Knowledge resource exchange in strategic alliances

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Strategic alliances are no longer a strategic option but a necessity in many markets and industries. Dynamic markets for both end products and technologies, coupled with the increasing costs of doing business, have resulted in a significant increase in the use of alliances. Yet, managers are finding it increasingly difficult to capture value from alliances. In this paper, we present a model that describes the knowledge resource exchange between alliance partners. This model focuses on the different dimensions of knowledge resources (tacitness, specificity, and complexity) and their associated value implications, as well as the different roles of the partner based on its position within an industry network (complementor, competitor, supplier, customer, or other). We also argue that in order to capture and internalize knowledge obtained through an alliance, a firm must have an alliance learning capability. We illustrate the use of this model in the computer industry by analyzing the publicly announced alliances of Dell Computer Corporation and Sun Microsystems, Inc. By applying our resource exchange model, we were able to analyze the alliance strategy for each firm and to understand the alignment between the announced business strategy and alliance strategy for each firm. The findings suggest that what is important is not necessarily a particular alliance strategy, but rather an alignment between alliance strategy and business strategy.

Alliances between organizations have become an increasingly important aspect of strategic management and are playing a major role in the transfer and management of knowledge resources. Whereas most of the literature on knowledge management has focused on the creation, acquisition, transfer, and value creation associated with knowledge *within* an organization, comparatively little work has been done to understand the management of knowledge *across* organizations.

The alliance, in its various forms, continues to be a popular means of conducting business. The number of U.S. alliances has grown by more than 25 percent annually for the past five years.[1] While alliance use is appearing across many industries, the spread of alliances seems especially prevalent in the high-technology industries, where both the number of alliances and the average value per alliance has been increasing steadily.[2] These alliances tend to focus on the transfer of knowledge and technology in industries characterized by rapid change in both structure and competitive dynamics. Indeed, an emerging management view is that firms no longer can develop, manufacture, and market products on their own, and alliances are a means to gain access to complementary resources and capabilities they lack. Hagedoorn[3] found that technology complementarity, innovation time-span reduction, market access, and market structure influence are the most mentioned motives behind technology alliances. Other motives behind alliance formation in volatile, high-tech industries include: the immense costs of developing the technology, uncertainty in terms of emerging technologies, the convergence of several industry segments, and a "follow the herd" mentality. Although there seems to be an increase in the number of alliances formed, at the same time, there is also evidence that

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strategic alliances are underperforming. Success rates of less than 50 percent have often been cited in the literature.[4,5]

Recent research has indicated that alliances can be viewed as mechanisms to acquire know-how and to learn from other firms.[6–8] Henderson and Subramani,[9] for example, propose a topology of alliance types that emphasizes differences in the role of knowledge. The types of knowledge resources exchanged in alliances can range from intangible, tacit resources such as employee expertise or company brand name, to tangible, physical resources such as equipment, components, or products. The management and implications for value creation, we argue, are dependent on the nature of the knowledge resource exchange between alliance partners.

One critical aspect of the knowledge exchange between partners is the position or *role* of the partner relative to a firm (which we refer to as *focal firm* throughout the paper) within an industry. Alliance partners can be suppliers, customers, complementors, competitors, or others (i.e., a partner outside the industry). Brandenburger and Nalebuff[10] use the term *co-opetition* to describe the multiple roles of a partner, and how a partner may simultaneously be both a competitor and complementor to a firm. In fact, this seems to be occurring with respect to alliance formations in practice: over 50 percent of organizations surveyed today admit they are partnering with competitors.[1] If we extend the notion of partner role to alliance formations, we can investigate why firms form alliances with their competitors, complementors, suppliers, and customers. In particular, we seek to understand the implications of these alternative roles on the knowledge exchange between partners.

Therefore, both the nature of the knowledge resource exchange and the role of the partner raise strategic and management questions such as:

- Is there the potential for more value creation in alliances characterized by the exchange of tacit, specialized resources versus explicit, nonspecialized resources?
- How do firms with differences in business strategy differ with respect to their alliance strategy?
- What are the implications for alliance management based on the role of the partner in an industry value network (e.g., alliances with competitors versus alliances with complementors)?

In this paper, we provide a conceptual model, the Partner Resource Exchange Model, to help the manager answer the above questions. The model addresses the nature of the knowledge resource exchange based on three critical dimensions of knowledge (tacitness, specificity, and complexity), as well as the role of the partner in an industry context (complementor, competitor, supplier, customer, and other). To illustrate the use of the model, we analyze alliance announcements from two major computer hardware firms, Sun Microsystems, Inc. and Dell Computer Corporation, from 1990 to 1998. We also seek to understand the alignment between the announced business strategy and the alliance strategy for each firm. The alliance examples included in the paper are for example purposes only and may not represent the companies' current business strategies—since these companies may have moved away from the alliances used in the examples.

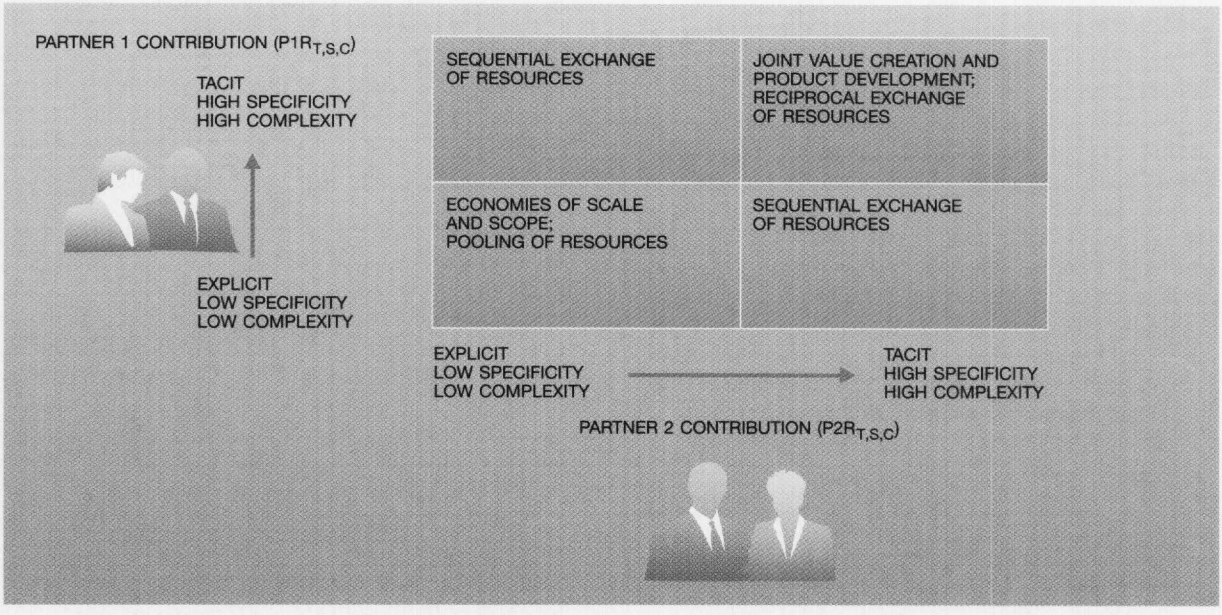
The Partner Resource Exchange Model

The issue of value creation through alliance structures has received significant attention over the years. One perspective that addresses this value question is called the relational view of the firm.[11,12] The relational view of the firm argues that a firm's critical resources may extend *beyond* its boundaries, and that firms that combine resources in unique ways with alliance partners may realize a competitive advantage over competing firms. The firm's network of alliance partners is the important unit of analysis, and network positioning is the key performance issue. A strong network position provides the firm with competitive advantage. The relational view differs from the more traditional perspectives of the firm, such as the resource-based view of the firm[13–15] and capabilities view of the firm,[16,17] which describe competitive advantage as an outcome of resources and capabilities residing *within* the firm.

