Department of Agricultural, Environmental, and Development Economics
The Ohio State University
Working Paper: AEDE-WP-0031-03

Challenges to Future Agrifood Corporate Strategy: Knowledge Management, Learning, and Real Options

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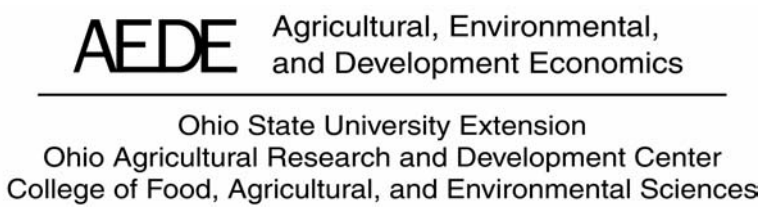
May 2003

Abstract: A future challenge for agrifood firms is to embrace strategy that includes, at least conceptually, knowledge as a strategic asset of a firm. The analysis examines a *learning* supply chain and the relationships between network embeddedness and the strategic mix between exploitation and exploration. Also real options logic as a potential source of new thinking about corporate strategy formulation is examined.

Keywords: Knowledge management, embeddedness, learning, real options, food supply chain



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Introduction

The nature of dramatic and continuing agrifood system transformation is broadly recognized by the managerial and the academic communities focused on the production, processing, and distribution of goods and services with an agricultural and natural resource base. The litany that describes this transformation is well known: globalization of markets on both the supply and demand dimensions, consolidation at each level of the supply chain, and all manner of tighter linkages between and among firms both vertically and horizontally. At the heart of this transformation lies a number of driving forces: (1) final consumer demands for a vast array of product attributes that include convenience, safety, health and ethical considerations, (2) the technological innovations that have and will enable vast improvements in productive efficiency, traceability and interfirm coordination, and (3) the increasing role of intangible assets and complex managerial competencies that are the real source for the creation of customer value and competitive advantage.

Apropos to this third driver is the dramatic decline in tangible assets as a proportion of total corporate assets, Figure 1. Intangible assets of firms have grown in importance to the point where they now account for nearly half of all assets. The dynamics of rivalry are increasingly based on soft assets as opposed to hard. Knowledge, intellectual capital, relationships, and the ability to manage these in real time and with true responsiveness are key to success in this new rivalry. This softer foundation to competitive advantage challenges more conventional notions of firm strategy and managerial skill. Causal ambiguity within the interplay of human and technical resources within the firm, the

seemingly shrill demands of customers for tailored value, the need to develop and protect intellectual property, and concurrently the need to share information with a ever-widening array of supply chain and network partners makes the managerial task daunting.

Fortunately, these dynamics coincide with developments in the field of knowledge management. This field has a growing and well-received body of knowledge within the business management literature. The goal here is to apply the concepts and logic from this field to create insights into corporate strategy and management for the global agrifood system. As a beginning, this effort raises issues of knowledge management's potential as a guide to academic research and to business practice.

The material that follows is organized to introduce the concepts of knowledge management, expand the concepts to encompass novel classifications of the agrifood supply chain by *learning* potential, and then explore the relationship of knowledge management and intangibles to the issues of the appropriate mix between corporate strategies of exploitation and exploration, and finally the potential of real options to enhance the understanding of managerial flexibility within the context of all these concepts. The underlying assumption is that knowledge management has a rich applicability to explain and to guide the emergence of improved strategies for confronting agrifood system transformation, improve our understanding of the economic drivers within the global food system, and to create future transformations of benefit to supply chain participants and the consumer.

The Emergence of Knowledge Management

The Definition of Knowledge Management

There is an emerging appreciation among analysts that managers of almost all organizations have some responsibility that could be loosely regarded as the management of knowledge (Seemann, et al, 2000). In fact, the field of inquiry that advances an integrated approach to identifying, creating, managing, sharing, and exploiting all of the information and knowledge assets of an organization is known as knowledge management (KM). Fundamental aspects of KM include skill acquisition, learning, and the accumulation of capability over time within an organization (Teece, 2000).

One contemporary model of organizational knowledge management is as a process of knowledge creation where organizational performance outcomes result from that knowledge, Figure 2 (Soo, et al, 2001). Sources of information include acquiring information from external and internal sources through the organization's networks and the organization's employees' networks. The Soo et al view is based on the notion that networking improves the flow of information. The capacity of an individual or organization may differ in ability to recognize, assimilate, and incorporate information (Cohen and Levinthal, 1990). This concept is known as *absorptive capacity* and partially determines the use of knowledge and its quality and understanding by managers. The KM model incorporates the notion that absorptive capacity of an organization or an individual actually increases as more new knowledge is created. An important link within the model is that knowledge creation will increase as innovation

increases. Innovation and improved financial performance of the organization result from knowledge creation within the organization.

The knowledge within an organization is composed of both intellectual capital stocks and organizational learning flows. Thus, some intellectual capital is cumulative over time. To illustrate, brands may be a portion of the intangible assets and therefore the intellectual capital of a firm. The value of brand equity at any point in time is cumulative and indeed may appreciate or depreciate in value over time.

KM offers a unique perspective of the firm and the development of KM as a field of specialization dates back only to the early 1990s. The emergence was propelled by the work of Nonaka and Takeuchi. They define a firm as a collection of resources and capabilities (Reinhardt, 2000). Analysts have highlighted knowledge management as a part of the resource-based theory of the firm (Conner and Prahalad, 2002). KM highlights knowledge as a distinct factor of production and asset potentially unique to the firm (Grant, 2002, p. 133; von Krogh and Grand, 2002).

