in the trade and managerial press.

Second, our findings may be of practical use to suppliers in TI markets, particularly in telecommunications. For example, our finding that buyers are concerned about tacit knowledge leakage to suppliers when they outsource or concentrate their purchases may help suppliers overcome this barrier. In suppliers' positioning and communication, they may learn to deal with buyers' concerns about tacit knowledge leakage.

Third, our finding that moderate-know-how buyers have a higher preference for outsourcing but a lower preference for single sourcing may aid suppliers in their targeting decisions. Suppliers that seek more system-integration business, such as pure system integrators, should target moderate-know-how buyers. Suppliers that are strong in component technology but do not want to integrate forward in system integration, such as Alcatel, should especially target knowledgeable incumbent telecommunications operators or low-know-how new entrants. Suppliers that seek to be a single source for their customers, such as Nortel, should also target low- or high-know-how telecommunications operators but not moderate-know-how operators. This finding counters the naive idea of only targeting customers that need the company's service most (i.e., low-know-how firms).

Fourth, our findings can guide suppliers' strategic decisions about their objectives for integrating systems for their customers or for being a single source. In this respect, it is important for suppliers to be able to assess future market trends. Although our study is cross-sectional, it can aid in such assessment. For example, the telecommunications industry is evolving from voice to integrated data/voice transmission, which is an entirely different technology than in the past. The transition to this new technology will bring higher technological volatility and will make the know-how of knowledgeable buyers obsolete to a large extent. From our theoretical framework, we can deduct that this evolution will lead to increased outsourcing of system integration and multiple sourcing of system components. In other words, the increasing volatility of telecommunications technology will create an opportunity for pure system integrators, and some of them are already trying to capture this. Because pure system integrators are not involved in component manufacturing, telecommunications operators that want to outsource system integration may consider them ideal partners.

Limitations and Directions for Further Research

Although our hypotheses tests were generally consistent with the developed theory, there are certain limitations of this study that we wish to note. First, although we assessed a conjoint study to be the best possible method given the theoretical objectives of the study, it remains unclear if the relationships we found will hold if tested in a retrospective study. Although we would welcome attempts to research the phenomenon in a retrospective field study, we are conscious of the difficulty of such an endeavor.

Second, the sample size is rather small. We did everything possible to increase response rates in the chosen application field. New studies that extend on our theoretical framework would benefit from a larger sample and more statistical power. Although we believe the telecommunications industry is a fascinating environment because of its rapid evolution, time pressure on executives prohibits large-scale research studies that depend on the executives' cooperation. In addition, validation in another industry would certainly contribute to the external validity of the theory developed.

Third, although our results yield some insights into possible dynamics in buying behavior, our study is evidently a cross-sectional study. A longitudinal or historical study that explains dynamics in buying behavior and attitudes in TI markets would be most valuable. On the basis of our results, we expect this to be tied to the evolution in the presence of know-how and technological volatility.

Fourth, this study did not measure constructs such as commitment and trust in relationships or relational norms in general, which may safeguard knowledge transfer. A more complete study of how companies can safeguard tacit knowledge leakage would be most valuable.

Overall, the buying of modular systems remains a relevant and understudied topic. This article provides only one particular perspective on this exciting phenomenon, and we can but hope that many others will follow.

REFERENCES

Achrol, Ravi and Louis W. Stern (1988), "Environmental Determinants of Decision-Making Uncertainty in Marketing Channels," *Journal of Marketing Research*, 25 (February), 36–50.

Agrawal, Deepak and Rajiv Lal (1995), "Contractual Arrangements in Franchising: An Empirical Investigation," *Journal of Marketing Research*, 32 (May), 213–21.

Anderson, Erin and Barton Weitz (1992), "The Use of Pledges to Build and Sustain Commitment in Distribution Channels," *Journal of Marketing Research*, 29 (February), 18–34.

Armstrong, J. Scott and Terry S. Overton (1977), "Estimating Non-Response Bias in Mail Surveys," *Journal of Marketing Research*, 14 (August), 396–402.

Auster, Ellen R. (1992), "The Relationship of Industry Evolution to Patterns of Technological Linkages, Joint Ventures, and Direct Investment Between U.S. and Japan," *Management Science*, 38 (6), 778–92.

Balakrishnan, Srinivasan and Birger Wernerfelt (1986), "Technical Change, Competition, and Vertical Integration," *Strategic Management Journal*, 7 (July–August), 347–59.

Bourgeois, L.J. and Kathleen M. Eisenhardt (1988), "Strategic Decision Processes in High Velocity Environments: Four Cases in the Microcomputer Industry," *Management Science*, 34 (July), 816–35.

Bunn, Michele D. (1993), "Taxonomy of Buying Decision Approaches," *Journal of Marketing*, 57 (January), 38–56.

Calantone, Roger J. and Kim E. Schatzel (2000), "Strategic Foretelling: Communication-Based Antecedents of a Firm's Propensity to Preannounce," *Journal of Marketing*, 64 (January), 17–30.