Dyer and Singh[11] also argue that the exchange of knowledge resources provides value to the alliance partners. Substantial knowledge exchange results in joint learning, and the integration of complementary resources results in the joint creation of new products, technologies, and services.

If the resources exchanged in an alliance are the source of value and competitive advantage, then what aspects of these resources are critical? We identify three dimensions of knowledge resources that are critical to the knowledge exchange between alliance partners: *tacitness*, *specificity*, and *complexity*. These

Figure 1 Partner Resource Exchange Model (PREM): Four quadrants of value creation



three dimensions make it difficult to imitate a resource, and thus provide a source of both value creation and competitive advantage.[11,18] They are represented in the Partner Resource Exchange Model (PREM) shown in Figure 1.

The model. Figure 1 describes a two-partner resource exchange in which the resources each partner contributes can be measured against the dimensions of tacitness, specificity, and complexity. We define a variable that reflects the degree to which a given partner contributes tacit, specific, and complex knowledge resources to the alliance. Thus, a high value of $P1R_{T,S,C}$ would indicate Partner 1 contributed highly tacit, highly specific, and highly complex knowledge resources to the alliance. This could be accomplished, for example, by Partner 1 providing on-site, experienced engineers to the alliance. Alliance value creation, Y, is a function of both the main effects of each partner's resource contribution, $P1R_{T,S,C}$ and $P2R_{T,S,C}$, as well as the interaction between the two, P1R * P2R.

$$Y = f(P1R_{T,S,C},\quad P2R_{T,S,C},\quad P1R * P2R)$$

As shown in Figure 1, the nature of knowledge resource exchange and the anticipated value varies significantly as one moves from alliances characterized by the lower-left quadrant to ones reflecting exchanges in the upper-right quadrant.

Resource dimension 1: Explicit ⇒ tacit. Explicit resources are resources that are codified and transferable in a formal, systemic language. It is knowledge that can be found in contracts, manuals, databases, licenses, or embedded in products. Tacit resources are those resources made up of knowledge that has a personal quality, making it difficult to formalize and communicate.[19] Tacit resources can reside in individuals, such as employees with expertise and know-how resulting from years of on-the-job experience, as well as in organizations, such as those with an established brand name and company culture. Tacit resources therefore by definition are more strategic than explicit resources, because they are more difficult to transfer and imitate.

> *On 9/18/97, Compaq Computer Corp. and Intel Corp. entered into a strategic alliance to develop 100-megabit ethernet equipment. Under the terms of the agreement, Compaq and Intel shared engineers and marketing resources in the development of the ethernet network equipment.* [SDC database,[20] 9/18/97]

In the above example, both partners provide employees—highly tacit resources—to develop ethernet

equipment. Most likely, these engineers will draw on their past experiences in product development projects to assist them in this alliance. Since this alliance involves tacit resources (engineering know-how), it will be difficult to imitate and therefore provides both Compaq Computer Corporation and Intel Corporation with a distinct advantage.

Resource dimension 2: Low specificity ⇒ high specificity. Resource specificity involves investments in durable, specialized resources that cannot be redeployed from existing uses and users except at a significant loss of productive value. Therefore, specificity refers to the condition that a resource is specialized to the needs of a specific transaction, either within a firm or between the firm and its external partners.[21] There has been evidence that resource specificity in an alliance leads to higher performance.[22]

> *Gold Disk Inc. granted Compaq Computer Corp. a non-exclusive license to market its Astound CSE software. Under the terms of the agreement, Compaq would market the multimedia presentation software called Astound CSE with Compaq's newest line of Presario multimedia.* [SDC database, 4/3/95]

> *Accounting software developer State Of The Art Inc. Wednesday announced that it has finalized a distribution agreement with Apple Computer Inc., making the StarCore division of Apple the exclusive distributor of Expense It!, the business expense reporting software developed specifically for the Newton by State Of The Art. Under the agreement, Apple and its subsidiaries will license, market and resell the Expense It! software worldwide.* [Business Wire, 9/29/93]

In the first alliance, there is low specificity since it involves a nonexclusive license. Therefore, another computer maker could market and bundle Gold Disk, Inc.'s software with its computers, as Compaq is doing now. This may result in low competitive advantage for Compaq if it fails to distinguish its product from the competition. The second alliance implies high specificity since the business software is being designed specifically for the Apple Newton platform. Therefore, this alliance has the greater potential for competitive advantage.

Resource dimension 3: Low complexity ⇒ high complexity. In the context of alliances, complexity refers to the degree of partner interdependence associated with alliance activities. Thompson[23] distinguishes between pooled, sequential, and reciprocal interdependence. Pooled interdependence exists in alliances when partners pool their resources to achieve a shared strategic goal. Usually, these alliances achieve economies of scale and scope by sharing high, fixed costs, or substituting existing resources with more efficient partner resources. Sequential interdependence indicates that the activities of each partner are distinct and linear so that the activities of one partner precede those of another. The objective in these alliances is to *gain access* to certain knowledge resources, such as market knowledge through a marketing agreement or technology knowledge through a licensing agreement. However, with both pooled and sequential alliances, the emphasis is on resource access/substitution and not on internalization or learning.

The highest degree of interdependence, or complexity, occurs with reciprocal interdependence when partners come together to exchange resources with each other simultaneously. These alliances involve a high degree of integration and coordination of each other's knowledge resources (e.g., research and development agreement), and offer the greatest opportunity to learn. From a relational-view perspective, complexity adds value in an alliance, because increased interdependence results in a unique combination of resources that is difficult to imitate.

> *Citrix Systems, Inc. (Nasdaq: CTXS) today announced a definitive licensing agreement with Hewlett-Packard for Citrix's Independent Computing Architecture (ICA), an emerging industry standard for thin-client/server computing.* [Business Wire, 11/4/97]

> *Hitachi and Hewlett-Packard will jointly develop and manufacture an advanced model of HP's Precision Architecture RISC MPU.* [SDC database, 6/13/90]

The first alliance involves a basic exchange agreement in which Hewlett-Packard Company receives licensed technology from Citrix Systems, Inc. There is most likely low interdependence and thus low complexity, because it involves a sequential exchange of resources. The second alliance has higher complexity, because both partners are involved in *joint* development and manufacturing, or reciprocal interdependence. This alliance will be difficult for other firms to imitate.

PREM: Four quadrants of value creation. So far, we have defined three dimensions of knowledge ex-

change and have provided an example from the alliance literature. What is perhaps most significant is the interaction of each partner's resource contributions. In general, we argue that the potential for highest value creation and competitive advantage is achieved when both partners contribute strategic resources (i.e., those high on tacitness, specificity, and complexity dimensions) to the alliance, corresponding to the upper-right quadrant. Although all quadrants provide value, it is for different purposes. Therefore, relationships can be designed to deliver different levels of value based on strategic intent.

