A Knowledge Accessing Theory of Strategic Alliances

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ABSTRACT The emerging knowledge-based view of the firm offers new insight into the causes and management of interfirm alliances. However, the development of an effective knowledge-based theory of alliance formation has been inhibited by a simplistic view of alliances as vehicles for organizational learning in which strategic alliances have presumed to be motivated by firms’ desire to acquire knowledge from one another. We argue that the primary advantage of alliances over both firms and markets is in accessing rather than acquiring knowledge. Building upon the distinction between the knowledge generation (‘exploration’) and knowledge application (‘exploitation’), we show that alliances contribute to the efficiency in the application of knowledge; first, by improving the efficiency with which knowledge is integrated into the production of complex goods and services, and second, by increasing the efficiency with which knowledge is utilized. These static efficiency advantages of alliances are enhanced where there is uncertainty over future knowledge requirements and where new products offer early-mover advantages. Compared with alternative learning-based approaches to alliance formation, our proposed knowledge-accessing theory of alliances offers the advantages of greater theoretical rigour and consistency with general trends in alliance activity and corporate strategy.

INTRODUCTION

One of the most important trends in industrial organization of the past quarter century has been the growth of collaboration between independent companies. As large companies have pulled back their corporate borders through outsourcing and divestment of ‘non-core’ activities, they have increasingly cooperated with other companies in order to engage in activities and access resources outside their own boundaries.

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These interfirm alliances involve cooperative relationships that are not fully defined either by formal contracts or by ownership. Hence, in terms of the theory of economic organization, they fall between the polar models of markets and hierarchies. As a result, cooperative relationships between firms have been viewed as ‘intermediate’ or ‘hybrid’ organizational forms (Borys and Jemison, 1989; Powell, 1987; Thorelli, 1986). To distinguish longer-term more substantial collaboration from more casual cooperative arrangements between firms, the term ‘strategic alliance’ has been used to refer to ‘agreements characterized by the commitment of two or more firms to reach a common goal entailing the pooling of their resources and activities’ (Teece, 1992, p. 19). Within such alliances, ‘the parties . . . maintain autonomy but are bilaterally dependent to a non-trivial degree’ (Williamson, 1991, p. 271).

Strategic alliances embrace a diversity of collaborative forms. The activities covered include supplier-buyer partnerships, outsourcing agreements, technical collaboration, joint research projects, shared new product development, shared manufacturing arrangements, common distribution agreements, cross-selling arrangements, and franchising. While the defining governance mode is the informal ‘relational contract’, strategic alliances may involve contractual agreements (e.g. franchising and cross-licensing agreements) and ownership links (e.g. cross-equity holdings and joint ventures).

The increasing importance of strategic alliances has resulted in growing interest in theorizing about their causes and consequences. However, the diversity of the phenomenon challenges our ability to develop all-encompassing theories. The problem is not so much a lack of theory as an overabundance. Theories of alliance formation include the creation of market power to generate monopoly rents (Katz, 1986; Schwartz, 1987; Stocking and Watkins, 1946), resource-dependency theory (Barley et al., 1992; Guetzkow, 1966; Van de Ven, 1976), strategic options (Hurry, 1993; Kogut, 1991; Sanchez, 1993), product complementarities and network externalities (Rotemberg and Saloner, 1991), and transaction cost theory (Oxley, 1997; Ring and Van De Ven, 1992; Williamson, 1991). However, the emergence of resource-based approaches to strategy – especially those emphasizing the role of knowledge – has provided a broader basis upon which to build a theory of interfirm cooperation.

At the same time, the usefulness of knowledge-based approaches to the analysis of strategic alliances has been limited by cursory analysis of the role of knowledge in alliance relationships and the widespread presumption that the goal of alliances is to facilitate organizational learning. This emphasis on learning – the acquisition of knowledge – fails to recognize the central attribute of the strategic alliance as an organizational mode that can reconcile the benefits of knowledge specialization with those of flexible integration.

The purpose of this paper is to present a theory of strategic alliances that focuses upon the role of strategic alliances, not in acquiring, but in accessing the knowledge.
resources of other firms. In doing so, we offer two main contributions to the literature on interfirm alliances. First, we clarify alternative knowledge-based motives for strategic alliances within the knowledge-based economy and counter the widespread presumption that the primary motive is knowledge acquisition through organizational learning. Second, we develop the knowledge-accessing explanation of strategic alliances by outlining a theory of the efficiency advantages of strategic alliances (relative to both firms and markets) in exploiting knowledge assets. Our theory does not purport to be a comprehensive theory of strategic alliances. We recognize that in as diverse a phenomenon as strategic alliances, there are likely to be multiple motives and that a single theory cannot address all types of alliances. In particular, we recognize that some alliances may be motivated by market power considerations, others may be formed to access resources other than knowledge, and – even within the knowledge-view of alliances – some may be created with the primary intention of acquiring rather than to accessing knowledge. However, our contention is that knowledge accessing provides the predominant motive for alliance formation, especially within the knowledge-based sectors where alliance activity has been especially prevalent (e.g. pharmaceuticals, semiconductors, aerospace, telecommunications, and consumer electronics).[2]

We begin by reviewing knowledge-based approaches to the analysis of interfirm alliances. We then outline an analysis of knowledge-based production that permits us to identify the circumstances in which alliances offer efficiency advantages over both firms and markets.