Defining a Learning Organization

Seeman et al define *learning* as "the process by which knowledge assets are increased over time." (p. 91). Learning is thus the key to the creation, maintenance and expansion of knowledge for the firm. A *learning organization* is one that develops knowledge management systems that allow it to continuously adapt to its environment based on learning (Senge). A learning organization explicitly manages the building of intellectual capital that supports its business

strategy (Seeman et al.). The benefits of a learning organization arguably are an enhanced and more sustainable competitive advantage (Skyrme; Lee and Yang; Dyer and Nobeoka). When an organization consciously uses learning to grow and apply its knowledge and intellectual capital, it can sense and respond to internal challenges and external market opportunities based on speed, efficiency, and effectiveness. Learning organizations are truly *responsive* to their economic environment.

Learning arises from the creation and sharing of both tacit and explicit knowledge. *Tacit knowledge* is embedded in people, their know-how, skills, practice, and experience while *explicit knowledge* is formally held in the form of policies, procedures, systems, and historical/financial records (Lee and Yang; Takeuchi and Nonaka). Explicit knowledge is relatively easily shared within an organization precisely because it is explicit.[1] In contrast, tacit knowledge is based on its embeddedness in individuals and teams within the firm and it is far more difficult to capture, store and transfer. Creating and deploying tacit knowledge on behalf of corporate strategy is challenging. However, tacit knowledge may well be the more valuable form of knowledge because it is (1) unique to an organization and thus a potential source of competitive advantage, and (2) difficult for competitors to copy due to barriers arising from a competitor's inability to know that such knowledge exists and to the presence of casual ambiguity that may lead to the internal holder of such knowledge being less than fully aware of its value.

[1] That is, explicit knowledge is captured in a formal, documented way. An additional implication of this formal capture is that information technology (IT) handles explicit knowledge quite well, such as knowledge contained in a Management Information System (de Vries and Brijder).

Tacit knowledge is not handled well by IT (de Vries and Brijder). Socialization and social capital are the critical processes by which tacit knowledge is captured, shared, and applied. Because of tacit knowledge residing in a firm's human resources, people must be able and motivated to share the tacit knowledge (Ives, Torrey, and Gordon). The presence of an effective IT system for explicit knowledge thus provides no guarantee that tacit knowledge is useable by the organization. Therefore, a learning organization must have the technology and processes, both electronic and human, to convert tacit knowledge into explicit knowledge and vice versa (Takeuchi and Nonaka). Learning and knowledge cannot be fully captured, stored, and utilized without the ability to convert the forms of knowledge.

Aspects of Intellectual Capital

There is general recognition that the intellectual capital of an organization has three components: structural capital, social capital, and human capital (Seemann, et al 2002). Contemporary thought clearly defines intellectual capital broadly with the characteristic that both structural capital and human capital are principally internal to the firm whereas social capital adds an external aspect to the total intellectual capital of an organization. This is an important distinction for managers to recognize in the sense of their own managerial flexibility.

Structural capital is composed of the usual tangible assets such as plant and equipment and intangibles, such as patents, trademarks, and brand names.

Intangibles can include process and product technology or know-how, licenses, trade secrets, or other agreements that have commercial value.

One characteristic difference among these capital types is ownership. Structural capital, e.g. brick and mortar, is the sole capital type owned exclusively by the firm. Employees of the firm earn income from renting their capacity to the firm, but the employee owns the intellectual capital, not the firm.

Social capital ownership is distinct from either structural capital or human capital. The connections and contacts among individuals is the core of social capital, and no one individual has undivided right over social capital. All individuals collectively share the authority and control of social capital. Although social capital is not precisely defined, it is intuitively composed of relationships by individuals within the firm and the relationships of the firm itself as a valuable resource. Measurement of social capital is difficult (Bontis, 1998). A summary statement defining the essence of social capital is the *capacity to collaborate* (Maury, Maybury, and Thuraisingham, 2000).

KM views the firm as a social community or knowledge system capable of generating information. The firm as a unique repository of capacity for creating value from new intellectual capital is indicated by a recent analysis by Sporleder and Moss (p. 1347):

> As such, firms have unique advantages over other forms of institutional arrangement in their capability for creating value through new intellectual capital (Nahapiet and Ghoshal, 1998). Nahapiet and Ghoshal further suggest that social capital facilitates the creation of intellectual capital in that social capital influences the conditions necessary for the combination and exchange of existing explicit or tacit

knowledge resources. The creation process has a structural dimension (e.g., network ties which provide access to resources, and "who you know" influences what you know), a cognitive dimension (e.g., shared language, metaphors and paradigms), and a relational dimension (e.g., trust, social norms, and group identification).

Learning Supply Chains

Definition of a Learning Supply Chain

KM has mostly been explored as a firm-level concept. Now consider its application to an integrated supply chain. Several authors (Peterson; Mason-Jones and Towill; Dyer and Nobeoka; de Vries and Brijder) have suggested that a new rung in the evolutionary ladder of supply chains emerges from this application of KM. A *learning supply chain* is an integrated supply chain that has a dynamic, agile ability to learn from and respond to changing market environments because knowledge and intellectual capital are held and applied collectively by the supply chain. The added benefits of a learning supply chain over a basic integrated supply chain arise from even tighter coordination among member firms based on shared KM that focuses on marketplace responsiveness and not merely supply chain transactional efficiency.

True market responsiveness is often argued to be the benefit of any integrated supply chain (National Research Council). The hypothesis here is that only a learning supply chain can achieve true dynamic responsiveness. As defined, a learning supply chain is differentiated by its competency in knowledge management and learning. Put a different way, " . . . both the capacity and the

incentives for knowledge management must be present if a learning supply chain and not just an integrated supply chain is to exist" (Peterson, p. 1332).