In the lower-left quadrant, where both partners contribute resources that are low on the tacitness, specificity, and complexity dimensions, emphasis is on improving operations, resulting in efficiency, risk reduction, and cost reduction. The purpose of these "operations-based" alliances is to interlink the two partners for better integration (e.g., firms align with their suppliers to achieve just-in-time deliveries, to improve the quality of materials and components and to reduce costs). An example of an operations-based alliance may be a manufacturing agreement. Since no one company may have enough market demand to build a plant of large capacity, it may make more sense to have a joint manufacturing alliance to improve scale costs. For example, in the semiconductor industry, with fabrication plants costing more than $1 billion, we are seeing more and more "fabless" (without fabrication facility) semiconductor firms forming manufacturing alliances with companies with excess capacity.

In the upper-left and lower-right quadrants of the diagram, one partner of the alliance provides a strategic resource while the other partner provides a low-level resource. An example includes a marketing agreement in which one partner provides customer knowledge, market access, or a brand name (each scoring high on the tacitness dimension), while the other partner provides the product to market (low on the tacitness dimension). Another common occurrence is a technology licensing agreement, with one partner paying royalties to gain access to the other partner's technology. Often, low complexity and specificity characterize these alliances. No new products or technologies are developed between partners, and there is very little joint effort or integration. The technology that is exchanged is usually in codified form. The tacit knowledge that is provided by one partner is often not shared, and very little learning takes place between partners.

In the upper-right quadrant, both partners provide strategic resources that are high on the tacitness, specificity, and complexity dimensions. As a result, the value created often results in strategic or highly differentiated capabilities. These alliances often involve partners that integrate their tacit knowledge to jointly develop new products or technologies. The resources that are exchanged are often customized to the relationship, and both partners usually have exclusive use of the technologies and products resulting from the alliance. The knowledge shared between partners is often tacit and integrated across several functions, and partner learning may be a major objective of each partner. Often, the partners may be from two different industries, and they combine resources in order to develop an emerging product market. In the next section, we use the PREM to explore alliance patterns in an industry setting.

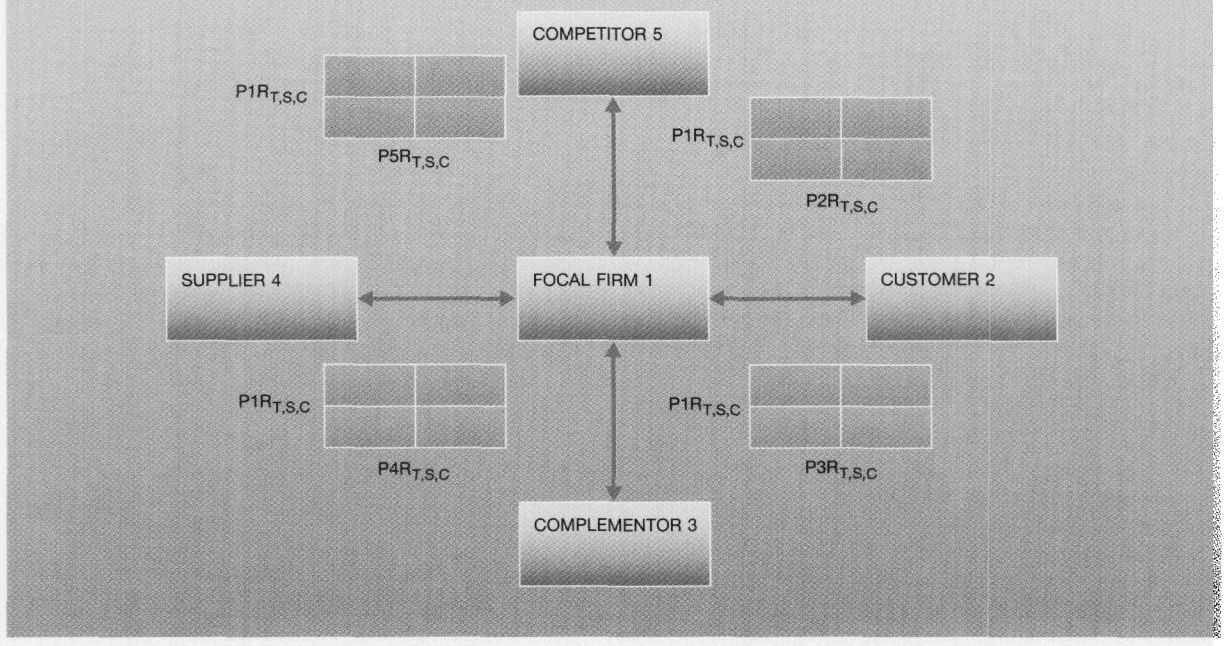
PREM and the industry value network. Another critical aspect of the relational view of the firm is the positioning of the alliance partners within a network structure. We use Brandenburger and Nalebuff's[10] model of an industry value network, which describes a firm's network position as its *role* relative to a focal firm in the industry. The role of the partner can take several forms, such as supplier, customer, complementor, competitor, and other (i.e., outside the industry). Brandenburger and Nalebuff[10] use the term *co-opetition* to describe the multiple roles of a partner, and how a partner may simultaneously be both a competitor and complementor to the focal firm. They define a competitor and complementor from both the customer and the supplier perspectives:

- A firm is your *complementor/competitor* if customers value your product *more/less* when they have the firm's product, than when they have your product alone.
- A firm is your *complementor/competitor* if it is *more/less* attractive for a supplier to supply resources to you when it is also supplying the firm, than when it is supplying you alone.

The motivations behind supplier, customer, complementor, and competitor alliances vary, which has implications on alliance management and performance.

We can now apply the PREM, shown previously, within this industry value network (Figure 2). A focal firm within an industry exchanges resources with its partner, who can be a complementor, competitor, supplier, or customer. We believe this integra-

Figure 2 Partner Resource Exchange Model within an industry framework



tion is important since the resource exchange, and thus the value created, may be affected by the network positions of the alliance partners. For example, issues with misappropriation of critical knowledge may be more relevant in alliances with competitors than alliances with complementors. Also, by applying the PREM in an industry value network, we can analyze how a company's alliance strategy is affected by industry characteristics, such as time, concentration, and degree of technological change.

Complementor alliances. The underlying motivation behind alliances with complementors is to increase the customer base of a firm's product. If we designate a computer hardware firm as our focal firm, then alliances with complementors (e.g., software companies, network companies) are beneficial to both alliance partners, because the computer industry is dependent on network externalities and the benefits associated with an increased base of complementary products. These alliances often take the form of research and development (R&D) agreements, in which a product is developed that will help sell the focal firm's products, or joint marketing alliances, in which the focal firm will "bundle" the complementor's product with its own.

> *The ASK Group Inc., a strategic business software developer and one of the largest independent software companies worldwide, expanded its partnership with Sun Microsystems to provide world-class enterprise computing solutions.* [Business Wire, 11/10/93]

In this example, the ASK Group's software products are a complement to Sun, because it increases the installed base of software for Sun's computers, and this adds value for both existing and future Sun users.