**KNOWLEDGE AND INTERFIRM ALLIANCES**

In the same way that the knowledge-based view of the firm has grown out of resource-based theory of the nature and existence of firms (Grant, 1996), knowledge-based explanations of the formation of strategic alliance formation have their roots in resource-based approaches to alliances. Drawing upon resource-dependence theory (Pfeffer and Salancik, 1978) and the resource-based view of the firm (Penrose, 1957), several studies (Eisenhardt and Schoonhoven, 1996; Gulati, 1999; Rothaermel, 2001; Van De Ven and Walker, 1984) have viewed alliances as a quest for resources. Moreover, certain types of resources appear to particularly influential in alliance formation. The concentration of alliances in R&D intensive sectors points to technology as playing a key role in alliance formation (Dickson and Weaver, 1997; Dodgson, 1992; Doz, 1988; Hagedoorn, 1993). As technology management became absorbed within the wider field of knowledge management, so alliances have been viewed from a broader knowledge perspective. Several studies of strategic alliances have identified the sharing of knowledge (including technology, know-how and organizational capability) as their dominant objective (Ciborra, 1991; Dyer and Nobeoka, 2000; Inkpen and Crossan, 1995; Kale et al., 2000; Khanna et al., 1998; Larsson et al., 1998; Lyles,
1988; Mody, 1993; Mowery et al., 1996, 1997; Simonin, 1997, 1999). Among these studies, the great majority have adopted an organizational learning perspective: assuming that the goal of strategic alliances is to acquire the knowledge of alliance partners. The outcome may be a ‘competition for learning’ where each alliance member seeks to learn at a faster rate than its partner in order to achieve a positive balance of trade in knowledge (Hamel, 1991). This can destabilize the relationship (Inkpen and Beamish, 1997), unless the alliance partners are successful in building ‘relational capital’ that can reconcile reciprocal learning with the protection of core knowledge assets (Kale et al., 2000).

The knowledge-based literature identifies two conceptually distinct dimensions of knowledge management. First, those activities that increase an organization’s stock of knowledge – what March (1991) refers to as ‘exploration’, and Spender (1992) calls ‘knowledge generation’. Second, those activities that deploy existing knowledge to create value – what March (1991) refers to as ‘exploitation’, and Spender (1992) calls ‘knowledge application’. In relation to strategic alliances, this distinction between knowledge generation and knowledge application corresponds to a key distinction in the ways in which knowledge is shared among alliance partners. Knowledge generation points to alliances as vehicles of learning in which each member firm uses the alliance to transfer and absorb the partner’s knowledge base. Knowledge application points to a form of knowledge sharing in which each member firm accesses its partner’s stock of knowledge in order to exploit complementarities, but with the intention of maintaining its distinctive base of specialized knowledge.

Several prior studies have distinguished these two types of knowledge sharing within alliances. Hamel (1991, p. 84) notes, ‘The crucial distinction between acquiring such skills in the sense of gaining access to them . . . and actually internalising a partner’s skills has seldom been clearly drawn.’ Similarly, Inkpen (1998, p. 72) observed that: ‘In some alliances, partners aggressively seek to acquire alliance knowledge while in others, the partners take a more passive approach to knowledge acquisition.’ From a transaction cost perspective, Hennart (1988) has also identified a similar competition/cooperation tension. The distinction between acquisition and accessing is critically important of the evolution of the alliance partners’ knowledge bases. Among Japanese-US joint ventures, Nakamura et al. (1996) observed technological convergence in joint ventures where the partners engaged in mutual organizational learning, and the opposite tendency among joint ventures where ‘partner firms’ competitive capabilities have become dissimilar but complementary’ (p. 536). A similar dichotomy was detected by Mowery et al. (1996): the lack of significant overall trend towards either convergence or divergence between partners’ technology bases among 792 alliances appeared to disguise the fact that some alliances were converging (implying mutual learning) while others were diverging (implying specialization and knowledge accessing).[3]
While acknowledging that learning occurs in all alliances and that some alliances are motivated primarily by the desire to acquire partners’ knowledge,[4] our contention is that knowledge accessing rather than knowledge acquisition is the primary motivation for knowledge-based alliances. This view of alliances is consistent with the trends in corporate strategy over the past two decades. The primary trend since the early 1980s has been towards refocusing: the emergence of ‘truly focused companies . . . concentrated around a core set of knowledge or service skills’ (Quinn, 1992, p. 373). This trend is not obviously consistent with the firms using alliances to continually broaden their knowledge bases as they acquire their partners’ knowledge. On the basis of both logic (to be developed more formally in subsequent sections) and casual empiricism, we suggest a general tendency for firms to concentrate upon a few core competences and to collaborate with other firms in order to access additional capabilities. Thus, Daimler-Benz’s initial collaboration with Swatch in designing its ‘Smart car’ was motivated, not by Mercedes’ desire to acquire Swatch’s precision engineering and microdesign capabilities and Swatch’s desire to acquire Daimler’s automotive know-how, but by both parties’ desire to create value through combining their separate knowledge bases. Similarly, Luciano Pavarotti’s collaboration with the Spice Girls was for the purposes of combining their different styles and capabilities in a music album, not about Pavarotti learning how to be a girl band, or the Spice Girls acquiring operatic skills (Pavarotti, 1998).