Capon, Noel and Rashi Glazer (1987), "Marketing and Technology: A Strategic Co-alignment," *Journal of Marketing*, 51 (July), 1–14.

Cohen, Wesley M. and Daniel A. Levinthal (1990), "Absorptive Capacity: A New Perspective on Learning and Innovation," *Administrative Science Quarterly*, 35 (September), 128–52.

Dawes, Philip L., Don Y. Lee, and Grahame R. Dowling (1998), "Information Control and Influence in Emergent Buying Centers," *Journal of Marketing*, 62 (July), 55–68.

Dougherty, Deborah (1992), "Interpretative Barriers to Successful Product Innovation in Large Firms," *Organization Science*, 3 (May), 179–202.

Dutta, Shantanu and George John (1995), "Combining Lab Experiments and Industry Data in Transaction Cost Analysis: The Case of Competition as a Safeguard," *Journal of Law, Economics, and Organization*, 11 (1), 189–204.

——— and Allen M. Weiss (1997), "The Relationship Between a Firm's Level of Technological Innovativeness and Its Pattern of Partnership Agreements," *Management Science*, 43 (3), 343–56.

Eisenhardt, Kathleen (1989), "Making Fast Strategic Decisions in High-Velocity Environments," *Academy of Management Journal*, 33 (September), 543–76.

Gatignon, Hubert and Thomas S. Robertson (1989), "Technology Diffusion: An Empirical Test of Competitive Effects," *Journal of Marketing*, 53 (January), 35–49.

Ghosh, Mrinal and George John (1999), "Governance Value Analysis and Marketing Strategy," *Journal of Marketing*, 63 (Special Issue), 131–45.

Glazer, Rashi (1991), "Marketing in an Information-Intensive Environment: Strategic Implications of Knowledge as an Asset," *Journal of Marketing*, 55 (October), 1–19.

Granovetter, Mark S. (1973), "The Strength of Weak Ties," *American Journal of Sociology*, 6 (May), 1360–80.

Grenadier, Steven R. and Allen M. Weiss (1997), "Investment in Technological Innovations: An Option Pricing Approach," *Journal of Financial Economics*, 44 (1), 397–416.

Hajivassiliou, Vassilis A. and Paul A. Ruud (1994), "Classical Estimation Methods for LDV Models Using Simulation," in *Handbook of Econometrics*, Robert F. Engle and Daniel L. McFadden, eds. Amsterdam: North Holland, 2384–2438.

Hansen, Morten T. (1999), "The Search-Transfer Problem: The Role of Weak Ties in Sharing Knowledge Across Organization Subunits," *Administrative Science Quarterly*, 44 (1), 82–111.

Heide, Jan B. and George John (1988), "The Role of Dependence Balancing in Safeguarding Transaction-Specific Assets in Conventional Channels," *Journal of Marketing*, 52 (January), 20–35.

——— and ——— (1990), "Alliances in Industrial Purchasing: The Determinants of Joint Action in Buyer–Supplier Relationships," *Journal of Marketing Research*, 27 (February), 24–36.

——— and Allen M. Weiss (1995), "Vendor Consideration and Switching Behavior for Buyers in High-Technology Markets," *Journal of Marketing*, 59 (3), 30–43.

Hennart, Jean-Francois (1988), "A Transaction Cost Theory of Equity Joint-Ventures," *Strategic Management Journal*, 9 (4), 361–74.

Jackson, Barbara B. (1985), *Winning and Keeping Industrial Customers*. Lexington, MA: Lexington Books.

John, George (1984), "An Empirical Investigation of Some Antecedents of Opportunism in a Marketing Channel," *Journal of Marketing Research*, 21 (August), 278–89.

———, Allen M. Weiss, and Shantanu Dutta (1999), "Marketing in Technology-Intensive Markets: Toward a Conceptual Framework," *Journal of Marketing*, 63 (Special Issue), 78–91.

Katz, Michael L. and Carl Shapiro (1994), "Systems Competition and Network Effects," *Journal of Economic Perspectives*, 8 (2), 93–115.

Klein, Benjamin, Robert G. Crawford, and Armen A. Alchian (1978), "Vertical Integration, Appropriable Rents, and the Competitive Contracting Process," *Journal of Law and Economics*, 21 (2), 297–326.

Klein, Saul, Gary L. Frazier, and Victor J. Roth (1990), "A Transaction Cost Analysis Model of Channel Integration in International Markets," *Journal of Marketing Research*, 27 (May), 196–208.

Kumar, Nirmalaya, Lisa K. Scheer, and Jan-Benedict E.M. Steenkamp (1995), "The Effects of Perceived Interdependence on Dealer Attitudes," *Journal of Marketing Research*, 32 (August), 348–56.

Leblebici, Huseyin and Gerald R. Salancik (1981), "Effects of Environmental Uncertainty on Information and Decision Processes in Banks," *Administrative Science Quarterly*, 26 (4), 578–96.