Supplier alliances. Alliances with suppliers achieve tighter integration resulting in reduced costs, improved efficiencies, and improved quality for the focal firm. The supplier may also benefit from the legitimacy that comes with partnering or aligning oneself with a focal firm, especially if that focal firm is a market leader. Also, since the supplier understands the technology and components associated with the firm's products, supplier alliances may also involve product development. In the following example, Compaq and Storage Technology Corp., a supplier to Compaq, form an alliance to develop storage solutions.

Storage Technology Corp. and Compaq Computer formed a strategic alliance to conduct advanced research and development projects to enhance the capabilities of emerging storage networks for Windows NT Enterprise Computing. [SDC database, 4/21/98]

Customer alliances. Customer alliances benefit both parties (the focal firm and its partner), because customers are an important source of innovation for enhancing existing products or developing new products, customizing design, improving customer service, and reducing costs through tighter integration of the distribution channel. Customer alliances, often referred to as "relationship marketing," tend to focus on customer retention, again through a deep involvement of the customer in the design and development of the firm's product or service offerings.[24]

On 1/28/98, Compaq Computer Corp. and Radio Shack, a unit of Tandy Corp., signed a letter of intent to enter into a strategic alliance to market a line of specially exhibited Compaq Presario Computers and accessories. Compaq also granted Radio Shack a license to provide services for the entire line of Compaq Computers. [SDC database, 1/28/98]

In this example, the retail customer Radio Shack Co. is deepening its relationship with Compaq by providing specialized service and marketing for Compaq's computers.

Competitor alliances. Alliances with competitors may take the form of licensing arrangements, joint ventures, and consortia.[25] Joint ventures with competitors may occur for the following reasons: lower costs of high-risk, technology-intensive development projects; gain economies of scale and scope; learn from the partner through access to a partner's technology and accumulated knowledge; and shape a basis for future competition in the industry. Licensing with a competitor may be due to: an inability to capitalize on the technology by itself, the desire to set industry standards early in a product's life cycle, or the need for a defensive mechanism to protect against future litigation.

Hitachi and Hewlett-Packard will jointly develop and manufacture an advanced model of HP's Precision Architecture RISC MPU. [SDC database, 6/13/90]

Hitachi and Hewlett-Packard are competitors, because they both compete in the workstation and server markets. In this example, Hewlett-Packard may want to make its core RISC (reduced instruction set computing) chip an industry standard so it is teaming up with a competitor to increase acceptance of its technology.

"Other" alliances. Alliances with partners outside the computer industry may allow for a new revenue stream for both firms in the alliance. Usually, each firm in the alliance brings a different capability or knowledge base, which is then integrated to produce a new product or service offering. In the following example, both Sun Microsystems and Eastman Kodak Company generate a new revenue stream by developing photography solutions for the computer. Sun provides computer technology expertise, while Kodak provides photography expertise. Most likely, it would be very difficult or inefficient for either firm to try to provide computer photography on its own.

Sun and Kodak Announce Initiative to Provide Digital Photo Management and Internet Distribution. [Business Wire, 3/12/97]

Using this industry value network approach, we can now examine how firms with different business strategies pursue different alliance strategy portfolios. In the next section, we empirically examine the alliance strategy portfolio for two firms in the computer sector. We use the PREM to illustrate how firms can effectively link their business strategy to their alliance strategy.

Applying the model: Two case studies

We applied the overall resource exchange model (Figure 2) within the computer hardware industry. We analyzed two-partner alliance announcements for both Dell Computer and Sun Microsystems in the period 1990–1998. We used two sources: (1) Securities Data Company's (SDC) commercially available database of alliance announcements, and (2) the Lexis-Nexis on-line database. SDC contains alliance announcements from press wires (e.g., Dow Jones, Reuters), major newspapers (e.g., the *Wall Street Journal*, the *New York Times*), and leading trade magazines. The keywords used to perform the Lexis-Nexis search were *agreement* **or** *alliance* **or** *partnership* **and** the name of the focal firm in the announcement title (i.e., Dell Computer or Sun Microsystems). For Lexis-Nexis, only alliance announcements obtained from either PR Newswire or Business Wire were used. We included all types of alliance announcements: licensing, equity investment, joint venture, OEM (other equipment manu-

facturers), marketing, R&D, technology transfer, and service agreements.

A coding scheme was developed to measure what each partner in the alliance provides in terms of *tacitness*, *specificity*, and *complexity* resources.[26] Scores for each resource variable ranged from "0" (low tacitness, low specificity, low complexity) to "1" (high tacitness, high specificity, high complexity).

Tacitness—The tacitness variable measures a firm's tacit resource contribution to the alliance. Resources that are more tangible or contractual in form (e.g., products, licenses) score low in tacitness, while resources that are more intangible in form (e.g., brand, employee expertise) score high in tacitness. Each of the two firms in the alliance receives a separate score for tacitness, depending on what each firm contributes.

Specificity—The specificity variable measures the specificity of a firm's resource contribution to the alliance. For alliances that involve exclusive and specialized resources, the specificity score is high. Alliances that involve nonspecific resource exchange score low with respect to specificity.

Complexity—The complexity variable measures the complexity of the alliance activities between the two partners. We define two separate measures of complexity: *number of alliance activities* (complexity#, for short) and *interdependency of alliance activities* (complexity-coordination, for short). The number of alliance activities variable is calculated by summing the number of activities in the alliance. An alliance can have more than one activity (e.g., an R&D and marketing alliance), and complexity# increases as there are more activities. The interdependency of alliance activities variable measures the degree of activity coordination between the two partners. Alliances with high coordination between partners (e.g., joint ventures, joint R&D projects) score high in complexity-coordination, while alliances with low coordination between partners score low.

Technology—We also included a resource measure called *technology*. Actually, we consider the technology variable to be closely related and correlated with the tacitness variable, but there is enough distinction to warrant measuring these variables separately. The technology variable measures a firm's technology resource contribution to the alliance. We define technology as input resources that are used in the development of products or services. Whereas the tacitness variable measures the types of resource (i.e., tangible versus intangible), the technology variable measures the resource as a factor of development. Therefore, there can be some empirical differences between the two variables. For example, a technology license scores low with respect to tacitness since it involves a contractual form with explicit information, but scores high with respect to technology since the technical information will be used to develop new products.

Table 1 Partner roles in the Dell Computer, Sun Microsystems study

Partner Role Assigned	Partner Main Product
Complementor	Software, networking, telecommunications, IT service
Competitor	Computer hardware
Supplier	Peripherals, semiconductors, storage, electronics
Customer	Computer reseller, distributor, retailer, end customer
Other	Outside the technology industry (e.g., media, publishing, entertainment)

We followed Weber's[27] content analysis methodology when developing the coding scheme. The coding scheme is a process by which each variable is assigned a score between "0" and "1" based on the appearance of certain keywords in the alliance announcement. Special attention is paid to developing a list of synonyms for critical keywords and providing examples for the more ambiguous interpretations. Three M.B.A. (Master of Business Administration) students were the coders for this research. The coders were trained and given test sample alliance announcements. In total, the coders went through three iterations of test samples, and inter-rater reliability numbers using Cohen's Kappa went from .7, .75, to .8. The reliability of the coders was also assessed during and after the final coding was completed. The reliability numbers remained in the .7 to .8 range.