A key feature of knowledge-based explanations of alliances is imprecision around the concepts of organizational learning, knowledge sharing, and knowledge transfer. Mowery et al. (1996) concluded that: ‘The “learning” that takes place within alliances thus appears to be more complex than most of the literature on this topic suggests, underlying the need for better definitions of learning in theoretical discussions of alliance activity and highlighting this as an area ripe for further study’ (p. 89). Our goal is to develop a more precise theory concerning the role of knowledge in alliances, emphasizing the role of alliances as mechanisms for knowledge accessing. We begin with a few precepts concerning the characteristics of knowledge and its role in economic activity from which we derive implications for the circumstances under which interfirm alliances are more efficient than both markets and firms in organizing production.

ALLIANCES AND STATIC EFFICIENCY IN KNOWLEDGE APPLICATION

Features of Knowledge-based Production

The key challenge facing any theory of strategic alliances is to specify the circumstances in which interfirm alliances are superior governance structures to either markets or single firms. This has been a particular problem for organiza-
tional economics that has found it easy to establish the transaction costs associated with markets and the agency problems inherent within firms, but more difficult to identify the circumstances under which alliances and other ‘hybrid’ forms emerge. Thus, Williamson’s (1991) observation that ‘hybrid’ forms are associated with intermediate levels of asset specificity, adaptability and incentive intensity presents the problem that quantitative assumptions are required in order to generate qualitative predictions. Knowledge-based theory has the potential to illuminate more powerfully the rationale for interfirm alliances.

Let us begin with some basic assumptions concerning knowledge and its role in production:

(1) Knowledge is the overwhelmingly important productive resource in terms of market value and the primary source of Ricardian rents (Grant, 1996; Machlup, 1980).[5]

(2) Different types of knowledge vary in their transferability: explicit knowledge can be articulated and easily communicated between individuals and organizations; tacit knowledge (skills, know-how, and contextual knowledge) is manifest only in its application – transferring it from one individual to another is costly and slow (Kogut and Zander, 1992; Nonaka, 1994).

(3) Knowledge is subject to economies of scale and scope. Since the costs of replicating knowledge tend to be lower than the costs of the original discovery of creation of the knowledge, it is subject to economies of scale. To the extent that knowledge is not specific to the production of a single product, economies of scale imply economies of scope. The extent of economies of scale and scope vary considerably between different types of knowledge. They are especially great for explicit knowledge, information in particular, which is ‘costly to produce, but cheap to reproduce (Shapiro and Varian, 1999, p. 3). Tacit knowledge tends to be costly to replicate, but these costs are lower than those incurred in its original creation (Winter, 1995).

(4) Knowledge is created by individual human beings and to be efficient in knowledge creation and storage, individuals need to specialize (Simon, 1991, p. 127).

(5) Producing a good or service typically requires the application of many types of knowledge (Kogut and Zander, 1992).

If we accept these (relatively uncontroversial) initial premises, we are immediately faced with some intriguing challenges for economic organization. In particular, the fundamental dichotomy between knowledge creation (exploration) and knowledge application (exploitation) becomes clear: knowledge creation requires specialization (points 3 and 4 above), while knowledge application requires diversity of
knowledge (point 5). Given the limited transferability of knowledge (point 2), this presents considerable difficulty for the institutions of production. The solution lies in some process of knowledge integration that permits individuals to apply their specialized knowledge to the production of goods and services, while preserving the efficiencies of specialization in knowledge acquisition (Demsetz, 1991).

If we abstract, for the time being, from knowledge generation and focus upon knowledge application, what factors determine the efficiency with which knowledge assets are transformed into goods and services? If production requires the combination of many different types of specialized knowledge (point 5), each of which is subject to economies of scale and scope (point 3), then efficiency in knowledge application depends upon, first, the ability to integrate many different types of knowledge and, second, the ability to utilize knowledge to its full capacity. Let us explore knowledge integration and knowledge utilization in alternative institutional mechanisms: markets, firms, and alliances.

Alliances and the Efficiency of Knowledge Integration

Efficiency of integration relates to the costs of combining multiple types of knowledge into goods and services. These costs depend critically upon the mode of integration used. As Demsetz observes, it is highly inefficient for individuals to combine their knowledge by each learning what the other knows: ‘Although knowledge can be learned more effectively in specialized fashion, its use to achieve high living standards requires that a specialist somehow uses the knowledge of other specialists. This cannot be done only by learning what others know, for that would undermine gains from specialised learning’ (Demsetz, 1991, p. 172). Efficiency in knowledge integration requires modes of coordination that can avoid the high costs of extensive mutual learning.

The knowledge-based view of the firm views the critical advantage of firms over markets as providing a superior context for supporting knowledge integration mechanisms. Firms are ‘social communities in which individual and social expertise is transformed into economically-useful products and services by the application of a set of higher-order organizing principles’ (Kogut and Zander, 1992, p. 384). Drawing upon two streams of literature, classical organizational theory (e.g. Hall, 1972) and evolutionary economics (e.g. Nelson and Winter, 1982), we identify two primary mechanisms through which knowledge is integrated within the firm: direction and routine.

Direction provides a ‘low-cost method of communicating between specialists and the large number of persons who are either non-specialists or specialists in other fields (Demsetz, 1991, p. 172). Firms convert sophisticated specialized knowledge into directives, rules, and operating procedures that can be imposed through authority-based relationships."
Organizational routines are complex patterns of co-ordination that permit different specialists to integrate their knowledge into the production of goods and services while preserving the efficiencies of knowledge specialization (Nelson and Winter, 1982). Organizational routines require continuity of association and propinquity – conditions most readily provided by firms.