In terms of capacity, explicit management procedures and systems must exist among the members of the chain for bilateral and multilateral knowledge sharing (Dyer and Nobeoka). These procedures and systems would provide the complete functions of KM facilitated by both IT and human processes. The supply chain would also need to achieve efficient, timely, and value-enhancing knowledge transfers among an extended group of individuals from the various firms in the chain (Dyer and Nobeoka). Both explicit and tacit knowledge would need to flow freely and effectively across the chain.

Beyond these capacity issues, the supply chain would need an incentive structure to assure that joint knowledge management occurs. In this regard, Dyer and Nobeoka note two dilemmas any supply chain faces in effective knowledge sharing: (1) how to get supply chain members motivated to share valuable knowledge when the natural tendency of firms is to keep valuable knowledge proprietary and not share it for the collective good of the chain, and (2) how to overcome the reality that the supply chain is a coalition subject to all of the classic collective action problems of a coalition. Both of these dilemmas can be managed if and only if an appropriate incentive structure assures a fair distribution of returns from KM for each member of the chain[2].

[2] A more complete treatment of the prerequisite conditions for a learning supply chain is available in Peterson.

Classifying Supply Chain Models by Their Learning Potential

Many integrated supply chains cannot assure both capacity and proper incentives for KM. Consider three supply chain models adapted from Rice and Hoppe: (1) the chain master, (2) the chain web, and (3) the chain organism.

The *chain master* model is a supply chain in which one dominant firm, the chain master (or channel captain) specifies the terms of trade across the entire supply chain, and the supply chain's performance is driven primarily by the coordinating skill of this firm. Examples of this model include most existing automotive supply chains (a key exception is noted shortly) and the "integrators" found in many agrifood chains (e.g., Tyson, Purdue, and Smithfield). As a model of an integrated supply chain, the chain master has been effective at coordinating behavior largely based on specification contracts that keep supporting suppliers focused on a limited number of product attributes. IT capacity to move explicit knowledge seems to be a frequent strength of such chains in practice.

As a learning supply chain, the chain master model suffers incentive problems inconsistent with KM. Consider tournament contracts in integrated pork or poultry chains as an example. These contracts tend to pit producers against one another to the benefit of the integrator. Incentives are thus high to keep knowledge proprietary to the producer rather than share it for the benefit of the chain. Such proprietary knowledge is one of the few protections that the less dominant firms in the chain would have against the behavior of the chain master. One would predict that a supply chain with a chain master would only be as responsive and dynamic as the chain master. The chain would be unable to tap its full innovation potential based on learning from all members.

The second model of the integrated supply chain, the *chain web*, is quite literally a web of interfirm relationships continually changing shape, dimension, and membership. Individual firms in the web may be members of multiple supply chains and compete with others outside their respective supply chains based on their own supply network capabilities (Rice and Hoppe). Such firms will connect and disconnect from these chains based on pursuing their own best interests. A broad range of relationships, including joint ventures, joint marketing arrangement, and collaborative initiatives in systems and processes, create a coordinated system even if the coordination seems chaotic from afar. All firms retain their individual strategies in pursuit of optimal web memberships. The computer industry (Rice and Hoppe), as well as smaller food firms, appears to fit this supply chain model. As an integrated chain, the chain web assures responsiveness to particular end-user needs through the ability to make and remake the web while each firm pursues its own competitive advantage. As a learning supply chain, the chain web (like the chain master) fails in regard to incentives. The continual making and remaking of the web minimizes the incentive for KM because there is substantial potential for knowledge loss to others who may be opportunistic, either now or when the next shift in the web occurs.

The third integrated supply chain model, the *chain organism*, is a chain that competes as one entity, one dynamic organism. As a distinguishing feature from the chain master model, there is no firm that dominates the chain. Each firm shares in the decision-making, and all firms find themselves inherently interdependent. They act in a truly collective manner. Such a model matches

the prerequisites of a learning supply chain by definition and thus suggests that the dilemmas of incentives and group action have been resolved. The question is how.

Consider the case of Toyota, as extensively documented in Dyer and Nobeoka. They describe Toyota and its system of suppliers as a high-performance knowledge-sharing network, or conceptually a learning supply chain. Dyer and Nobeoka carefully construct an argument that the Toyota chain is not a chain master model but rather a chain organism. When Toyota's various coordination mechanisms are examined, they represent the epitome of a KM system. A network is created including:

- a supplier association
- Toyota's operations management consulting division
- voluntary small learning teams, and
- interfirm employee transfers.

This network creates and promotes knowledge sharing, both explicit and tacit, in multilateral and bilateral settings. Although IT systems are strong, Dyer and Nobeoka emphasize the human-centric processes as the fundamental drivers of the system's performance. These processes are consistent with the KM principles cited earlier.

The Toyota system has also solved the incentive dilemmas. Dyer and Nobeoka articulate two norms that play a key role in the system: (1) intellectual property rights reside at the network level rather than at the firm level, and (2) the creator of new knowledge is allowed to appropriate all of its benefits in the short run. The sanction for violating the first norm is loss of membership in the system.

The limit to the second norm is that over time the benefits must ultimately be shared with the whole network. Dyer and Nobeoka cite one particularly relevant example of this second norm. When Toyota's consulting team shares valuable knowledge that results in a supplier creating new knowledge that reduces manufacturing costs, the supplier is allowed to keep the full benefit of the cost reduction for some time before Toyota begins sharing it in the form of lower prices for components. Dyer and Nobeoka note, in contrast, that GM suppliers are reluctant to accept assistance or engage in knowledge sharing because GM pursues an alternative norm by which GM immediately demands all the benefits in the form of price reductions when their consultants inspect and make recommendations in a supplier's plant.