We also measured *partner role* in each alliance as "complementor," "competitor," "supplier," "customer," or "other" (Table 1). The main product classification of the partner was used to determine the role of the partner. The partner main product codes were obtained from the SDC database and 10-K SEC (Se-

Table 2 Knowledge resource measures of partners' contributions

	Suppliers	Customers	Complementors	Competitors	Others	Overall Statistics
Tacitness						
Sun	.34	.08	.42	.40	.33	.38 (.32)
Dell	.23	.09	.16	.38	.23	.21 (.28)
Sun partners	.34	.31	.44	.37	.52	.40 (.34)
Dell partners	.25	.22	.39	.26	.30	.31 (.29)
Technology						
Sun	.53	.18	.53	.65	.41	.52 (.40)
Dell	.24	.09	.21	.23	.13	.22 (.27)
Sun partners	.39	.23	.50	.46	.45	.45 (.40)
Dell partners	.38	.09	.44	.41	.05	.38 (.33)
Specificity						
Sun/partners	.27	.22	.37	.28	.25	.32 (.30)
Dell/partners	.28	.25	.44	.41	1.0	.39 (.37)
Complexity#						
Sun/partners	.22	.31	.25	.17	.13	.23 (.31)
Dell/partners	.22	.13	.29	.32	.10	.25 (.31)
Complexity-Coordination						
Sun/partners	.35	.16	.39	.34	.28	.36 (.37)
Dell/partners	.20	.13	.26	.32	.35	.24 (.26)

curities and Exchange Commission) filings. Since Dell Computer and Sun Microsystems, makers of computer hardware, are the focal firms in our study, complementors include software companies and network/telecommunications/information technology (IT) solution providers, since these partners "complement" or aid the computer hardware makers in selling more of their products. Competitors are other computer hardware makers. Suppliers include companies involved with peripherals (e.g., printers), electronics (e.g., semiconductors, motherboards), and storage (e.g., disk drives). Customers include IT distributors, retailers, and end customers. Finally, "others" include firms not involved in the above computer technology sectors, such as entertainment, pharmaceutical, news content, and publishing companies.

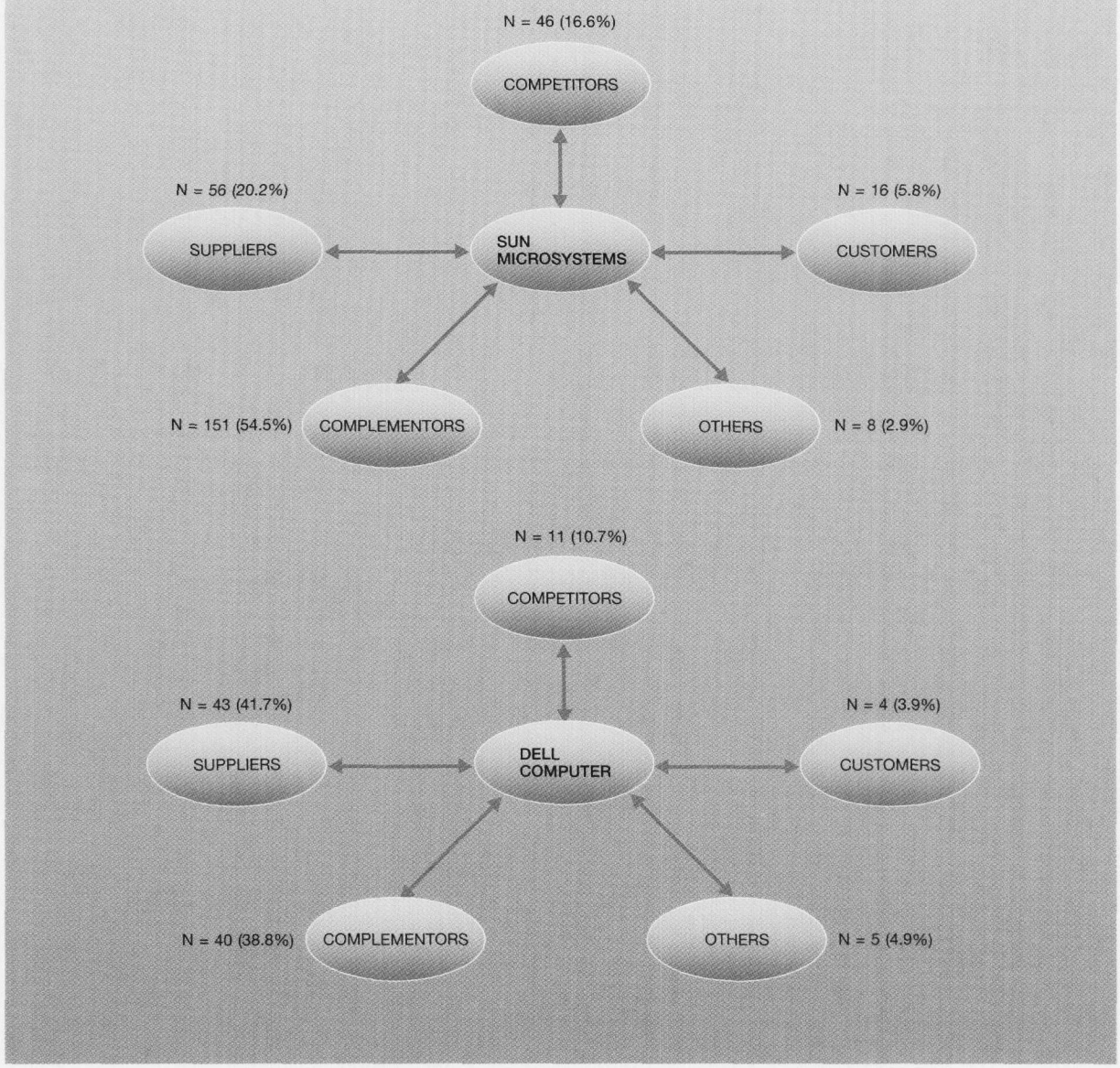
Dell Computer and Sun Microsystems alliance portfolios (1990–1998). Based on our research methodology, Figure 3 shows the alliance portfolios for Dell Computer and Sun Microsystems based on the number of alliances each has had with each partner type. Table 2 lists the knowledge resource measures of contributions by Dell, Sun, and their partners. The five resource variables—tacitness, technology, specificity, complexity#, and complexity-coordination—are measured on a scale between "0" and "1." The overall statistics column contains entries of the form A(S), where A is the average and S is the standard deviation. The specificity and complexity variables are alliance-level variables and therefore have the same value for the focal firm and its partners.

These portfolios illustrate within the PREM the alliance strategy for both Sun and Dell. Figure 3 shows that Dell relies heavily on alliances with its suppliers (41.7 percent of total). Also, we see in Table 2 that Dell relies on its partners both for technology (.38 overall score) and tacit resources (.31 overall score). Both are higher levels than what Dell provides to its partners for technology (.22) and tacit resources (.21).

Meanwhile, as we see in Table 2, Sun relies heavily on licensing its technology to develop industry standards, and so Sun shows high levels of technology resource contributions (.52 overall), especially to competitors (.65). When comparing Sun versus Dell directly, Sun provides its partners with much higher overall tacit resources (.38 vs .21) and technology resources (.52 vs .22) than Dell provides its partners.