By contrast, market contracts suffer from the familiar sources of transaction cost that afflict exchange transactions in knowledge. Information and other forms of explicit knowledge suffer problems of non-exclusivity of use and the difficulty of concluding contracts without first revealing the knowledge involved (Arrow, 1962).[7] Tacit knowledge is also problematical because, in order to mesh their areas of know-how, transacting parties are likely to require a ‘... common language or ... overlaps in cognitive frameworks ...’ This requires time and effort: investments which are to some extent ... transaction specific ... [hence] yield issues of dependence and lock-in’ (Nooteboom, 1996, p. 331). Within the firm, these problems are ameliorated by a social context characterized by a common identity of organizational members (Kogut and Zander, 1996) and the ability of the firm to appropriate knowledge rents through secrecy (Liebeskind 1996).[8] In addition, markets are less able than firms to support either direction or routine. While routines develop within markets, market-based routines are often less adaptable and less effective in integrating the individuals’ specialist knowledge than those within a single firm.[9]

Alliances can avoid many of the costs associated with knowledge transactions across markets. Alliances limit opportunism by converting single period into multi-period games and fostering investments in trust (Gulati, 1995; Ring and Van de Ven, 1992; Simonin, 1997; Teece, 1992). Yet, inevitably alliances are inferior to firms in terms of their inability to integrate knowledge through ‘higher-order organizing principles’. They typically lack the authority-based relationships needed for rules and directives and, although many alliances are very long lasting, most lack the close, continuous association conducive to developing routines.[10]

Are there circumstances where alliances can be superior to firms in knowledge integration? The key problem for knowledge integration within the firm is that, whether integration is by direction or routine, the efficiency of integration tends to decline as the firm’s knowledge domain expands. As with any complex system, the large-scale knowledge integration required for producing goods and services requires a hierarchy of integration (Simon, 1962). On the basis of intensity of interdependence (Thompson, 1967), knowledge can be combined into specific tasks, which can then be integrated in activity-related and functional capabilities (Grant, 1996). With loose coupling of components and sub-systems, such structures permit adaptability and evolutionary development (Sanchez and Mahoney, 1996; Weick, 1976).

To be efficient as integrating devices, directives and rules must be standardized (March and Simon, 1957; Thompson, 1967). Similarly with organizational rou-
tines: to the extent that they are embedded within organizational values and norms, the common culture of an organization limits the variety of routines that can be efficiently performed. Thus, as the range and diversity of knowledge increases, so integration mechanisms need to be increasingly differentiated, resulting in rising marginal costs of knowledge integration within the firm. In these circumstances, efficiency of integration may be maximized through separate firms integrating knowledge at the component or subsystem level, with overall integration through an alliance between the firms.

To summarize:

*Proposition 1*: (a) In integrating knowledge, interfirm alliances are generally superior to market contracts, but are generally inferior to individual firms. (b) Increasing marginal costs of knowledge integration within the firm imply that, where products require a broad range of different knowledge types, efficiency of integration is maximized through separate firms specializing in different areas of knowledge and linked by strategic alliances.

*Illustration and evidence.* Prior research points to numerous examples of companies turning to strategic alliances when they extend their knowledge domains to areas of know-how that need to be integrated with different rules and routines. The rapid growth in strategic alliances within biotechnology reflects the advantages of alliances between dedicated biotechnology companies and large, integrated pharmaceutical companies as compared to mergers and acquisitions. Any benefits of full merger in terms of closer integration are likely to be offset by the difficulty of reconciling the different routines and operating rules required in the pharmaceutical business from those required for leading-edge biotechnology research (Barley et al., 1992; Powell, 1998). Similarly in semiconductors, although firms are more effective than alliances in sharing and developing knowledge (Almeida et al., 1998), as the range of knowledge required for the design and manufacture of semiconductors continues to expand, so alliances have proliferated, both between semiconductor design companies and between designers and fabricators (Macher, 2001). Even so, for alliances to achieve effective knowledge integration within networks of alliances typically requires one firm to act as overall system integrator (Lorenzoni and Baden-Fuller, 1994). This role requires some duplication of knowledge by the integrating firm. As Prencipe (1997) has shown, the role of aero engine manufacturers as ‘systems integrators’ for many hundreds of suppliers of components and sub-systems requires that they maintain a residual level of R&D in the component technologies that they are responsible for integrating.

Consider too Eastman Kodak’s transition from chemical to digital imaging. During its first 100 years of development, Kodak established a highly integrated corporate structure that was very effective in integrating knowledge of optical,
polymer, silver halide, technologies; consumer and professional markets; large-scale, low-cost manufacturing; and worldwide distribution. However, the digital imaging revolution required Kodak to extend its knowledge base into ‘infoimaging’ – including new technologies ranging from electronic sensing to file compression. Many of the rules and organizational routines that Kodak had developed for managing traditional photography were not well-suited to the faster moving world of digital imaging (Grant and Neupert, 2003). In particular, when CEO George Fisher requested the company to introduce a fully digital camera for the consumer market, he was told that the company’s standardized system of phases and gates would require three years of development. Through an alliance with Apple Computer, the camera – the Apple Quicktake – was developed and brought to market within seven months (Pinto, 2000). Digital imaging’s need for differentiated rules and routines to achieve fast response capability and compressed product development and manufacturing cycles resulted in Kodak’s widespread use of strategic alliances in its digital imaging business.