The Toyota system is offered as a joint example of a chain organism and a learning supply chain. The two models are inherently one. Toyota is obviously not an agrifood example, while earlier the point was made the many agrifood chains fall into the chain master category. In and of itself, this is neither good nor bad strategically. However, if a given agrifood supply chain needs to be truly responsive to perform well, then the chain master model will likely not result in a learning and dynamically responsive supply chain over time.

Application to the Agrifood System

Typical agrifood examples do suggest obstacles to the formation of learning supply chains. Consider two additional examples. King documents and analyzes the LoSatSoy™ oil supply chain which, at the time, included Iowa State University, Pioneer Hi-Bred International, Optimum Quality Grains (OQG),

Protein Technologies International (PTI), elevators, and producers. This supply chain results in high performance ($2.21 per bushel of added value). The holding of the intellectual property rights results in DuPont playing the role of chain master, rather than exhibiting processes and procedures consistent with a learning supply chain. The high performance suggests that a learning supply chain may not add value in this instance. In a broader sense, many agrifood chains have dominant actors who control either critical production technology (e.g., the life science firms) or critical end-consumer marketing knowledge (e.g., grocery retailers). The supply chain does not collectively own proprietary knowledge and complete knowledge sharing is not a goal.

Consider a second case, the Efficient Consumer Response (ECR) initiative. ECR was at its heart a knowledge management program built on KM systems throughout the chain. Recently, ECR has been criticized as delivering performance that has fallen far short of its promised potential. Grocery inventory levels are even higher today than when ECR began, and non-ECR adopters have seen as much performance success as adopters (Frankel, Goldsby, and Whipple). Frankel, Goldsby, and Whipple found that when performance success did occur this success arose from five factors: (1) a willingness among supply chain members to innovate and change, (2) an ability among collaborative firms to understand the partner's business, (3) the existence of common goals and objectives, (4) the use of appropriate measures and incentives for supply chain performance, and (5) the presence of effective techniques for information sharing. In other words, success did follow from the application of KM. If ECR

failed in a broader sense, this failure may be evidence that conditions supportive of a learning supply chain may not exist in the current agrifood system.

Many other cases need to be explored before final conclusions can be drawn about the relevance of the learning supply chain model to agrifood markets. Several pieces of anecdotal evidence about Frito-Lay's supply system may make it a candidate for examination in a manner similar to the Dyer and Nobeoka study of Toyota[3]. Other likely cases may also exist. This analysis may prompt more efforts to find and document these cases. In any event, this analysis has attempted to show that the full set of benefits often ascribed to any integrated supply chain will not be realized in many instances. Any benefits arising from knowledge sharing, e.g., faster response to changing markets, shorter product realization cycles and lower product development costs, would appear to demand a learning supply chain rather than a chain master or a chain web.

Links between KM, Embeddedness and Corporate Strategy

The Toyota KM system is built upon a rich, dense network structure. This case suggests that effective networking strategy is likely critical to making KM work in a supply chain setting. Thus the literature on networking becomes yet another piece to the analysis and application of KM. The analysis investigates

[3] Even though Frito-Lay manufacturers potato chips, for other mainline products or brands they outsource all or a majority of the production. This is especially true of corn chips (an extrusion process) and caramel popcorn. For example, they contract all of their Cracker Jack™ production to Wyandot, Inc in Marion, Ohio. Stylized facts indicate that over time the arrangement meets the Frankel, Goldsby, and Whipple five factor test and allows Frito-Lay to off-load some of their R&D expense to Wyandot. There is an interfirm vertical tie rich in information sharing, to the point that the contract producer knows the corporate strategy of Frito-Lay. The arrangement appears to be at least a microcosm of a true learning supply chain involving agrifood firms.

the relationships among KM and network embeddedness with the eventual link to corporate strategy.

Business and social networks form as a natural outcome of social capital. These business and social networks can be analyzed using the concepts of relational and structural embeddedness (Gulati, 1998; Rowley, Behrens and Krackhardt, 2000). Network embeddedness, composed of either structural embeddedness or relational embeddedness, can influence a firm's interfirm relationships and can affect the design and implementation of strategy relating to quality signaling in supply chains (Sporleder and Goldsmith, 2002). Contemporary thought among analysts is that the firms that are better connected in their networks have a competitive advantage over firms with weaker ties to networks.[4]

An exciting and novel avenue for analysis of agrifood corporate strategy within supply chains lies with the insight that can be provided through network embeddedness. The competitive environment may change the type of social capital that generates optimal sustainable competitive advantage. Corporate strategy may exhibit tension between exploration versus exploitation. The exploration strategy means that firms develop new products, processes, routines, or strategies. The exploitation strategy means that firms generate returns from existing products, processes, and routines. Prevailing thought is that firms that engage in the strategy of knowledge exploitation, rather than knowledge exploration, need the specific know-how that is best obtained from dense network

[4] Structural and relational embeddedness have been recently defined and discussed by numerous analysts and hence the discussion will not be repeated here. For details see Sporleder and Goldsmith, 2002; Rowley, Behrens and Krackhardt, 2000; Lazzarini, et al, 2002; Sporleder and Moss, 2002; Gulati, 1998; and Ng, 2002.

structures (Rowley, Behrens, and Krackhardt, 2000). In addition, dense networks may lead managers to ignore new information and alternatives external to the network (Nahapiet and Ghoshal, 1998).

In terms of corporate strategy, Sporleder and Moss have previously identified some characteristics unique to the environment in which agrifood firms operate within supply chains. They argue that relatively less dense networks exist in food distribution and there is an exploration focus of large food manufacturers. They characterize the food industry supply chain in the United States as one of weak ties (the relational embeddedness dimension), and sparse networks (the structural embeddedness dimension). As such, the typical characteristics of the supply chain are agrifood firms with comparatively low embeddedness, low social capital, and relatively low levels of trust, with substantial corporate and human tacit knowledge that is difficult to exchange. These characteristics are the antithesis of an environment in which KM could be effectively implemented.