We also tried to understand the alignment of announced business strategy with alliance strategy and to understand the different approaches of Dell and

Figure 3 Sun Microsystems and Dell Computer alliance portfolios



Sun with regard to alliance strategy (Table 3). We used press releases, analyst reports, and company reports to understand each firm's business strategy, and we used the alliance data from this research to understand each firm's alliance strategy.

Sun Microsystems business and alliance strategy. Sun Microsystems is vertically integrated, since it owns or controls the major components of its computer systems. It develops its own operating system, designs its own microprocessor and other hardware components, and provides services to its platform customers. Sun develops much of its technology in-house, and its alliance strategy (based on our research results) focuses on technology licensing agreements to develop industry standards.

Table 3 Sun Microsystems and Dell Computer announced business and alliance strategy

Focal Firm	Business Strategy	Alliance Strategy
Sun Microsystems	Highly vertical: ownership of technology (operating system plus CPU), provide services	Align with partners to provide services (e.g., IBM, EDS, Andersen Consulting)
	Use of shared software and hardware components among different vendors to create industry standards	Licensing of technology (e.g., Java, Solaris, SPARC) to develop industry standards
	Belief in open systems to allow computers to talk to one another	Align with resellers to sell into indirect channels
	Internet/e-commerce specialist	Outsource manufacturing of SPARC chips to Texas Instruments
		Internet alliances (e.g., Netscape/AOL) to deliver applications and services
Dell Computer	Virtual integration: control flow of information from suppliers to customers	OEM alliances with key component suppliers such as Intel
	Assembler versus owner of technology	Service alliances with Decision One, IBM, EDS, Andersen Consulting
	Direct model (with both suppliers and customers) offers competitive advantage (low cost, first-to-market with latest technology)	Generate revenue "outside the box" by aligning with Internet service providers (e.g., AOL)
	Desire to move into the enterprise computer market	Streamline logistics with suppliers by implementing valuechain.com
		Distribution alliances with value-added resellers and retailers to gain international presence
		Technology transfer agreements (e.g., IBM) to move into enterprise market

Sun Microsystems is a market leader in computer servers and workstations, but unlike many of its peers, does not compete in the personal computer market. Sun's business strategy has been to pioneer the use of shared software and hardware components among competing computer makers in order to promote industry standards. In the late 1980s, Sun introduced its SPARC** microprocessor, one of several RISC-based microprocessors in the industry running the UNIX** operating system. Realizing the fragmented state of the UNIX market, Sun licensed SPARC to stimulate high-volume, low-cost sales of its SPARC-based computers and also to increase the application software support for its systems.[28]

In the early 1990s, Sun essentially became a hybrid hardware-software company by developing the Solaris** operating system, which not only ran on its SPARC systems, but also on Intel-based microprocessors. This, again, increased application software support for its systems. In 1995, Sun introduced Java**, a programming language and platform that allows users to run programs on any computer system. With the advent of the Internet in the mid-1990s, Sun has been very successful promoting its servers as the building block of the Internet.[28]

Based on our research results, Sun's alliance strategy in the 1990–1998 period has been to license its technology to develop industry standards. From our study sample, a large percentage of its alliances involve licensing, and the number of licenses it provides is twice the number of licenses it receives. A majority of Sun's licenses involve its Java and Solaris software. In fact, from our study sample, over 40 percent of Sun's total alliances involve software, and over half of Sun's alliances involve complementors (e.g., software, networking, IT service firms). Sun will license its technology not only to its complementors, such as software companies, but also to its competitors or other computer hardware makers.

Sun does outsource the manufacturing of several of its hardware components, namely the manufacturing of its SPARC chips to Texas Instruments, Inc. Sun does rely on indirect channels to sell its systems, with alliances with resellers such as Ingram Micro, Inc., and Merisel, Inc. Sun contracted service alliances for its SPARC systems with consultant companies and system integrators such as Andersen Consulting and EDS, as well as with competitor IBM. More recently, Sun has formed Internet alliances with Netscape Communications Corporation and AOL in order to deliver applications and services that allow enterprise customers to get launched on the Internet. Future alliances, we predict, will involve the licensing and promotion of Sun's new software technology (called Jini**) to connect a vast array of electronic devices and appliances to the Internet.

Dell Computer business and alliance strategy. Dell Computer has a much different business and alliance strategy than Sun Microsystems. Dell designs, customizes, and assembles PC (personal computer) products and services to end-user requirements using industry standard components. Dell has never vertically integrated PC component production into its manufacturing model, instead leveraging supplier alliances to obtain parts on a build-to-order basis.[29] This direct model approach has given Dell a competitive advantage, and today Dell ranks as one of the leading PC vendors in the world.

Based on our research results, Dell's alliance strategy fully complements its business strategy of being the leading direct marketer of personal computers. From our study, 33 percent of Dell's alliance activities are OEM arrangements, and 42 percent of Dell's alliances are with suppliers, such as semiconductors and peripheral companies. These include agreements with key component suppliers such as Intel and 3Com Corporation. Also, Dell has streamlined logistics with suppliers by implementing valuechain.com, an electronic market of 50 of its suppliers.

From our study sample, Dell also has a relatively high percentage of service alliances. Customer service is a critical aspect of Dell's business model, and Dell may need to rely on alliances to perform this capability. Recent service partners include Decision One, IBM, Wang Laboratories, Unisys, EDS, and Andersen Consulting. Even though they have relied on the direct model of selling PCs in the United States, Dell has formed alliances with value-added resellers (VARs), distributors, and retailers in international markets where they have not yet established a presence, and in certain corporate accounts where selling direct is not possible. Dell has formed alliances with Ingram Micro, Inc., Tech Data Corporation, and Merisel in foreign markets. Dell may continue to align itself with foreign distributors or retailers until it has established a presence and achieved enough critical mass to set up a direct sales operation.

Our study shows that Dell has a relatively low percentage of R&D alliances, and relatively low tacitness and technology contribution scores among its peers. Dell has considered itself as much a marketing company as a hardware company, and has focused its R&D resources on selecting and evaluating appropriate technology and architectures, as opposed to new product development.[29,30]

However, Dell's announced future business model is to move into more complex enterprise computing and services, such as e-commerce service, and this will require more technology and service capabilities. We predict alliances will be a critical enabler of this strategy. Most likely, Dell will form joint R&D, technology transfer, and service alliances with established companies that have these capabilities, as opposed to developing all these capabilities internally. In fact, we are starting to witness this trend with the recent announcements of joint technology and service agreements with IBM, Microsoft Corporation, Intel, and Redhat. Finally, like all PC makers, Dell is looking to generate revenue "outside the box" and their recent alliance with AOL is one such example.