Lieberman, Marvin B. (1991), "Determinants of Vertical Integration: An Empirical Test," *The Journal of Industrial Economics*, 49 (5), 451–66.

Maddala, G.S. (1983), *Limited-Dependent and Qualitative Variables in Econometrics*. Cambridge: Cambridge University Press.

McQuiston, Daniel H. (1989), "Novelty, Complexity, and Importance as Causal Determinants of Industrial Buying Behavior," *Journal of Marketing*, 53 (April), 66–79.

Money, R. Bruce, Mary C. Gilly, and John L. Graham (1998), "Explorations of National Culture and Word-of-Mouth Referral Behavior in the Purchase of Industrial Services in the United States and Japan," *Journal of Marketing*, 62 (October), 76–87.

Murry, John P. and Jan B. Heide (1998), "Managing Promotion Program Participation Within Manufacturer–Retailer Relationships," *Journal of Marketing*, 62 (January), 58–68.

Nelson, Richard R. and Sidney Winter (1982), *An Evolutionary Theory of Economic Change*. Cambridge, MA: Harvard University Press.

Nickerson, Jack A., Barton A. Hamilton, and Tetsuo Wada (2001), "Market Position, Resource Profile, and Governance: Linking Porter and Williamson in the Context of International Courier and Small Package Services in Japan," *Strategic Management Journal*, 22 (3), 251–74.

Nunnally, Jum C. (1978), *Psychometric Theory*, 2d ed. New York: McGraw-Hill.

Olson, Eric M., Orville C. Walker, and Robert W. Ruekert (1995), "Organizing for Effective New Product Development: The Moderating Role of Product Innovativeness," *Journal of Marketing*, 59 (January), 48–62.

Phillips, Lynn (1981), "Assessing Measurement Error in Key Informant Reports: A Methodological Note on Organizational Analysis in Marketing," *Journal of Marketing Research*, 18 (November), 395–415.

Pisano, Gary P. (1990), "The R&D Boundaries of the Firm: An Empirical Analysis," *Administrative Science Quarterly*, 35 (1), 153–76.

Polanyi, Michael (1962), *Personal Knowledge: Towards a Post-Critical Philosophy*. New York: Harper and Row.

Quinn, James Brian, Jordan J. Baruch, and Karen Anne Zien (1997), *Innovation Explosion*. New York: The Free Press.

Rindfleisch, Aric and Jan B. Heide (1997), "Transaction Cost Analysis: Past, Present, and Future Applications," *Journal of Marketing*, 61 (October), 30–54.

——— and Christine Moorman (2001), "The Acquisition and Utilization of Information in New Product Alliances: A Strength-of-Ties Perspective," *Journal of Marketing*, 65 (April), 1–18.

Schilling, Melissa A. (2000), "Toward a General Modular Systems Theory and Its Application to Interfirm Product Modularity," *Academy of Management Review*, 25 (2), 312–334.

Sheridan, John H. (1988), "Betting on a Single Source," *Industry Week*, 236 (3), 31–35.

Sheth, Jagdish (1973), "A Model of Industrial Buyer Behavior," *Journal of Marketing*, 37 (Spring), 50–56.

Steenkamp, Jan-Benedict E.M. and Dick R. Wittink (1994), "The Metric Quality of Full-Profile Judgments and the Number-of-Attribute-Levels Effect in Conjoint Analysis," *International Journal of Research in Marketing*, 11 (3), 275–86.

Teece, D.J. (1981), "The Market for Know-How and the Efficient Transfer of Technology," *Ann. American Academy of Political and Social Sciences*, 458, 81–96.

Tushman, Michael L. and Philip Anderson (1986), "Technological Discontinuities and Organizational Environments," *Administrative Science Quarterly*, 31 (3), 439–65.

——— and Richard R. Nelson (1990), "Introduction: Technology, Organizations and Innovation," *Administrative Science Quarterly*, 35 (4), 1–8.

Walker, Gordon and David Weber (1984), "A Transaction Cost Approach to Make-or-Buy Decisions," *Administrative Science Quarterly*, 29 (3), 373–91.

Wathne, Kenneth H., Harald Biong, and Jan B. Heide (2001), "Choice of Supplier in 'Embedded' Markets: Relationship and Marketing Program Effectiveness," *Journal of Marketing*, 65 (April), 54–66.

Weiss, Allen M., Erin Anderson, and Deborah J. MacInnis (1999), "Reputation Management as a Motivation for Sales Structure Decisions," *Journal of Marketing*, 63 (4), 74–89.

——— and Jan B. Heide (1993), "The Nature of Organizational Search in High Technology Markets," *Journal of Marketing Research*, 30 (May), 220–33.

Williamson, Oliver E. (1985), *The Economic Institutions of Capitalism*. New York: The Free Press.

Wilson, Lynn O., Allen M. Weiss, and George John (1990), "Unbundling of Industrial Systems," *Journal of Marketing Research*, 27 (May), 123–38.