The present authors would suggest that intangibles, especially in the form of substantial brand equity, influence the agrifood firm's corporate strategy of exploration versus exploitation. The relationship posited is that agrifood firms that possess substantial brand equity tend to engage in exploration activities relatively more than exploitive activities[5]. Food supply chains have relatively large numbers of transactions, significant exploitive innovation, and a high degree of new food product failure (about 2 out of 3). It is interesting to note that

[5] Or alternatively, firms that historically have emphasized exploration activities relative to exploitation activities possess greater levels of brand equity, ceterus paribus.

large food manufacturers, such as Heinz and Campbell Soup, may engage in exploration relatively more compared to large grocery retailers, such as Kroger, that engage in exploitation through the introduction of imitative private label brands. Sporleder and Moss report that access to top management of large retailers increases dramatically when the food processors possess significant brand equity, thereby enhancing both structural and relational embeddedness.

Intangible assets, especially those in the form of category-leading brands, may change the fundamental characteristics of the supply chain to strong ties and close networks. Some of the specific characteristics would be high embeddedness, high social capital, more easily exchanged tacit knowledge, and higher levels of trust. These characteristics are entirely consistent with KM and learning.

The main point would be that KM logic suggests that corporate strategy, especially the optimal mix between exploration and exploitation, may be linked to embeddedness and thereby influence the type of learning supply chain that could result from vertical coordination mechanisms or particular interfirm vertical ties. This logic forms the embryonic stages of an exciting new dimension to the analysis of agrifood supply chains and is worthy of substantial future investigation.

Real Options and Knowledge Management

The analysis to this point strongly suggests that the critical benefit of KM and learning is enhanced organizational responsiveness. That is, an organization can bend and adapt to its economic environment in strategically

superior ways. KM gives firms and supply chains greater capacity to be dynamic, it helps reduce the constraints of embeddedness, and it enables strategies of exploration. How can the value of this responsiveness be adequately measured qualitatively or quantitatively?

Real options theory, yet another stream of management literature, may be helpful in answering the valuation question for knowledge management. The real options literature has arisen from a thorough critique of existing capital budgeting techniques. Traditional discounted-cash-flow analysis of investment decisions assumes that cash flows can be estimated at the outset of an investment, even if they are uncertain, and that managerial decisions once made about the investment are irreversible. These assumptions are often flawed (Kester, Myers, Trigeorgis). In real life, as uncertainty is resolved and competitive interactions emerge across time, managers can alter the pattern of the cash flows by deferring, expanding, contracting, abandoning, or in some other way changing the nature of the investment project (Trigeorgis).

This managerial flexibility to change course as events unfold is said to give rise to *real options*-- the ability to improve an investment's upside returns or to limit its downside loses by making a sequence of decisions rather than just one initial decision. The resulting altered pattern of the real cash flows that arise from the exercise of managerial flexibility behaves like a financial option, either a put or a call, and thus the derivation of the term, real option. Because of the asymmetric nature of the option decision (exercise the option if it is valuable and do not exercise it if it is not), an investment having real options embedded in it is more valuable than one that does not. To truly value an investment project, one must calculate both "the traditional (static or passive) NPV of direct cash flows and the option value of operating flexibility and strategic interactions" (Trigeorgis, p 4).

Kester decomposed the stock value of various publicly traded firms into two parts-their capitalized value of earnings (a DCF valuation) and their residual value above this base. He argued that the residual was a measure of the embedded growth options available to the firms. Growth option value exceeded 50% of total market value for many firms in the study. For the three food firms in the study, the option value ranged from 11% to 46% of value. The ability of one investment to open the option for subsequent investments or to have its initial estimated returns improved through dynamic decision making would appear to add substantially to firm value.

Various analytic and numeric models for valuing real options have been developed (Trigeorgis). All of these valuation methods suggest that the value of a real option (as with financial options) is explained by several critical variables, including the price of obtaining or creating the option, the price of the underlying investment, the exercise price, the time to maturity of the option, and the underlying risk or uncertainty in the investment. Two of these variables are particularly relevant to this KM analysis-- the time to maturity and the underlying uncertainty.

Unlike a financial option, the time to maturity for a real option can be altered by changing market circumstances, e.g., whether others share the option in an industry or the intensity of the competition (Kester). Therefore, judging when or if a real option should be exercised is a complex decision. Knowledge and learning can assist in resolving endogenous uncertainty related to investments and thus alter the time to maturity of an option. If a firm through KM is more aware of and responsive to market changes, it can develop a superior ability to understand and act upon the moments of decision that propel the exercise of any real option related to the knowledge discovered. Getting first-

mover advantage when the exercise of the option is valuable and walking away with it is not would give a firm potentially significant competitive advantage.

KM can also influence the uncertainty of the underlying investment opportunity in another way. A firm could rely upon KM and learning to create an ever-expanding portfolio of real options. KM could be used to deliberately generate or, at the very least, anticipate valuable additional decision points in the future. Each decision point results in a new option that can be exercised or not to produce enhanced value. One example of this option generating capability would be a particularly effective research and development pipeline within a firm. Rather than merely resolving existing uncertainties as suggested by KM's influence on time to maturity, this second influence of KM on option value relies on increasing future uncertainty by expanding the possible set of outcomes in a deliberate and strategic manner.