Alignment between business strategy and alliance strategy is key. Based on our analysis, we do find an alignment between the announced business strategy and the alliance strategy for both Dell and Sun. In other words, Dell and Sun may have designed their alliances with their business strategy in mind. We also find significant differences between the firms in terms of strategy. Sun's strategy seems to be ownership of technology to create industry standards, whereas Dell positions itself as an assembler versus an owner of technology. Our point here is not that one particular strategy is more successful, but it is the alignment between business strategy and alliance strategy that is important. The implication is critical since most managers are focused on the allocation and management of *internal* resources to achieve business strategy. With more and more firms relying on *external* knowledge resources from its alliance partners, managers must now ensure the proper alignment between business and alliance strategy. An-

Table 4 Knowledge resource measures of partners' contributions—pre- and post-Internet

	Suppliers	Customers	Complementors	Competitors	Others	Overall Statistics
Tacitness						
Sun pre-94	.40	.08	.40	.40	.25	.36 (.33)
Sun post-94	.28	.08	.44	.42	.41	.39 (.32)
Partner pre-94	.45	.32	.46	.37	.56	.43 (.33)
Partner post-94	.24	.25	.43	.38	.47	.39 (.34)
Technology						
Sun pre-94	.51	.20	.38	.62	.28	.44 (.37)
Sun post-94	.55	.11	.61	.69	.53	.59 (.41)
Partner pre-94	.48	.23	.54	.44	.56	.47 (.38)
Partner post-94	.32	.19	.48	.50	.34	.44 (.41)
Specificity						
Sun/partners pre-94	.27	.23	.42	.26	.25	.33 (.29)
Sun/partners post-94	.27	.17	.34	.33	.25	.32 (.30)
Complexity#						
Sun/partners pre-94	.25	.31	.35	.19	.13	.28 (.31)
Sun/partners post-94	.20	.33	.19	.13	.13	.19 (.30)
Complexity-Coordination						
Sun/partners pre-94	.39	.17	.44	.32	.25	.37 (.38)
Sun/partners post-94	.31	.08	.36	.37	.31	.35 (.36)

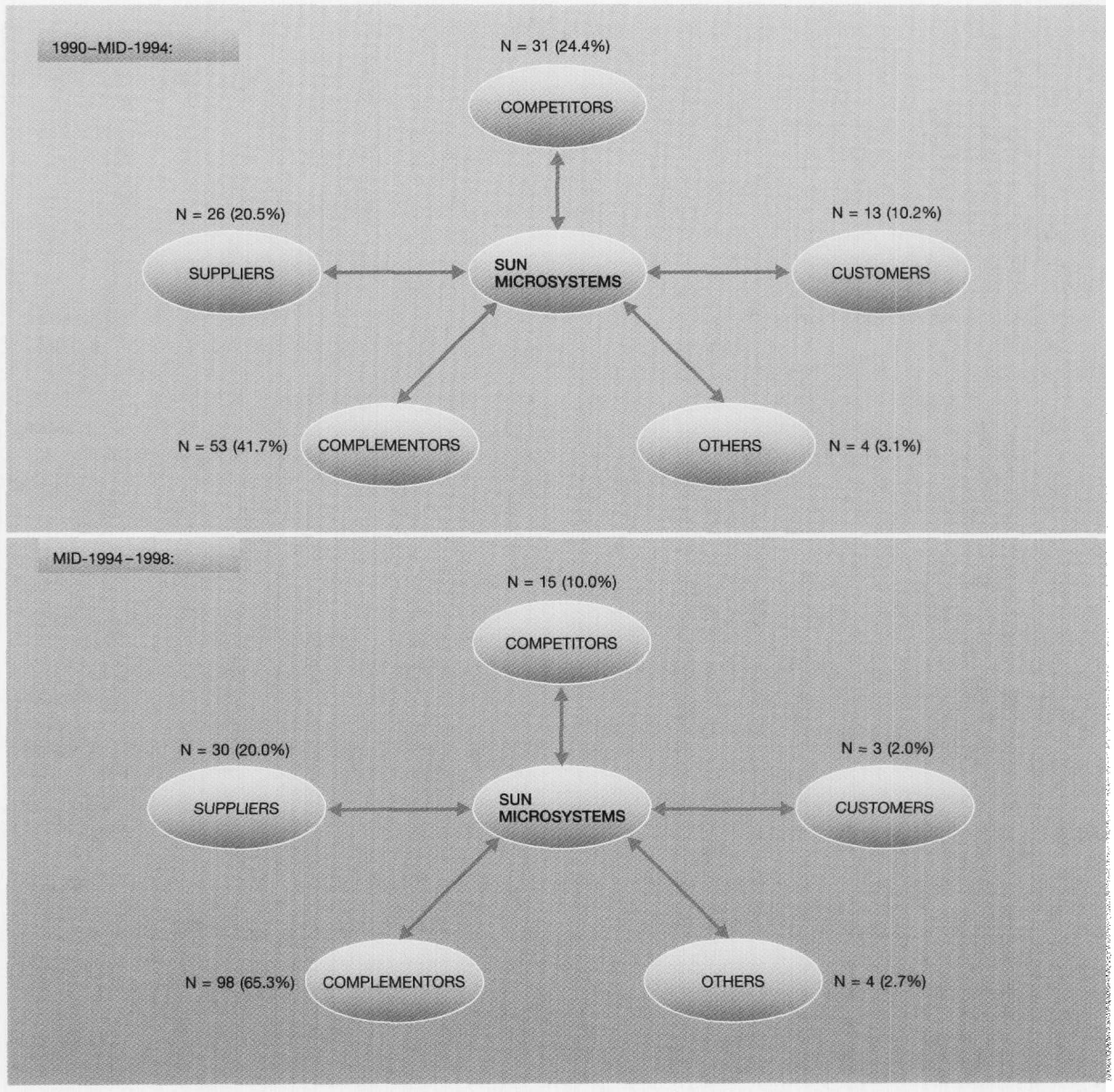
other implication is that we have to expand our thinking on alliance "success." Traditional alliance success measures such as duration and financial-based metrics may be insufficient if the business strategy is to reduce exposure to risk or to develop industry standards. Alliance success measurement, therefore, should include a linkage to business strategy.

Changes in alliance portfolio over time. So far, we have shown that our Partner Resource Exchange Model is a useful lens to analyze the knowledge resources that a firm provides and receives in an alliance, as well as the different types of partners with which it conducts business. We believe our model is also useful in a *dynamic* environment, because it can represent changes in a firm's alliance portfolio over time. A firm's alliance portfolio changes over time, because the firm is either constantly adding or removing partners from its portfolio, or the firm is changing its behavior toward its partners in terms of resource contribution and management, or the firm's position in the industry network is constantly in flux. For example, a partner, who has been a supplier for many years, has now become a competitor. Most likely, this will change how the firm behaves toward this partner, in terms of resource exchange.

To illustrate how the resource exchange model can represent a dynamic environment, we use changes in Sun Microsystem's alliance portfolio over time. We divided our sample in half, from 1990 to mid-1994, and from mid-1994 to 1998 (Figure 4, Table 4). From 1990 to mid-1994, Sun has alliances with many competitors, in which Sun contributes computer technology in the form of licensing arrangements. From mid-1994 to 1998, we notice a drop-off in alliances with competitors and a large increase in alliances with complementors. Also, these alliances with complementors involve technology licensing, a large percentage of which involve Java licensing to software firms in order to establish Java as an industry standard. The emergence of the Internet in the latter half of the 1990s most likely had an effect on Sun's alliance strategy, and this is reflected in Sun's attempt to develop "open" software standards, such as Java.