**Alliances and the Efficiency of Knowledge Utilization**

Given economies of scale and scope in knowledge, utilizing knowledge assets to their full capacity represents a key challenge to the firm. These economies of scale and scope are reinforced by the fact that, unlike most other resources, knowledge expands rather than depreciates when it is used.

Given that market contracts for knowledge are plagued by transaction costs, it is typically assumed that economies of scale and scope in knowledge are best exploited within the firm. However, once we explore the problem faced by the firm in reconciling its product and knowledge boundaries, we can identify circumstances where alliances can offer efficiencies in knowledge utilization beyond those available through full internalization.

Achieving a match between a firm’s knowledge domain and its product domain poses a significant problem for most firms because limits to firm growth within individual markets typically prevent full exploitation of knowledge within a single market. Hence, for a firm to fully exploit its knowledge resources usually means diversifying into additional products. However, if different types of knowledge have different product domains, the problem of fit arises between the firm’s knowledge domain and its product domain.

Conventionally, a firm is described by the products it supplies. The knowledge-based view implies that a firm may also be described by the range of knowledge that it encompasses. The two are closely related, and it is the closeness of this relationship that is a critical determinant of the efficiency of knowledge utilization. If knowledge is not product specific and is subject to economies of scope, excess capacity in knowledge encourages the firm to expand its product scope (Penrose,
1959). Efficient utilization of knowledge is achieved where the knowledge domain of the firm matches exactly the knowledge requirements of the product domain of the firm with no overlap and, thus, no underutilization of knowledge. The problem is that different types of knowledge are applicable to different sets of products. This presents difficult choices for the firm over which types of knowledge to possess and which products to produce.\[11\]

The relationship between a firm’s knowledge domain and its product domain may be shown as an input-output matrix of knowledge and products, where inputs of specialized knowledge form the columns, and outputs of products form the rows. Consider Figure 1 which shows the product and knowledge domains of the ABC Corporation. Figure 1a begins with the products (rows A–H) supplied by ABC Corporation. Figure 1a shows the knowledge inputs (columns 1–18) required to produce these products. Figure 1b then considers ABC Corporation’s knowledge assets (columns 1–10) and identifies the different products (rows A–N) that each type of knowledge could be applied to.

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Figure 1. ABC Corporation’s product and knowledge domains. (a) ABC’s product outputs and their knowledge requirements. (b) ABC’s knowledge resources and their potential product applications.
From the point of view of efficient knowledge utilization, the boundaries of ABC Corporation are determined by a combination of knowledge types and products that permits ABC's knowledge resources to be utilized to the fullest extent possible. But, if different products have different knowledge requirements, there will always be a problem of under-utilized knowledge resources. Thus, in relation to product A, ABC Corporation could supply internally all the knowledge required for its production. In the case of knowledge types 1–3 and 7 and 8, the ability to apply these to products B–H as well, means that these types of knowledge can be utilized fully. But what about knowledge types 11–17 that are also required to produce product A? Because these knowledge types can be used in only two or three of the other products that ABC supplies, the risk is that these knowledge resources will be under-utilized if ABC owns them.

Similar issues arise when we look at the core knowledge resources that ABC uses to supply products A–H. Knowledge types 1–10 could also be used in one of more additional products (I–N). These products I–N could be produced by ABC; however, if this was so, ABC would also need access to the additional types of knowledge required by these products that lie beyond the columns of our table. Hence, if ABC expands to include products I–N, this will only exacerbate the problem of under-utilized knowledge resources.

Strategic alliances can help overcome the problems of under-utilized knowledge arising from incongruent product and knowledge domains. If ABC can source knowledge types 11–16 from other companies, it can avoid the excess capacity problems of providing these knowledge inputs internally. If ABC can offer knowledge types 1–10 through strategic alliances with other firms that specialize in supplying products I–N, it can improve the utilization of knowledge types 1–10.[12]

If we overlay Figures 1a and 1b, the basic patterns of knowledge-product relationships become clear. Figure 2 identifies four quadrants. Quadrant 1 shows internalization: internal knowledge is used to produce goods and services within the firm. Quadrant 2 shows knowledge imports: products supplied by the firm using knowledge from outside the firm. Quadrant 3 shows opportunities for knowledge exports: knowledge within the firm, which has the potential for application to products supplied by other firms. Quadrant 4 is an empty zone: there is no involvement by ABC.

The greater is the mismatch between the firm’s product domain and its knowledge domain, then the greater are the advantages offered by collaborative arrangements with other firms in order to (a) access and integrate knowledge that can be more efficiently provided by other firms (quadrant 2 of Figure 2), and (b) more fully utilize the firm’s own knowledge (quadrant 3 of Figure 2). The extent of the mismatch is indicated by the area of quadrants 2 and 3 relative to quadrant 1. This will be a positive function of the number of different types of knowledge required by the firm’s products (breadth of knowledge) and the extent of economies of scope in that knowledge, which depends upon its lack of product specificity.[13]

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To summarize our central prediction:

*Proposition 2*: The greater the incongruity between the product domain of the firm and its knowledge domain, the greater its propensity to form alliances with other firms. The incongruity between product and knowledge domains is a positive function of the breadth of knowledge required by the firm’s products and the extent of economies of scope in that knowledge.