This first attempt to link knowledge management and real options is merely enough to suggest that further exploration of the interrelationship between the two fields would seem useful. In particular, if KM leads to enhanced real option values for firms and for supply chains, then the real option valuation models can be used to estimate in a more concrete way the value of KM and learning. It is one thing to speculate about the benefits of KM, but quite another to discover its underlying value creation mechanism and move toward quantifying its value. Building individual firm and supply chain strategies based on knowledge management and learning will only happen if benefits can be more clearly measured.

Summary and Conclusions

Knowledge management is an integrated approach to identifying, creating, managing, sharing, and exploiting all of the information and knowledge assets of an organization. Fundamental aspects of KM include skill acquisition, learning, and the accumulation of capability over time within an organization. The analysis here adopts KM logic in an effort to make more informed corporate strategy decisions. Corporate strategy is directly linked to social capital and network embeddedness along with learning and real options.

The intellectual capital of an organization has three components: structural capital, social capital, and human capital. One difference among these capital types is ownership. Structural capital, such as plant and equipment, is the sole capital type owned exclusively by the firm. Employees of the firm earn income from renting their capacity to the firm, but employees own their intellectual capital, not the firm. Both structural capital and human capital are principally internal to the firm whereas social capital adds an external aspect to the total intellectual capital of an organization.

KM and learning provide novel approaches to the analysis of agrifood firms and agrifood corporate strategy. Three types of learning supply chains are defined: (1) the chain master, (2) the chain web, and (3) the chain organism. The *chain master* model is where one dominant firm, the chain master, specifies the terms of trade across the entire supply chain, and the supply chain's performance is driven primarily by the coordinating skill of this firm. Examples of this model include the "integrators" found in many agrifood chains (e.g., Tyson, Purdue, and

Smithfield). This chain type is effective at coordinating behavior (imposing a governance structure) largely based on specification contracts that keep supporting suppliers focused on a limited number of product attributes.

As a learning supply chain, the chain master model suffers incentive problems inconsistent with KM. Consider tournament contracts in integrated pork or poultry chains as an example. Incentives are high to keep knowledge proprietary to the producer rather than share it for the benefit of the chain. Such proprietary knowledge is one of the few protections that the less dominant firms in the chain would have against the behavior of the chain master. One would predict that a supply chain with a chain master would only be as responsive and dynamic as the chain master.

The second model of the integrated supply chain, the *chain web*, is a web of interfirm relationships continually changing shape, dimension, and membership. Individual firms in the web may be members of multiple supply chains and compete with others outside their respective supply chains. The chain web assures responsiveness to particular end-user needs but as a learning supply chain, the chain web and the chain master models fail in regard to incentives or as governance structures.

The third integrated supply chain model, the *chain organism*, is a chain that competes as one dynamic organism. As a distinguishing feature from the chain master model, no firm dominates the chain. Each firm shares in the decision-making and acts in a truly collective manner. Toyota and its system of suppliers as a high-performance knowledge-sharing network is a documented

example of a learning supply chain. The Toyota system has solved the incentive dilemmas that exist in the other chain models.

As a potential example in the agrifood supply chain, the relationship between Frito-Lay and at least one of their suppliers is a possible microcosm of a true learning supply chain involving agrifood firms. There is an interfirm vertical tie rich in information sharing, to the point that the contract producer knows the corporate strategy of Frito-Lay. Frito-Lay contracts all of their Cracker Jack™ production to Wyandot, Inc. The arrangement appears to meet the Frankel, Goldsby, and Whipple five-factor test and allows Frito-Lay to off-load some of their R&D expense to Wyandot.

Corporate strategy can also be directly linked to social capital and network embeddedness. One consequence of the explicit recognition and analysis of social capital extends to networks and network embeddedness. The competitive environment may change the type of social capital that generates optimal sustainable competitive advantage. Corporate strategy may exhibit tension between exploration versus exploitation. Firms that engage in the strategy of knowledge exploitation, rather than knowledge exploration, need the specific know-how that is best obtained from dense network structures.

Relatively less dense networks exist in food distribution and there is an exploration focus of large food manufacturers. The food industry supply chain in the United States has weak ties and sparse networks. As such, the typical characteristics of the supply chain are agrifood firms with comparatively low embeddedness, low social capital, and relatively low levels of trust, with substantial corporate and human tacit knowledge that is difficult to exchange. A

major implication of the present analysis is that intangibles, especially in the form of substantial brand equity, influence the agrifood firm's corporate strategy of exploration versus exploitation. If agrifood firms possess substantial brand equity then they tend to engage in exploration activities relatively more than exploitive activities. It is interesting to note that large food manufacturers with national brands, such as Heinz and Campbell Soup, may engage in exploration relatively more compared to large grocery retailers, such as Kroger, that engage in exploitation through the introduction of imitative private label brands.

Real options have rapidly emerged as new decision logic to guide managers faced with uncertainty and irreversibility. Managerial flexibility to change course as events unfold creates *real options*-- the ability to improve an investment's upside returns or to limit its downside loses by making a sequence of decisions rather than just one initial decision. Because of the asymmetric nature of the option decision, i.e. exercise the option if it is valuable and do not exercise it if it is not, an investment having real options embedded in it is more valuable than one that does not.