This example is at an aggregate level, since it takes into account all of Sun's alliance partners. However, we can use our model to analyze changes with a particular partner, or group of partners, over time. For example, Sun Microsystems may have had ten separate alliances with a particular partner. Over time, the role of the partner may have changed (e.g., from

Figure 4 Change in Sun's alliance portfolio over time

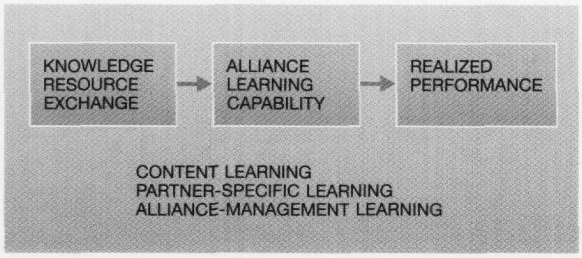


supplier to competitor to complementor), and the resource exchange may have changed. Therefore, what is critical to understand is not simply the number of previous ties with this partner (in this case ten), but the change in network positioning and resource exchange with the partner over time. Therefore, the resource exchange model is useful in analyzing changes in a firm's alliance portfolio over time.

Alliance learning capability

So far, we have discussed knowledge resource exchange and the potential for value creation based on the type and nature of the resource exchange. We have also presented an overall model that looks at this resource exchange within an industry value network, and have used the model in a study of the al-

Figure 5 Alliance learning capability



liances of Dell and Sun. However, we have not yet discussed the process of learning from, and managing, the knowledge obtained through alliances. Next, we discuss the implications of knowledge resource exchange on alliance management.

The partner resource exchange may be part of the initial structure to the alliance. For example, we have argued that alliances that involve an exchange of tacit, specialized knowledge resources have the *potential* to have high value creation. Our study analyzed the initial resource exchange at the time of the alliance announcement. However, as the alliance evolves, an important construct related to *realized* performance is *alliance learning capability* (Figure 5). In other words, alliances involving a significant exchange of tacit, specialized, and complex resources may be successful if there is an alliance learning capability. The literature has identified three types of learning associated with alliances,[31] which we refer to as *alliance learning capability*.

Content learning. The first type of learning, and the most commonly studied, is content learning, and it is often referred to as private benefits. Content learning represents the ability of the focal firm leader to internalize the knowledge it receives from the alliance partner, and is dependent on such factors as learning intent and absorptive capacity. Intent to learn refers to the firm's propensity to view alliances as an opportunity to learn. As described earlier, alliances can be used as resource access or substitution mechanisms, with the intent on cost reduction or compensation for lack of knowledge, as opposed to opportunities to learn from the partner. In U.S.-Japanese alliances, for example, Japanese firms have often viewed collaboration as a way to learn, while U.S. firms have used alliances as a way to substitute for more competitive skills, resulting in an erosion of internal skills and ultimately competitive disadvantage.[32] Therefore, even if there is an exchange of tacit resources in an alliance, the partner must have learning as an objective in order to capture long-term benefits.

Absorptive capacity refers to the firm's ability to internalize the knowledge it receives from its partner. This involves the firm's ability to recognize the value of new, external information, assimilate it, and apply it to commercial ends.[33] Absorptive capacity is a function of the firm's level of prior related knowledge. For example, if a firm collaborates with a partner outside its industry, absorptive capacity might be an issue since the firm might not have the level of understanding needed to internalize a new knowledge domain. Alliances with competitors, meanwhile, often present an ideal situation to learn, because the knowledge bases of the partners are similar.

Partner-specific learning. Partner-specific learning involves the process of learning from, and learning about, an individual alliance partner. A key component of this process is called *transparency*, which is the firm's opportunity to learn from its partner.[32] The easier it is to transfer the knowledge and skills from a partner, the easier it is to learn. Often, compatible language and culture between the alliance partners enable transparency. Social aspects of the relationship, such as trust, reputation, and previous ties, are also very important to partner specific learning, because they allow for greater transparency. For example, previous ties or interactions with a partner enable a firm to understand where the critical partner's expertise resides and whom to contact in order to gain access to this knowledge. Trust and reputation allow for the establishment of knowledge-sharing routines between partners without fear of opportunism or the free-rider problem. Trust and reputation also reduce transaction costs (e.g., costs of writing and enforcing contracts), while simultaneously allowing the alliance partner to invest in specialized resources or share tacit resources without fear of misappropriation.[11] Also, not everything has to be written in contracts. Emergent or changing goals, redefined joint activities, and management of decision rights and residual claims can be handled effectively through an informal structure due to the close working relationship with a partner. In summary, partner-specific learning is very critical when there is an exchange of tacit, specialized, and complex knowledge resources. The existence of partner-specific knowledge routines, coupled with an effective working environment, will enable learning to take place. If there is low trust, a cautious alliance environment will exist, resulting in a low likelihood of finding, transferring, and sharing knowledge.

Alliance management learning. The third type of learning is often referred to as *alliance-management learning* and is often built over time with alliance experience. This type of learning involves the management of a *portfolio of alliances*. Whereas partner-specific learning focuses on an individual alliance, alliance-management learning focuses on the firm's ability to manage multiple alliances simultaneously. The critical success factor, we believe, is the ability to manage the interdependencies between alliances to produce a complementary portfolio. The role of the partner plays an important part in understanding the interdependencies. For example, a portfolio of alliances that consists of competitors promoting competing standards might result in a "negative" portfolio, even if the objective of the focal firm is to learn from its competitors. Partners might be protective and reluctant to share any important knowledge with the focal firm when they realize the focal firm is also partnering with their competitor. However, a portfolio consisting of partners promoting similar standards or technology innovations might be considered a complementary portfolio, because partners are more likely to share their knowledge resources. The manager could perhaps think of a complementary portfolio as a balanced number of competitor partners for learning, developing standards, and sharing costs; complementor partners to increase the user base of its products; supplier and customer partners to improve logistics; and "other" partners to diversify from the core product line. Similarly, a complementary portfolio could mean a balance between receiving knowledge resources and providing knowledge resources. Finally, the manager must ensure that the capabilities and resources the firm receives from its alliance partners complement the capabilities and resources it already has internally. The important point we want to convey is that the manager must manage alliances holistically as well as individually, since the firm has multiple alliances, with each alliance having an effect on the other alliances.

Concluding remarks

Strategic alliances are no longer a strategic option but a necessity in many markets and industries. Dynamic markets for both end products and technologies, coupled with the increasing costs of doing business, have resulted in a significant increase in the use of alliances. Yet, practitioners are finding it increasingly difficult to capture value from alliances. In this paper, we have presented a model (PREM) that illustrates the knowledge resource exchange between alliance partners. This model focuses on the different dimensions of the resources and their associated value implications. We applied this model in an industry value network, where we studied the different roles of the partner. We have also argued that in order to capture and internalize knowledge obtained through alliances, a firm must have an alliance learning capability. We illustrated this model in the computer industry by analyzing the publicly announced alliances of Dell Computer and Sun Microsystems. By applying our Partner Resource Exchange Model, we were able to analyze the alliance strategy for each firm, and to understand the alignment between their announced business strategy and alliance strategy. We hope this paper stimulates further thinking and research in the area of learning and knowledge transfer in alliance relationships and networks.

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