*Illustration and evidence.* Returning to our example of Eastman Kodak’s adaptation to the digital imaging, the key impact of the digitization of imaging was to upset the close congruity between Kodak’s product and knowledge domains. Digital imaging was based upon a number of areas of electronic knowledge, most of which – including electronic sensing, image storage, file compression, internet-protocol file transmission, and ink-jet and laser colour printing – have wide domains of application and are subject to substantial economies of scope. Since internalizing these areas of knowledge would inevitably result in substantial underutilization, Kodak relied primarily upon strategic alliances to access these areas of knowledge. Alliance partners included:

- Intel for data storage expertise first used in Picture CD and other image storage devices and later applied to on-line image management systems.
- Microsoft for the document and image management know-how used in Kodak’s work management software.
- Hewlett-Packard for thermal inkjet technologies required for Kodak’s digital photofinishing printers.
• Lockheed Martin for know-how in integrating massive information systems in order to develop large scale document management systems required for censuses, tax returns, and the like.
• Motorola for the semiconductor manufacturing expertise required for producing Kodak’s range of CMOS image sensors.

At the same time, Kodak resorted to alliances in order to increase the utilization of its internal knowledge resources. For example:

• Kodak’s knowledge of optics and lens design was shared through alliances with the manufacturers of telescopes and for the high resolution cameras required for satellite imaging systems.
• Kodak supplied digital scanning and colour management software technology to Heidelberg Druckmaschinen AG for its range of digital colour printing presses.
• Kodak’s data compression, image storage, and colour management technologies were deployed in alliances with Hewlett-Packard, Lexmark, Canon, and Heidelberg.
• Kodak’s long-established proprietary knowledge of CCD and CMOS image sensors (its first patents on single sensor colour imagers were granted in 1976) was supplied to a number of manufacturers of cameras and other forms of digital imaging equipment.

The incidence of strategic alliances both cross-sectionally and longitudinally is consistent with Proposition 2. Evidence from both the MERIT-CATI database (Hagendoorn, 2001; Hagendoorn et al., 2000) and SDC’s Joint Venture and Strategic Alliances Database (Schilling and Steensma, 2001) shows strategic alliances to be concentrated in relatively few sectors – notably computers and office equipments, communications equipment, consumer electronics, medicines and pharmaceuticals, and motor vehicles. These are sectors where knowledge requirements tend to be broad, and where much of the knowledge tends not to be product specific, hence giving rise to economies of scope. By contrast, sectors with comparatively few alliances include wood and wood products, steel and non-ferrous metals, yarn and textiles, metal fasteners, and small tools. In these sectors knowledge requirements are narrower and the knowledge deployed tends to be comparatively product specific.

Over time (certainly since the early 1980s), the number of alliances has increased greatly in Europe and North America. This growth coincides with a broadening of the range of knowledge requirements for most goods and services, and increasing importance of knowledge that is not specific to particular products and sectors – e.g. digital technologies and management sciences.
ALLIANCES AND DYNAMIC EFFICIENCY IN KNOWLEDGE APPLICATION

Uncertainty in Knowledge-Product Linkages

In reality, input-output relationships between knowledge and products are not static but dynamic: knowledge is continually being created, refined, discarded, and reconfigured into new products. If the firm is uncertain as to the future knowledge requirements of its current products, and if acquiring and integrating new knowledge takes time, its knowledge investments are risky. In these circumstances, interfirm alliances offer two additional benefits to those outlined above. The first is pure risk spreading. The second is the option value of small initial investments in new areas of knowledge (Kogut, 1988; Sanchez, 1993). Investments in new products and technologies can be segmented in time; the condition is that to invest in any particular phase requires that the firm invests in the prior phases. In the face of uncertainty, investments in early phases of a project derive the major part of their value from the fact that they create the options to invest in the next and subsequent phases (Dixit and Pindyck, 1994).[^14]

To summarize:

*Proposition 3:* The greater the uncertainty as to the future knowledge requirements of a firm’s product range, the greater its propensity to engage in interfirm collaborations as a means of accessing and integrating additional knowledge.

Illustration and evidence. The risk spreading and option creating benefits of alliances are evident from the widespread propensity of firms to form alliances when faced with technological uncertainty. In 1988, faced with uncertainty over the future of microcomputer operating systems, Microsoft was investing not only in its proprietary MS-DOS and Windows systems but, through alliances, was developing OS/2 for IBM, writing Mac applications for Apple Computer, and collaborating in the launch of a PC version of UNIX (Beinhocker, 2000).

Similarly with Kodak’s development of digital imaging, when faced with technological uncertainty Kodak used alliances to take positions in rival technologies. For example, in sensors, Kodak, long a leader in CCD sensors, allied with Motorola in order to develop a range of CMOS sensors. Similarly, in managing the transition from photochemical to digital imaging, uncertainty over the evolutionary path has encouraged Kodak to use alliances to invest in alternative technologies and designs in different stages of its ‘digital infrastructure’. At the photofinishing stage of the value chain, Kodak has partnered with Hewlett Packard (Phogenix joint venture), Noritsu, Gretag, and Photome (System 88) to supply competing digital minilab systems. In using the internet for digital image...
transmission, Kodak’s initial Picture Network was soon supplemented by alliances with AOL (You’ve Got Pictures image delivery service), PictureVision (PhotoNet), Fotowire.com (to link consumers to link with Kodak’s retail photolabs), and AT&T (to develop broadband and internet protocol applications) (Eastman Kodak, 2001).