Unlike a financial option, changing market circumstances e.g. can alter the time to maturity for a real option, whether others share the option in an industry or the intensity of the competition. Therefore, judging when or if a real option should be exercised is a complex decision. *Knowledge* and *learning* can assist in resolving endogenous uncertainty related to investments and thus alter the time to maturity of an option. If a firm through KM is more aware of and responsive to market changes, it can develop a superior ability to understand and act upon the moments of decision that propel the exercise of any real option related to the

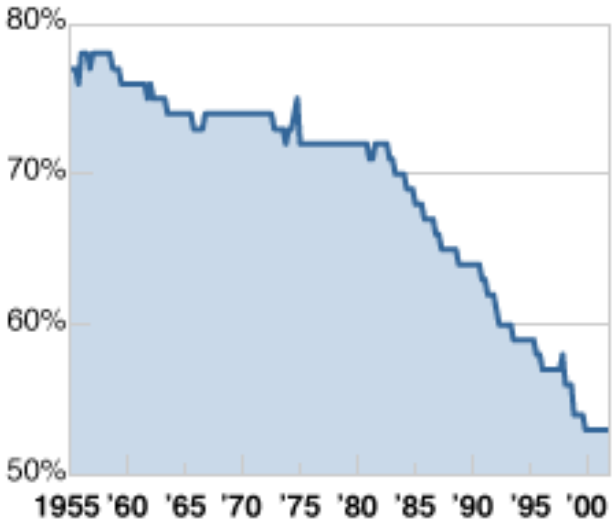
knowledge discovered. Getting first-mover advantage when the exercise of the option is valuable and walking away with it is not would give a firm potentially significant competitive advantage.

KM can also influence the uncertainty of the underlying investment opportunity in another way. A firm could rely upon KM and learning to create an ever-expanding portfolio of real options. KM could be used to deliberately generate valuable additional decision points where each decision point results in a new option produce enhanced value. One example of this option generating capability would be a particularly effective research and development pipeline within a firm. Rather than merely resolving existing endogenous uncertainties as suggested by KM's influence on time to maturity, this second influence of KM on option value relies on increasing future uncertainty by expanding the possible set of outcomes in a deliberate and strategic manner.

This first attempt to link knowledge management and real options is made in the present analysis. Clearly, if KM leads to enhanced real option values for firms and for supply chains, then the real option valuation models can be used to estimate the value of KM and learning.

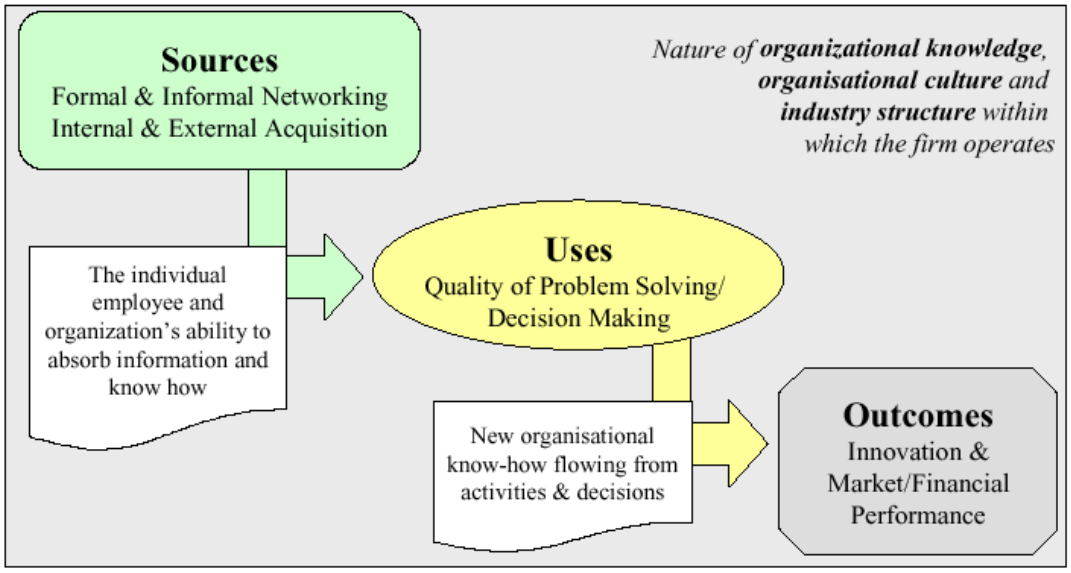
Building individual firm and supply chain strategies based on knowledge management and learning is a promising avenue for analysts. Those engaged in crafting future corporate strategy will gain useful insight into the optimal mix of competing corporate strategies when a KM view and KM logic is adopted by decision-makers. Unmistakably, KM is an emerging field that can potentially assist analysts in understanding the agrifood supply chain and agrifood corporate strategy.

Figure 1. Tangible Assets as a Percent of All Assets Of Nonfinancial Businesses, United States, 1955-2001



Source: Federal Reserve Board

Figure 2. A Model of Organizational Knowledge Creation and Performance



Source: Soo et al, 2001, p. 4

References

Bontis, N. "Intellectual Capital: An Exploratory Study that Develops Measures and Models." *Management Decision* 36(1998): 63-76.

Cohen, W. M. and D. A. Levinthal. "Absorptive Capacity: A New Perspective on Learning and Innovation." *Administrative Science Quarterly* 35(1990): 128-152.

Conner, K. R. and C. K. Prahalad. "A Resource-Based Theory of the Firm" in *The Strategic Management of Intellectual Capital and Organizational Knowledge*. C. W. Choo and N. Bontis, eds., pp. 103-131 (New York, New York: Oxford University Press, 2002).

de Vries, E.J., and H.G. Brijder. "Knowledge Management in Hybrid Supply Channels: A Case Study," *International Journal of Technology Management*, Vol. 20, Nos. 5/6/7/8/, 2000, pp. 569-587.

Dyer, J.H. and K. Nobeoka. "Creating and Managing a High-Performance Knowledge-Sharing Network: The Toyota Case," *Strategic Management Journal*, 21(2000), pp. 345-367.

Frankel, R., T.J. Goldsby, and J.M. Whipple. "Grocery Industry Collaboration in the Wake of ECR," *International Journal of Logistics*, Vol. 13, No. 1, 2002, pp. 1-16.

Grant, R. M. "The Knowledge-Based View of the Firm" in *The Strategic Management of Intellectual Capital and Organizational Knowledge*. C. W. Choo and N. Bontis, eds., pp. 133-148 (New York, New York: Oxford University Press, 2002) .

Gulati, R. "Alliances and Networks." *Strategic Management Journal.* 19(1998): 293-317.

Ives, W., B. Torrey, and C. Gordon. "Knowledge Sharing Is a Human Behavior," *Knowledge Management: Classic and Contemporary Works*, The MIT Press, Cambridge, MA, pp. 99-131.

Kester, W.C. "Today's Options for Tomorrow's Growth," *Harvard Business Review*, 62 (2, 1984): 153-160.

King, R.P. *Supply Chain Design for Identity Preserved Agricultural Products*, Seminar Paper, University of Minnesota, January 21, 2000.

Lazzarini, S. G., F. R. Chaddad, and M. L. Cook. "Integrating Supply Chain and Network Analysis: The Study of Netchains." *Chain and Network Science* 1(2001): 7-22.

Lee, C.C. and J. Yang. "Knowledge Value Chain," *Journal of Management Development*, Vol. 19, No. 9, 2000, pp. 783-793.

Mason-Jones, R. and D.R. Towill. "Total Cycle Time Compression and the Agile Supply Chain," *International Journal of Production Economics*, 62(1999), pp. 61-73.

Myers, S.C. "Finance Theory and Financial Strategy, *Interfaces*, 14 (1984): 126-137.

Nahapiet, J. and S. Ghoshal. "Social Capital, Intellectual Capital, and the Organizational Advantage." *Academy of Management Review* 23, no. 2(1998): 242-266.

National Research Council, Committee on Supply Chain Integration. *Surviving Supply Chain Integration: Strategies for Small Manufacturers,* National Academy Press, Washington, DC, 2000.

Peterson, H.C. "The 'Learning' Supply Chain: Pipeline or Pipedream?," *Amer. J. Agr. Econ.*, 84 (Number 5, 2002): 1329-1336.

Reinhardt, R. "Knowledge Management: Linking Theory with Practice." *Knowledge Management: Classic and Contemporary Works*. D. Morey, M. Maybury, and B. Thuraisingham, ed. pp. 187-221. (Cambridge, MA, MIT Press, 2000).

Rice, Jr., J.B. and R.M. Hoppe. "Supply Chain Versus Supply Chain: The Hype and the Reality," *Supply Chain Management Review*, September-October, 2001.

Rowley, T. J., D. Behrens, and D. Krackhardt. "Redundant Governance Structures: An Analysis of Structural and Relational Embeddedness in the Steel and Semiconductor Industries." *Strategic Management Journal* 21(2000): 369-386.

Seemann, P., David DeLong, S. Stukey, and E. Guthrie. "Building Intangible Assets: A Strategic Framework for Investing in Intellectual Capital, " *Knowledge Management: Classic and Contemporary Works*, The MIT Press, Cambridge, MA, pp. 85-98.

Seemann, P., et al. "Building Intangible Assets: A Strategic Framework for Investing in Intellectual Capital." *Knowledge Management: Classic and Contemporary Works*. D. Morey, M. Maybury, and B. Thuraisingham, ed. pp. 85-98. (Cambridge, MA, MIT Press, 2000).

Senge, P. "The Leader's New Work: Building Learning Organizations," *Knowledge Management: Classic and Contemporary Works*, The MIT Press, Cambridge, MA, pp. 19-52.

Skyrme, D.J. "Developing a Knowledge Strategy: From Management to Leadership," Takeuchi, Hirotaka and I. Nonaka, "Theory of Organizational Knowledge Creation," *Knowledge Management: Classic and Contemporary Works*, The MIT Press, Cambridge, MA, pp. 61-84.

Soo, C., T. Devinney, D. Midgley, and A. Deering. "Knowledge Management: Philosophy, Process, Pitfalls, and Performance." Working Paper, INSEAD, Fontainebleau, France, January 2001.

Sporleder, T. L. "Intellectual Property Driven Vertical Network Alliances within the Global Food System." in *Agricultural Law Seminar Proceedings*, Agricultural Law Committee, Ohio State Bar Association, Dayton, OH, May 2001, pp. 5.1-5.16.

Sporleder, Thomas L. "Brand Equity in the Global Food System" *Journal of Food Distribution Research*. 34(2003): forthcoming.

Sporleder, Thomas L. and LeeAnn E. Moss. "Knowledge Management in the Global Food System: Network Embeddedness and Social Capital" *American Journal of Agricultural Economics*, 84(Number 5, 2002): 1345-1352.

Sporleder, Thomas L. and Peter D. Goldsmith. "Network Embeddedness in the Food Supply Chain and Firm Strategy on Signaling Quality." *Paradoxes in Food Chains and Networks*. J. H. Trienekens and S. Omta, eds., pp. 720-728. (The Netherlands: Wageningen Academic Publishers, 2002).

Takeuchi, H. and I. Nonaka. "Theory of Organizational Knowledge Creation," *Knowledge Management: Classic and Contemporary Works*, The MIT Press, Cambridge, MA, pp. 139-182.

Teece, D. J. *Managing Intellectual Capital.* (New York, New York: Oxford University Press), 2000.

Trigeorgis, L., *Real Options-Managerial Flexibility and Strategy in Resource Allocation*, Cambridge, Massachusetts: The MIT Press, 1996.

von Krogh, G. and S. Grand. "from Economic Theory toward a Knowledge-Based Theory of the Firm" in *The Strategic Management of Intellectual Capital and Organizational Knowledge*. C. W. Choo and N. Bontis, eds., pp. 163-184 (New York, New York: Oxford University Press, 2002).