Early-Mover Advantage in New Products

In appropriating the returns to knowledge, we have noted that, in general, alliances are superior to market contracts but inferior to internalization within the firm. However, where knowledge is advancing rapidly, appropriating its returns often depends upon achieving early-mover advantage. Such advantage derives less from the generation of new knowledge, as from recombining knowledge into innovative products (Fleming, 2001; Galunic and Rodan, 1998). If early-mover advantage rests upon the ability to quickly identify, access, and integrate across new knowledge combinations, strategic alliances can greatly increase the speed with which a company can access the new combinations of knowledge needed to bring new products to market. Hence:

*Proposition 4*: The greater the benefits of early-mover advantage in technologically-dynamic environments, the greater the propensity for firms to establish interfirm collaborative arrangements in order to access new knowledge.

Illustration and evidence. Finally, Kodak has been explicit in recognizing the value of alliances in speeding its development and introduction of new digital imaging products. Fisher’s digital imaging strategy for the consumer market was built upon a flow of new digital and hybrid products that linked its well-established chemical imaging knowledge to the electronic hardware and imaging software expertise possessed by existing IT companies. In establishing leadership in digital image storage products, Kodak has increased speed to market through alliances with Intel and Seagate, while relying upon a joint venture with Matsushita to provide rapid access to the manufacturing capacity needed for speedy market penetration. In seeking to gain early mover advantage in the market for sensors, Kodak has moved quickly from prototype to mass manufacture using the manufacturing capabilities of Motorola and Texas Instruments. Similarly with internet-based transmission of digital images, Kodak alliances with AOL, Cisco, Yahoo! and AT&T enabled Kodak to build a market presence faster than would be possible than by internal development.

Note that Propositions 3 and 4 are complementary; if there were no early-mover advantages in a market, then the option value of investments in knowledge-accessing alliances would be small. Without early mover advantage, a firm faced with technological uncertainties could simply wait to see how technology unfolds.
DISCUSSION AND CONCLUSION

The ability of the knowledge-based view of the firm to provide insight into the nature, formation and on-going management of interfirm alliances has been limited by two factors. First, lack of clear specification of the role of knowledge in alliance formation. Second, the widespread presumption that the purpose of alliances is organizational learning. This study addresses both these issues. Starting from basic principles concerning knowledge and its use in production, we have presented a knowledge-based analysis of interfirm alliances that distinguishes between the knowledge generation (exploration) and knowledge application (exploitation) goals of alliances. This distinction corresponds to the difference between ‘knowledge acquisition’ and ‘knowledge accessing’ observed in previous studies of alliances. On the basis that knowledge accessing takes precedence over knowledge acquisition in most strategic alliances, the paper establishes the circumstances in which strategic alliances are more efficient than internalization within a single firm in integrating and utilizing knowledge. Although firms are generally superior to both alliances and markets in integrating knowledge to produce goods and services, alliances can overcome the limits of firms in encompassing highly differentiated knowledge integration processes, while offering efficiencies in knowledge utilization. The advantages of alliances are especially apparent under conditions of uncertainty and early mover advantages.

The goal of our study has been the development of better theory concerning the role of alliances in the knowledge-based economy and the circumstances conducive to their formation. In several places in the paper we have shown where our propositions yield predictions that are consistent with observations of recent alliance activity, but we offer little in the way of new or systematic empirical evidence. Nevertheless, we contend that the illustrative examples that we offer – for example, of Eastman Kodak, Microsoft, biotechnology, and semiconductors – together with more general observations of trends in alliance formation over time and across industry sectors, points to the plausibility of our propositions. Clearly there is a need for systematic empirical testing directed towards discriminating between alternative theories of alliances. To this end, the knowledge accessing theory we have developed offers predictions that can be compared with those of the knowledge acquisition approach. Table I summarizes these.

The predictions of the two approaches contrast sharply with regard to the evolution of firm boundaries. The alliances-as-learning thesis predicts that the knowledge bases of alliance partners will tend to converge as each partner learns from the other. The alliances-as-knowledge-accessing thesis predicts that alliance partners will maintain, and possibly increase their knowledge specialization. The approach taken by Mowery et al. (1996, 1997, 2001) in analysing convergence and divergence of alliance partners’ knowledge bases has made progress in unravelling these two processes.
In terms of alliance longevity and stability, the alliances-as-learning thesis predicts that alliances will have finite lives, their very success in learning causing their demise, and will be unstable as a result of competition for learning. The alliances-as-knowledge-accessing thesis predicts that alliances will tend to be longer-term and, other things remaining equal, their stability will increase rather than decline with time.

The approaches also have differing predictions about a firm’s potential for managing multiple alliances. If alliances are about acquiring knowledge, then each firm’s number of alliances will be limited by its absorptive capacity. Conversely, knowledge accessing alliances would permit a firm to engage in extensive networks of alliances.

In terms of the external factors conducive to alliances, the greater is the rate of change of knowledge and uncertainty over future changes, then the greater the risk spreading and option values of alliances under the knowledge accessing approach. However, there is no reason to suppose that the value of learning increases under such circumstances; indeed, uncertainty might discourage investments in learning.

On the empirical front, our theory appears to have the potential to explain a number of observed phenomena including the trend towards increasing numbers of alliances, and variations across industries and firms in the frequency of

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Table I. Contrasting the predictions of knowledge-accessing and knowledge acquisition theories of interfirm alliances
alliances. There is a particular need for empirical tests capable of discriminating more precisely between the proposed knowledge-accessing view of alliances and the alternative organizational learning view.

Clearly there is a need for further theoretical development. The dichotomy between knowledge accessing and knowledge acquisition in strategic alliances is not clear-cut and requires further clarification. To integrate separate areas of specialist knowledge, there needs to be some intersection of the separate knowledge sets in the form of ‘common knowledge’ (Grant, 1996, pp. 115–16). In addition, this integration may require a distinct level of ‘architectural knowledge’ (Henderson and Clark, 1990). Prencipe and Brusconi’s research into aero engines and other complex production systems identifies the critical importance of overlaps between partners’ knowledge bases, particularly where the firm acts as overall knowledge integrator (Brusoni and Prencipe, 2001; Brusoni et al., 2001; Prencipe, 1997). This need of knowledge duplication between alliance partners means that a key issue for the efficiency of alliances relative to individual firms is the amount of common knowledge required for effective knowledge integration.

This role of common knowledge is one among a broader set of issues concerning knowledge integration in the development and production of goods and services. It is clear that a knowledge-based approach to economic organization can enrich and extend transaction cost explanations of optimal modes of organization. The knowledge-based approach also links with other research streams in the alliance literature: the emphasis on co-ordination links with social network theory (e.g. Axelrod, 1984; Gulati, 1995; Hakansson and Johansson, 1992), and the knowledge-accessing role of alliances ties in with resource-dependence theory (e.g. Barley et al., 1992; Van de Ven, 1976). At the same time there is considerable scope for refining and extending our bare bones analysis. If knowledge is the most important resource of firms and if the primary task of production is to integrate a broad range of knowledge, we need to understand better the organizational processes to achieve this. Such extensions are important if we are to develop normative recommendations for the selection, design and on-going management of strategic alliances from our positive analysis.

NOTES

[1] Oxley (1997) presents a sequence of alliance types arranged from the least hierarchical (unilateral contractual agreements) to the most hierarchical (equity-based alliances).
[2] Evidence on the growth of alliances over time and their sectoral distribution is available in the Cooperative Agreements and Technology Indicators (CATT) database (Hagedoorn et al., 2000), the National Science Foundation’s CORE database (Link, 1996) and Securities Data Company’s Joint Venture and Strategic Alliances Database.
[3] Other studies, notably Khanna et al. (1998) and Das and Teng (2000) point to the coexistence of both cooperative (i.e. mutual knowledge accessing) and competitive (i.e. learning races) among alliance partners.
[4] General Motor’s NUMMI venture with Toyota has been viewed as GM’s attempt to acquire Toyota’s operational management skills (Kale et al., 2000, p. 219).
The evidence is fragmented yet overwhelming. For a knowledge-based company such as Cisco Systems, tangible assets account for less than 4 per cent of the company’s market value. Skandia, the Swedish insurance company, estimates that despite its huge financial assets, these are greatly outweighed by ‘knowledge capital’ (Edvinsson and Malone, 1997). In terms of employee remuneration, the fivefold difference in average earnings between unskilled workers and higher degree holders within the USA is indicative that knowledge is the primary determinant of income from employment.

Connor and Prahalad (1996) use the term ‘knowledge substitution’ to describe the process of direction of an employee by a superior in the hierarchy. In practice, such direction is not simply a case of substituting the superior’s knowledge for that of the subordinate. The essence of direction is that it permits different individuals’ specialist knowledge to be integrated. Thus, the computer technician can give directions to the CEO as to what to do when a virus infects his computer hard disk.

Patent and copyright law does establish property rights in some forms of knowledge, but typically only a small fraction of the knowledge used by firms is protected.

A further advantage of firms is in overcoming the problems of metering and shirking which team-based cooperation gives rise to (Alchian and Demsetz, 1972).

Lloyd’s of London, the international insurance market, has well-established routines, many of which can be traced back to Lloyds origins as a seventeenth-century coffee house. Lloyds’ problems of the late 1980s and early 1990s can be attributed, in part, to failure of these routines to adapt and to the inefficiency of these routines in integrating information and know-how.

The presence of common production processes and dominant designs within a sector can assist the establishment of organizational routines within between cooperating firms. More generally, the presence of an ‘institutional field within which members are located’ will assist the ‘social processes that constitute collaboration’ (Phillips et al., 2000).

The problem is well known in the technology management field; both Boeing and Xerox have examined the problem of defining optimal technology portfolios in the face of complementary, overlapping development projects (Dickinson et al., 2001; Loutfy and Belkhir, 2001).

This analysis does not take account of Henderson and Clark’s (1990) distinction between component knowledge and architectural knowledge. Busoni and Prencipe (2001) show that, once firms collaborate with one another in loosely-coupled networks, then the firm that acts as the ‘systems integrator’ within the network must maintain the architectural knowledge needed for overall product integration and design.

This framework showing internal and external exploitation of knowledge bears some similarities to that developed by Teece (1986) which identifies the conditions under which new technologies are best exploited internally or through contract. However, any similarities are only superficial. The Teece framework explores conditions for appropriating the returns to innovations where the central issue is the extent to which the innovation is protected by intellectual property rights.

It is worth noting that the option value of strategic alliances is greater within our knowledge-accessing model than in the alternative knowledge acquisition model, because the cost of taking and exercising the option is much higher if the purpose of the alliance is learning as opposed to knowledge accessing.

A key exception to this generalization is where knowledge is protected by intellectual property rights; in such cases, market contacts (i.e. licensing) can be effective in appropriating the returns to knowledge (Teece, 1986).

REFERENCES


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